RATE BASE OVERVIEW

1. INTRODUCTION

This Schedule provides an overview of Hydro Ottawa's distribution rate base and a discussion of year-over-year variances. Variance explanations are provided for program costs with variances greater than $1M, consistent with the materiality threshold that the utility is employing for purposes of this Application.

In accordance with the OEB's *Chapter 2 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications*, dated December 9, 2024, this Schedule provides yearly information on Hydro Ottawa's rate base, including information on forecast net fixed assets, calculated on a mid-year average basis, along with working capital allowance (WCA). Net fixed assets are gross assets in service minus accumulated amortization and contributed capital.

The capital expenditure plan for the 2026-2030 period is outlined in Schedule 2-5-1 - Distribution System Plan Overview, Schedule 2-5-5 - Capital Expenditure Plan and Schedules 2-5-6 - System Access Investments, 2-5-7 - System Renewal Investments, 2-5-8 - System Service Investments, and 2-5-9 - General Plant Investments. The in-service additions included in rate base are not equal to capital expenditures outlined in Schedule 2-5-5 - Capital Expenditure Plan, as some expenditures start in one year and are energized in a different year, including outside the Custom IR period.

Details regarding WCA can be found in Schedule 2-3-1 - Working Capital Requirement.

2. SUMMARY OF 2021-2025 OEB-APPROVED AND ACTUAL RATE BASE

Table 1 below shows Hydro Ottawa's OEB-Approved rate base values for 2021-2025, as per the 2021-2025 Approved Settlement Agreement.[1] Table 1 provides the opening, closing, and average balances for gross assets and accumulated depreciation. The table further provides the closing approved balance for net fixed assets and Hydro Ottawa's WCA.

Table 1 – Summary of Approved Rate Base 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Opening Gross Assets	$ 1,358,887	$ 1,507,478	$ 1,626,152	$ 1,700,252	$ 1,779,853
Closing Gross Assets	$ 1,507,478	$ 1,626,152	$ 1,700,252	$ 1,779,853	$ 1,896,452
Average Gross Assets	**$ 1,433,182**	**$ 1,566,815**	**$ 1,663,202**	**$ 1,740,052**	**$ 1,838,152**
Opening Accumulated Depreciation	$ (275,287)	$ (324,639)	$ (377,881)	$ (433,247)	$ (490,428)
Closing Accumulated Depreciation	$ (324,639)	$ (377,881)	$ (433,247)	$ (490,428)	$ (551,211)
Average Accumulated Depreciation	**$ (299,963)**	**$ (351,260)**	**$ (405,564)**	**$ (461,838)**	**$ (520,820)**
Opening Net Book Value	$ 1,083,600	$ 1,182,840	$ 1,248,271	$ 1,267,004	$ 1,289,424
Closing Net Book Value	$ 1,182,840	$ 1,248,271	$ 1,267,004	$ 1,289,424	$ 1,345,241
Average Net Book Value	**$ 1,133,220**	**$ 1,215,555**	**$ 1,257,638**	**$ 1,278,214**	**$ 1,317,333**
Working Capital Allowance	$ 85,459	$ 88,279	$ 91,546	$ 95,940	$ 99,394
RATE BASE	**$ 1,218,679**	**$ 1,303,835**	**$ 1,349,183**	**$ 1,374,154**	**$ 1,416,727**

Table 2 below summarizes Hydro Ottawa's rate base for Historical Years 2021-2023, and Bridge Years 2024 and 2025.

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Settlement Agreement*, EB-2019-0261 (September 18, 2020).

Table 2 AS ORIGINALLY SUBMITTED – Summary of Historical and Bridge Year Rate Base 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Opening Gross Assets	$ 1,345,265	$ 1,469,459	$ 1,607,631	$ 1,692,408	$ 1,810,056
Closing Gross Assets	$ 1,469,459	$ 1,607,631	$ 1,692,408	$ 1,810,056	$ 1,931,368
Average Gross Assets	**$ 1,407,362**	**$ 1,538,545**	**$ 1,650,020**	**$ 1,751,232**	**$ 1,870,712**
Opening Accumulated Depreciation	$ (271,071)	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)
Closing Accumulated Depreciation	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)	$ (545,380)
Average Accumulated Depreciation	**$ (295,928)**	**$ (346,666)**	**$ (399,750)**	**$ (455,759)**	**$ (514,973)**
Opening Net Book Value	$ 1,074,194	$ 1,148,674	$ 1,235,084	$ 1,265,454	$ 1,325,491
Closing Net Book Value	$ 1,148,674	$ 1,235,084	$ 1,265,454	$ 1,325,491	$ 1,385,988
Average Net Book Value	**$ 1,111,434**	**$ 1,191,879**	**$ 1,250,269**	**$ 1,295,472**	**$ 1,355,739**
Working Capital Allowance	$ 70,733	$ 71,503	$ 71,908	$ 73,914	$ 75,171
RATE BASE	**$ 1,182,167**	**$ 1,263,382**	**$ 1,322,177**	**$ 1,369,386**	**$ 1,430,910**

Table 2 UPDATED JUNE 4, 2025 – Summary of Historical and Bridge Year Rate Base 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	**2022**	**2023**	**2024**	**2025**
Opening Gross Assets	$ 1,345,265	$ 1,469,459	$ 1,607,631	$ 1,692,408	$ 1,810,056
Closing Gross Assets	$ 1,469,459	$ 1,607,631	$ 1,692,408	$ 1,810,056	$ 1,931,368
Average Gross Assets	**$ 1,407,362**	**$ 1,538,545**	**$ 1,650,020**	**$ 1,751,232**	**$ 1,870,712**
Opening Accumulated Depreciation	$ (271,071)	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)
Closing Accumulated Depreciation	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)	$ (545,380)
Average Accumulated Depreciation	**$ (295,928)**	**$ (346,666)**	**$ (399,750)**	**$ (455,759)**	**$ (514,973)**
Opening Net Book **Value**	$ 1,074,194	$ 1,148,674	$ 1,235,084	$ 1,265,454	$ 1,325,491
Closing Net Book Value	$ 1,148,674	$ 1,235,084	$ 1,265,454	$ 1,325,491	$ 1,385,988
Average Net Book Value	**$ 1,111,434**	**$ 1,191,879**	**$ 1,250,269**	**$ 1,295,472**	**$ 1,355,739**
Working Capital Allowance	$ 70,733	$ 71,503	$ 71,908	$ 73,992	$ 75,249
RATE BASE	**$ 1,182,167**	**$ 1,263,382**	**$ 1,322,177**	**$ 1,369,464**	**$ 1,430,988**

Table 3 below shows the variances between the OEB-Approved rate base amounts as shown in Table 1 and the Historical Year and Bridge Year amounts as shown in Table 2 for the 2021-2025 period.

1 **Table 3 AS ORIGINALLY SUBMITTED – Variances in 2021-2025 Rate Base - OEB-Approved**
2 **vs. Historical and Bridge Year Amounts ($'000s)**

	Historical Years			Bridge Years	
	2021	**2022**	**2023**	**2024**	**2025**
Opening Gross Assets	$ (13,622)	$ (38,019)	$ (18,521)	$ (7,844)	$ 30,203
Closing Gross Assets	$ (38,019)	$ (18,521)	$ (7,844)	$ 30,203	$ 34,916
Average Gross Assets	**$ (25,820)**	**$ (28,270)**	**$ (13,182)**	**$ 11,180**	**$ 32,560**
Opening Accumulated Depreciation	$ 4,216	$ 3,854	$ 5,334	$ 6,293	$ 5,863
Closing Accumulated Depreciation	$ 3,854	$ 5,334	$ 6,293	$ 5,863	$ 5,831
Average Accumulated Depreciation	**$ 4,035**	**$ 4,594**	**$ 5,814**	**$ 6,079**	**$ 5,847**
Opening Net Book Value	$ (9,406)	$ (34,166)	$ (13,187)	$ (1,550)	$ 36,067
Closing Net Book Value	$ (34,166)	$ (13,187)	$ (1,550)	$ 36,067	$ 40,747
Average Net Book Value	**$ (21,786)**	**$ (23,676)**	**$ (7,369)**	**$ 17,258**	**$ 38,406**
Working Capital Allowance	$ (14,726)	$ (16,776)	$ (19,638)	$ (22,026)	$ (24,223)
RATE BASE	**$ (36,512)**	**$ (40,453)**	**$ (27,006)**	**$ (4,768)**	**$ 14,183**

3

Table 3 UPDATED JUNE 4,2025 – Variances in 2021-2025 Rate Base - OEB-Approved vs. Historical and Bridge Year Amounts ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Opening Gross Assets	$ (13,622)	$ (38,019)	$ (18,521)	$ (7,844)	$ 30,203
Closing Gross Assets	$ (38,019)	$ (18,521)	$ (7,844)	$ 30,203	$ 34,916
Average Gross Assets	**$ (25,820)**	**$ (28,270)**	**$ (13,182)**	**$ 11,180**	**$ 32,560**
Opening Accumulated Depreciation	$ 4,216	$ 3,854	$ 5,334	$ 6,293	$ 5,863
Closing Accumulated Depreciation	$ 3,854	$ 5,334	$ 6,293	$ 5,863	$ 5,831
Average Accumulated Depreciation	**$ 4,035**	**$ 4,594**	**$ 5,814**	**$ 6,079**	**$ 5,847**
Opening Net Book Value	$ (9,406)	$ (34,166)	$ (13,187)	$ (1,550)	$ 36,067
Closing Net Book Value	$ (34,166)	$ (13,187)	$ (1,550)	$ 36,067	$ 40,747
Average Net Book Value	**$ (21,786)**	**$ (23,676)**	**$ (7,369)**	**$ 17,258**	**$ 38,406**
Working Capital Allowance	$ (14,726)	$ (16,776)	$ (19,638)	$ (21,948)	$ (24,145)
RATE BASE	**$ (36,512)**	**$ (40,453)**	**$ (27,006)**	**$ (4,690)**	**$ 14,261**

Hydro Ottawa's rate base in 2025 is approximately $14.2M higher than the OEB-Approved amount, driven mainly by higher in-service additions over the period, offset by a reduction in the WCA compared to the OEB-Approved amount. Please refer to Table 4 below for details.

3. IN-SERVICE CAPITAL ADDITIONS VARIANCE

Table 4 below shows the variances between the OEB-Approved Net In-Service Capital Additions and the Historical Year and Bridge Year amounts for the 2021-2025 period. The in-service additions were $45M (or 8%) above the OEB-Approved amounts over the historical period.

For additional details at the capital expenditures level, refer to Schedule 2-5-5 - Capital Expenditure Plan.

Table 4 – Variances in 2021-2025 Net In-Service Capital Additions - OEB-Approved vs. Historical and Bridge Year Amounts ($'000s)[2]

	2021-2025 OEB Approved	2021-2025 Historical/Bridge	Var. ($)	Var (%)
System Access	$ 86,018	$ 114,733	$ 28,715	33%
System Renewal	$ 211,821	$ 239,167	$ 27,346	13%
System Service	$ 142,375	$ 144,242	$ 1,867	1%
General Plant	$ 114,837	$ 101,822	$ (13,015)	(11)%
NET IN-SERVICE ADDITIONS	**$ 555,052**	**$ 599,963**	**$ 44,912**	**8%**

The major drivers of the higher in-service additions are as follows:

(i) Unprecedented Supply Chain Disruption: The 2021-2025 period witnessed an unprecedented confluence of global events, severely disrupting supply chains and driving inflationary pressures. The COVID-19 pandemic initiated widespread logistical challenges, exacerbated by surging demand for essential electrical equipment. Subsequent economic factors and shipping bottlenecks compounded these issues. Critically, the war in Ukraine also introduced a significant constraint on the availability of grain-oriented electrical steel, a vital component for transformer cores, further impacting material availability and costs. As noted in Schedule 1-2-5 - Impacts of Inflationary Pressure, Canada's inflation rate in the 2020-2024 period as measured by CPI was the highest in 40 years. Also with respect to capital costs, the approved plan did not include any amounts forecast for inflation, nor did it include any cost escalation adjustment mechanisms. Essentially the capital plan assumed that a modest level of inflation would continue and the impact of any inflation would be offset by productivity and efficiency savings. Furthermore, the 2022-2025 capital related revenue requirement was reduced by a cumulative annual 0.6% capital stretch factor as outlined in Section 8.

[2] Totals may not sum due to rounding.

(ii) Customer Connections Volume, Complexity, and Cost: an unprecedented increase in the volume and complexity of non-discretionary residential subdivision customer connections due to a combination of residential intensification and a growing demand for electricity.

(iii) Unforeseen Externally-Driven Projects: driven mainly by the unprecedented increase in the volume and cost of residential subdivision and commercial development customer connections, as well as several large plant relocation works involving major revitalizations on Bank Street and Montreal Road, as well as other large plant relocation works related to Phase II of the Light Rail Transit (LRT) project.

(iv) Increased Emergency Renewal Work due to Major Storms and Equipment Failure: Emergency Renewal capital expenditures that significantly exceeded historical levels were driven largely by the devastating 2022 Derecho (which became the 6th costliest natural disaster in Canada's history), other major storms, and a general increase in the amount and cost of equipment that needed to be replaced on an emergency, reactive basis. The 2022 Derecho caused over 1,000 individual outages, left 180,000 customers without power, and resulted in restoration efforts spanning multiple weeks. Over 500 poles were damaged and required replacement. For more detail, please reference Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report. The Derecho was not the only adverse weather event Hydro Ottawa experienced in the 2021-2025 rate period. An ice storm in April 2023 also required capital investments to replace damaged infrastructure during the restoration efforts. Further details regarding the adverse weather events Hydro Ottawa experienced from 2021-2025 can be found in Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Additionally, Hydro Ottawa experienced an increase in reactive capital expenditures to address failing equipment.

In response to these challenges, Hydro Ottawa implemented proactive financial management strategies, notably deferring certain planned projects such as Major Station Rebuilds, Voltage

Conversions, Enterprise Resource Planning (ERP) Upgrades, and Underground Switchgear Renewals. For additional details, refer to Section 4.1.3 of Schedule 2-5-5 DSP - Capital Expenditure Plan Section. Furthermore, Hydro Ottawa's labour productivity initiatives, as described in Schedule 1-3-4 - Facilitation Innovation and Continuous Improvement, played a crucial role in mitigating the overall financial impact. Without these initiatives, the net capital additions variance of $44.9M against the OEB-Approved budget would have been considerably higher. It is also worth noting that Hydro Ottawa did not apply for a Z factor during the 2021-2025 period.

The following Sections 3.1 through 3.4 provide details on the in-service capital additions variance by Investment Category on a five year total basis, while Section 4 provides a year-over-year variance analysis.

3.1. SYSTEM ACCESS IN-SERVICE CAPITAL ADDITIONS VARIANCE

Capital additions related to System Access over the 2021-2025 Rate Period are expected to be $28.7M higher than approved amounts. The variance detail by capital program is included in Table 5 below.

Table 5 – Variances in Net In-Service Capital Additions - System Access ($'000s)

Capital Program	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
Plant Relocation	$ 16,098	$ 22,292	$ 6,194	38%
System Expansion	$ 26,906	$ 24,995	$ (1,911)	(7)%
Corrective Renewal	$ 412	$ 1,365	$ 952	231%
Customer Connections	$ 37,049	$ 64,141	$ 27,092	73%
Generation Connections	$ 710	$ 342	$ (368)	(52)%
Metering	$ 4,843	$ 1,599	$ (3,245)	(67)%
TOTAL ADDITIONS	**$ 86,018**	**$ 114,733**	**$ 28,715**	**33%**

A symmetrical capital variance account for capital additions for which the drivers are either plant relocation requested by 3rd parties or residential subdivision expansion was granted in Hydro Ottawa's 2021-2025 Custom IR Application. The remaining System Access spending, along with System Renewal / System Service and General Plant was tracked through an asymmetrical account.

Table 6 provides a breakdown of the OEB-Approved System Access in-service additions vs. Historical/Bridge amounts for 2021-2025 by the capital variance sub-account (symmetrical) and other (asymmetrical). The majority of the variance reflects the expected increase in residential and plant relocations.

Table 6 – Variances in Net In-Service Capital Additions - System Access by Capital Variance Sub-Account ($'000s)

Capital Variance Sub Account	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
Residential & Plant Relocation	$ 30,946	$ 60,862	$ 29,916	97%
Other	$ 55,072	$ 53,871	$ (1,201)	(2)%
TOTAL ADDITIONS	**$ 86,018**	**$ 114,733**	**$ 28,715**	**33%**

The main drivers of the residential subdivision and plant relocation variance are:

- **Residential Subdivision:** Capital Additions are expected to exceed approved amounts by $23.7M, driven primarily by actual annual volumes that were approximately 58% higher on average than forecasted volumes resulting from the City of Ottawa's intensification policies, and increases in unit costs per connection from $852 to $1,350 due to inflationary pressures.
- **Plant Relocation:** Capital additions are forecast to exceed approved amounts by $6.2M. The major drivers of the overage are scheduling delays related to the LRT Phase II Confederation Line, which led to projects completing in 2021-2025 that were originally assumed to complete in 2016-2020, post Phase I rehabilitation work on Slater & Albert streets, and the Bank Street Revitalization and Montreal Road Revitalization projects, along with inflationary increases.

The remaining capital additions under System Access were materially in-line with approved amounts for 2021-2025, with an overall shortfall vs. approved amounts of $1.2M. Further detail regarding System Access expenditures can be found in Section 5.1 of Schedule 2-5-5 - Capital Expenditure Plan.

3.2. SYSTEM RENEWAL IN-SERVICE CAPITAL ADDITIONS VARIANCE

Capital additions related to System Renewal over the 2021-2025 Rate Period are expected to be $27.3M over OEB-Approved amounts. Details by capital program are included in Table 7 below.

Table 7 – Variances in Net In-Service Capital Additions - System Renewal ($'000s)

Capital Program	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
Stations & Buildings Infrastructure Renewal	$ 47,244	$ 38,221	$ (9,023)	(19)%
Overhead Distribution Asset Renewal	$ 44,779	$ 42,825	$ (1,954)	(4)%
Underground Distribution Assets Renewal	$ 57,382	$ 62,846	$ 5,464	10%
Corrective Renewal	$ 49,326	$ 83,581	$ 34,255	69%
Metering Renewal	$ 13,091	$ 11,694	$ (1,396)	(11)%
Total Additions	**$ 211,821**	**$ 239,167**	**$ 27,346**	**13%**

Unplanned capital additions from restoration efforts in response to emergency storms accounted for $16.1M or 59% of the total $27.3M overage. Capital additions related to the 2022 Derecho totaled $15.1M while other major weather events, particularly the April 2023 ice storm, led to an additional $1.0M of unplanned capital additions. Note that in addition to capital expenditures, the nature of the storms also had a significant amount of operating and maintenance expenses as noted in Schedule 4-1-2 - Operations, Maintenance & Administration Program Costs and Section 6 of Schedule 2-5-5 - Capital Expenditure Plan.

The remaining $11.2M of the total $27.3M overage is driven largely by:

- **Stations and Buildings Infrastructure Renewal:** Forecasted capital additions are expected to be below approved amounts by approximately $9.0M due mainly to a scope change in the Fisher Station Rebuild project to a voltage conversion, and the deferral of the Dagmar Voltage conversion from 2023 to the 2026-2030 rate period. Refer to Section 5.2 of Schedule 2-5-5 - Capital Expenditure Plan for more details on these deferrals and scope changes.
- **Overhead Distribution Asset Renewal:** Despite overages in Planned Pole Renewal and System Renewal overall, active deferrals in Insulator Replacement and Overhead Switch programs are projected to keep capital additions $2.0M below the approved amount.
- **Underground Distribution Asset Renewal:** Forecasted capital additions are expected to exceed approved amounts by $5.5M, due largely to overages in the Cable Replacement program resulting from significantly higher than anticipated material price increases. Refer to Sections 3.3.2 and 4.2.1 of Schedule 1-2-5 - Impacts of Inflationary Pressure for more information.
- **Corrective Renewal (excluding the $16.1M storm costs discussed above):** The Emergency Renewal program experienced higher than OEB-Approved capital additions of approximately $12.5M related to distribution transformers. Hydro Ottawa observed a general trend/issue with leaking transformers related to a specific manufacturer and certain localized regions. The identified transformers had to be phased out and replaced, with the new transformers requiring bigger foundations. Emergency underground transformer replacements in 2024 cost as much as $122,481 when remediation and base replacement were required. This was a sharp contrast to the $25,648 average cost for emergency replacement without remediation or base replacements. Additionally, Emergency Poles capital additions are expected to exceed budgeted amounts by about $5.6M, driven largely by forecasts for 2024 and 2025 reflecting a 50% per-pole cost increase compared to actual

costs from 2021-2023, which is attributed to inflationary pressures and updated estimating methodologies.

- **Metering Renewal:** Bridge and Test Year capital additions for the Metering Renewal program are expected to be below OEB-Approved amounts by $1.4M; driven by persistent delays in acquiring Gatekeeper meters that were part of the Self-Contained Meter Phone Line Elimination project. Consequently, in 2024 the Gatekeeper solution was deemed unsuccessful, which resulted in the reduction of the Metering Renewal program in 2024 and 2025. The new solution will be addressed as part of Hydro Ottawa's Advanced Metering Infrastructure (AMI) 2.0 initiative planned for 2026-2030.

Further information on System Renewal expenditures can be found in Section 5.2.1 of Schedule 2-5-5 - Capital Expenditure Plan.

3.3. SYSTEM SERVICE IN-SERVICE CAPITAL ADDITIONS VARIANCE

Capital additions related to System Service over the 2021-2025 Rate Period are expected to be $1.9M over OEB-Approved amounts. Details by capital program are included in Table 9 below.

Table 9 – Variances in Net In-Service Capital Additions - System Service ($'000s)

Capital Program	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
Capacity Upgrades	$ 96,723	$ 92,290	$ (4,433)	(5)%
Stations Enhancements	$ 2,301	$ 2,601	$ 300	13%
Distribution Enhancements	$ 28,174	$ 26,397	$ (1,777)	(6)%
Grid Technologies	$ 8,867	$ 20,875	$ 12,008	135%
Field Area Network	$ 6,069	$ 2,077	$ (3,992)	(66)%
Metering	$ 240	$ 1	$ (239)	(100)%
Total Additions	**$ 142,375**	**$ 144,242**	**$ 1,867**	**1%**

- **Capacity Upgrades:** Capital additions are expected to be below OEB-Approved amounts by $4.4M, driven mainly by delays in the Riverdale Switchgear Upgrade project. The Riverdale Switchgear Upgrade was delayed due to necessary scope adjustments required to adhere to capacity planning requirements identified through area planning. Construction is scheduled to start in 2025, and energization is planned for 2026-2030.
- **Distribution Enhancements:** Capital additions are expected to be below OEB-Approved amounts by approximately $1.8M, due largely to project scope adjustments and reprioritization efforts.
- **Grid Technologies:** Capital additions are expected to exceed OEB-Approved amounts by approximately $12M, due largely to the replacements of Hydro Ottawa's Outage Management System (OMS) and Advanced Distribution Management System (ADMS). Once the ADMS initiative commenced, detailed planning revealed significant gaps in the original requirements. Specifically, the need for a dedicated project resource model, expanded professional services, and the crucial addition of schematics map conversion significantly broadened the project's scope. These discoveries, which emerged only during detailed implementation planning, necessitated immediate and substantial adjustments. Given the program's criticality to operational stability and cybersecurity, Hydro Ottawa made the strategic decision to prioritize the ADMS project, even at the cost of deferring other planned projects. Delaying these crucial upgrades was not a viable option due to the escalating risks. This strategic decision, while resulting in increased immediate costs, was essential to secure the future reliability and resilience of Hydro Ottawa's infrastructure, and to fully realize the vital benefits of the ADMS platform.

Hydro Ottawa notes that the ADMS program is currently undergoing a comprehensive review, and therefore specific details of the Grid Technology budget program, including the capital budget and timing of in-service additions, are subject to significant change. Updated information and supporting documentation related to the program will be filed with the responses to interrogatories. This approach ensures transparency and allows stakeholders to fully assess the program's potential impact and provide informed feedback within the rate application process. Additional details can be found in Section 5.3.2 of Schedule 2-5-5 - Capital Expenditure Plan.

- **Field Area Network:** Forecasted capital additions are expected to be below approved amounts by $4.0M due largely to project delays while awaiting a change by the Canadian Radio-television and Telecommunications Commission that would allow local distribution companies to deploy and operate wireless communication services, which hindered the purchase and installation of base stations and cellular-enabled field devices. Consequently, funds were redistributed to Grid Technologies to offset the overspend on the ADMS projects. Further information on System Service expenditures can be found in Section 5.3 of Schedule 2-5-5 - Capital Expenditure Plan.

3.4. GENERAL PLANT IN-SERVICE CAPITAL ADDITIONS VARIANCE

Capital additions related to General Plant over the 2021-2025 Rate Period are expected to be $13.0M below approved amounts. Details by capital program are included in Table 10 below.

Table 10 – Variances in Net In-Service Capital Additions - General Plant ($'000s)

Capital Program	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
CCRA	$ 60,964	$ 45,434	$ (15,529)	(25)%
Fleet Replacement	$ 16,536	$ 17,748	$ 1,212	7%
Tools Replacement	$ 2,343	$ 2,909	$ 565	24%
Buildings - Facilities	$ 2,066	$ 7,045	$ 4,979	241%
Grid Technology (Ops Initiative)	$ 1,760	$ 2,073	$ 313	18%
Meter to Cash	$ 6,983	$ 3,655	$ (3,328)	(48)%
Customer Engagement Platform	$ 1,990	$ 7,622	$ 5,632	283%
Enterprise Solutions	$ 13,113	$ 5,845	$ (7,269)	(55)%
Infrastructure and Cyber Security	$ 7,474	$ 7,937	$ 463	6%
Data and System Integrations	$ 1,608	$ 1,553	$ (55)	(3)%
Total Additions	**$ 114,837**	**$ 101,822**	**$ (13,015)**	**(11)%**

- **Cost Recovery Agreement (CCRA):** Capital additions are expected to be below approved amounts by $15.5M, due largely to lower than budgeted costs for the Cambrian Municipal Transformer Station project, the elimination of the CCRA requirement on the Riverdale Switchgear Upgrade project in 2021-2025 and deferrals of payment on the Piperville station project related to delays with land acquisition.
- **Fleet Replacement:** Capital additions are expected to exceed approved amounts by $1.2M, due largely to unforeseen increases in vehicle costs well beyond historical annual inflationary increases as a result of COVID-19 supply chain disruptions. Nine vehicles were also deferred to offset the inflationary pressures.

- **Buildings - Facilities:** Capital additions are forecasted to exceed budget by $5.0M. The main drivers were the construction of a shared access roadway at the East entrance to the Hunt Club road facility which was driven by a 3rd party, the installation of EV charging stations at all Administration and Operations to accommodate Hydro Ottawa's growing EV fleet in support of its zero emissions target, and two initiatives that were completed as direct responses to health and safety hazards that were reported and required action during the period. Specifically the installation of a new HVAC/ventilation unit at the Bank Street garage to address health and safety concerns and to comply with Ministry of Labour standards for garage ventilation, as well as the creation of additional storage space at the garage to reduce trip hazards and alleviate congestion, while also providing improved conditions for vehicle servicing and training.
- **Meter to Cash:** Capital additions are expected to be below approved amounts by $3.3M, the main driver being the AMI Analytics & Integration Enablement project. The project experienced significant delays and unforeseen challenges due to external factors such as the COVID-19 pandemic, 2022 Derecho and the 84-day strike in 2023 where resources had to be deployed to other priorities.
- **Customer Engagement Platform:** Capital additions are expected to be above approved amounts by approximately $5.6M, driven largely by the replacement of Hydro Ottawa's My Account customer portal. The legacy portal had developed organically over a number of years resulting in an interconnected system of multiple web and mobile technologies, services and solutions. While the solution had served the company well, given the rate of technology change, increasing customer experience demands, a rapidly changing energy industry and continued Hydro Ottawa growth, the solution could no longer scale or adapt and was deemed inadequate to support Hydro Ottawa and customer needs. Spend was further influenced from the stated scope due to emerging regulatory obligations and necessary customer self-service enhancements. Examples of these include the implementation of Ultra-Low Overnight rate option, Net Metering, Green Button, Equal Monthly Payment Plan automation, Autopay registration and Move-In-Move-Out automation.

The investment has positioned Hydro Ottawa to better meet customer needs, adapt to unforeseen disruption and represents the company's commitment to continually enhance customer experience and engagement.

- **Enterprise Solutions:** Capital additions are expected to be below approved amounts by approximately $7.3M, largely due to the deferral of Hydro Ottawa's ERP system to the 2031-2035 time frame, which was originally scheduled for 2021-2025.

Further information on all General Plant expenditures can be found in Section 5.4 of Schedule 2-5-5 - Capital Expenditure Plan.

4. YEAR OVER YEAR IN-SERVICE CAPITAL ADDITIONS VARIANCE

4.1. 2021 APPROVED vs. 2021 ACTUAL

Table 11 below details the comparison between 2021 OEB-Approved and Historical in-service additions.

Table 11 – 2021 Net In-Service Additions, OEB Approved vs. Actual ($'000s)

Investment Category	2021 OEB Approved ($)	2021 Historical	Variance ($)	Variance (%)
System Access	$ 19,534	$ 19,808	$ 274	1%
System Renewal	$ 48,298	$ 41,857	$ (6,441)	(13)%
System Service	$ 19,207	$ 30,683	$ 11,476	60%
General Plant	$ 65,759	$ 34,462	$ (31,296)	(48)%
TOTAL	**$ 152,798**	**$ 126,811**	**$ (25,987)**	**(17)%**

Variance Analysis

- System Access capital additions were materially in line with OEB-Approved amounts.
- System Renewal in-service additions were $6.4M (13%) below OEB approved levels, driven largely by adjustments to project schedules in the Stations and Buildings Infrastructure Renewal Capital Program (Bells Corners Station Rebuild) from 2021-2023.
- System Service in-service additions were $11.5M (60%) above OEB approved amounts, the major driver being the early completion of the buildings at Cambrian Municipal Transformer Station (MTS) originally scheduled for completion in 2022.
- General Plant in-service additions were $31.3M (48%) lower than OEB approved amounts due largely to shifting energization in the CCRA program related to the Cambrian MTS from 2021 to 2022 to align with the in-use date of Hydro One's 230kV line extension connection to the station.

4.2. 2022 APPROVED vs. 2022 ACTUAL

Table 12 below details the comparison between 2022 OEB-Approved and Historical in-service additions.

Table 12 – 2022 OEB-Approved vs. Historical Net In-Service Additions, ($'000s)

Investment Category	2022 OEB Approved ($)	2022 Historical	Variance ($)	Variance (%)
System Access	$ 17,922	$ 17,796	$ (125)	(1)%
System Renewal	$ 45,132	$ 64,903	$ 19,770	44%
System Service	$ 47,330	$ 26,513	$ (20,817)	(44)%
General Plant	$ 12,086	$ 33,142	$ 21,056	174%
TOTAL	**$ 122,471**	**$ 142,354**	**$ 19,883**	**16%**

Variance Analysis

- System Access capital additions were materially in line with OEB-Approved amounts.

- System Renewal additions were $19.8M (44%) above OEB-Approved amounts driven largely by capital additions in response to the Derecho storm which totaled $15.1M. Additionally, capital additions in the Cable Replacement program were $7.5M above approved amounts, offset by shortfalls in Stations Buildings & Infrastructure Renewal (due to switching the Fisher station rebuild project to a voltage conversion project at a much lower cost) and Metering Renewal due to delays in acquiring Gatekeeper meters.
- System Service capital additions were $20.8M (44%) below approved amounts, driven largely by the early completion of the buildings at Cambrian MTS, which as mentioned above, were completed in 2021 but were expected to be completed in 2022.
- General Plant additions were $21.1M (174%) above approved amounts due to the timing of the Cambrian MTS CCRA energization, which as mentioned above was originally budgeted in 2021.

4.3. 2023 APPROVED vs. 2023 ACTUAL

Table 13 below details the comparison between 2023 OEB-Approved and Historical in-service additions.

Table 13 – 2023 OEB-Approved vs. Historical Net In-Service Additions ($'000s)

Investment Category	2023 OEB Approved ($)	2023 Historical	Variance ($)	Variance (%)
System Access	$ 17,620	$ 18,715	$ 1,095	6%
System Renewal	$ 40,813	$ 48,952	$ 8,140	20%
System Service	$ 13,106	$ 9,420	$ (3,687)	(28)%
General Plant	$ 6,237	$ 9,916	$ 3,679	59%
TOTAL	**$ 77,776**	**$ 87,003**	**$ 9,227**	**12%**

Variance Analysis

- System Access capital additions were $1.1M (6%) higher than approved amounts in 2023, driven largely by overages in Customer Connections due to increased volumes and unit costs, offset by shortfalls in Plant Relocation and System Expansion.
- System Renewal additions were $8.1M (20%) above approved amounts, driven mainly by timing of energization of the Bells Corners Station rebuild mentioned above (originally scheduled for completion in 2021).
- System Service additions were $3.7M (28%) below approved amounts, the main driver being the timing of completion of projects under the Distribution Enhancement capital program.
- General Plant additions were $3.7M (59%) higher than approved amounts, driven largely by the completion of the 1st phase of the MyAccount customer portal upgrade.

4.4. 2024 APPROVED vs. 2024 BRIDGE

Table 14 below details the comparison between 2024 OEB-Approved amounts vs. Bridge year in-service additions.

Table 14 – 2024 OEB-Approved vs. Bridge Year Net In-Service Additions ($'000s)

Investment Category	2024 OEB Approved ($)	2024 Bridge	Variance ($)	Variance (%)
System Access	$ 15,630	$ 32,616	$ 16,986	109%
System Renewal	$ 37,560	$ 43,242	$ 5,682	15%
System Service	$ 21,705	$ 28,869	$ 7,163	33%
General Plant	$ 7,877	$ 15,395	$ 7,519	95%
TOTAL	**$ 82,772**	**$ 120,122**	**$ 37,350**	**45%**

Variance Analysis

- System Access capital additions are expected to be $17M (109%) higher than OEB-Approved amounts, the main drivers being continued higher than budgeted volumes and unit costs in the Customer Connections program, which contributed $6.2M towards the overage. Additionally, approximately $8M is attributable to unforeseen cost overruns for the LRT Phase II System Expansion works, due to changes in the project's timeline and scope, as explained in Section 5.1.2 of Schedule 2-5-5 Capital Expenditure Plan.
- System Renewal additions are expected to be $5.7M (15%) higher than OEB-Approved amounts, driven largely by overages in Corrective Renewal due to higher than expected volumes of leaking transformers that required replacement.
- System Service additions are expected to be $7.2M (33%) above OEB-Approved amounts, driven largely by overages within the the Distribution Enhancements program which resulted from scheduling adjustments from prior years, and the energization of the Distribution Management System within the Grid Technologies, offset by delays of the Riverdale Switchgear replacement to 2026-2030 within the Capacity Upgrades program.
- General Plant capital additions are expected to be $7.5M (95%) higher than OEB-Approved amounts, driven largely by continued deployment of MyAccount customer portal functionality, the installation of EV Charging infrastructure at the Hunt Club and Dibblee facilities to support continued greening of Hydro Ottawa's vehicle fleet, and the deployment of the Service Now IT ticketing system.

4.5. 2025 APPROVED vs. 2025 BRIDGE

Table 15 below details the comparison between 2025 OEB-Approved amounts vs. Bridge year in-service additions.

Table 15 – 2025 OEB Approved vs. Bridge Year Net In-Service Additions, ($'000s)

Investment Category	2025 OEB Approved ($)	2025 Bridge	Variance ($)	Variance (%)
System Access	$ 15,312	$ 25,797	$ 10,485	68%
System Renewal	$ 40,018	$ 40,213	$ 195	0%
System Service	$ 41,026	$ 48,757	$ 7,731	19%
General Plant	$ 22,880	$ 8,907	$ (13,973)	(61)%
Total	**$ 119,235**	**$ 123,674**	**$ 4,438**	**4%**

Variance Analysis

- System Access capital additions are expected to be $10.5M (68%) higher than OEB-Approved amounts, the main drivers continue to be persistent higher than budgeted volumes and unit costs in Customer Connections, and overages in System Expansion resulting from the Department of National Defence Dwyer Hill Training Center Upgrade[3] and the OC Transpo's Zero Emission Buses.[4]
- System Renewal capital additions are forecasted to be materially in line with OEB-Approved amounts.
- System Service additions are expected to be $7.7M (19%) higher than OEB-Approved amounts, driven largely by the energization of the OMS replacement.
- General Plant capital additions are expected to be $14M (61%) below approved amounts, the main drivers being the deferral of the replacement of Hydro Ottawa's JD Edwards ERP system to the 2031-2035 time frame, and the deferral of CCRA payments to Hydro One for the Riverdale and Piperville station projects.

[3] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/
[4] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/news/article/oc-explained-zero-emission-bus-project/

5. SUMMARY OF SIGNIFICANT DISCRETE IN-SERVICE CAPITAL ADDITIONS (2021-2025)[5]

Table 16 below provides an overview of the significant capital additions for the 2021-2025 period compared against the OEB-Approved amounts.

[5] Totals may not sum due to rounding.

1 **Table 16 – 2021-2025 Overview of Significant In-Service Additions ($'000 000s)**

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost	Actual In-Service Date	Actual Capital Cost	Cost Variance ($)
General Plant	CCRA	Cambrian 28KV Substation	2021	$ 50.1	2021-2022	$ 44.6	$ (5.5)
General Plant	CCRA	Riverdale Switchgear Upgrade	2024-2025	$ 2.4	N/A	-	$ (2.4)
General Plant	CCRA	Piperville Station Capacity Upgrade-New East	2025	$ 6.1	N/A	-	$ (6.1)
General Plant	Customer Service	Elster EA-MS Upgrade	2021-2025	$ 1.6	2022	$ 0.4	$ (1.2)
General Plant	Operations Initiatives	AMI Program	2022	$ 1.6	N/A	-	$ (1.6)
General Plant	Customer Engagement Platform	MyAccount	N/A	-	2023-2025	$ 6.8	$ 6.8
General Plant	Enterprise Solutions	ERP Program	2025	$ 9.7	N/A	-	$ (9.7)
General Plant	Enterprise Solutions	Service Now	N/A	-	2022-2025	$ 2.7	$ 2.7
System Renewal	Stations and Buildings Infrastructure Renewal	Fisher AK Station Rebuild	2022-2024	$ 9.6	N/A	-	$ (9.6)
System Renewal	Stations and Buildings Infrastructure Renewal	Dagmar Voltage Conversion	2025	$ 6.0	N/A	-	$ (6.0)
System Renewal	Stations and Buildings Infrastructure Renewal	Bayswater Transformer Replacement	2021	$ 3.4	2021-2024	$ 5.0	$ 1.6
System Renewal	Stations and Buildings Infrastructure Renewal	Bell's Corners Station Rebuild	2021-2023	$ 10.3	2022-2024	$ 13.6	$ 3.3

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost	Actual In-Service Date	Actual Capital Cost	Cost Variance ($)
System Renewal	Stations and Buildings Infrastructure Renewal	Overbrook TO Switchgear Replacement	2022-2025	$ 6.7	2021-2024	$ 9.3	$ 2.6
System Renewal	Stations and Buildings Infrastructure Renewal	Lincoln Heights P&C Renewal	2021-2022	$ 1.1	2021-2024	$ 2.3	$ 1.2
System Renewal	Stations and Buildings Infrastructure Renewal	Rideau Heights DS T1 Renewal	2024	$ 3.2	N/A	-	$ (3.2)
System Renewal	Stations and Buildings Infrastructure Renewal	Shillington AD Station Renewal	2025	$ 2.5	N/A	-	$ (2.5)
System Renewal	Metering Renewal	2.5EL to 3EL	2021-2025	$ 2.4	2021-2025	$ 1.1	$ (1.3)
System Renewal	Metering Renewal	TR Communications Update	2021-2025	$ 2.1	2021-2025	$ 1.8	$ (0.3)
System Renewal	Metering Renewal	SC Communications Update	2021-2022	$ 2.0	2022-2025	$ 2.2	$ 0.2
System Renewal	Metering Renewal	TR Service to 200A SC	2021-2025	$ 1.1	2021-2025	$ 1.0	$ (0.1)
System Renewal	Metering Renewal	REX 1 Upgrade	2021-2025	$ 5.0	2023-2025	$ 5.3	$ 0.3
System Service	Capacity Upgrades	Cambrian 28KV Substation	2022	$ 26.9	2021-2023	$ 25.6	$ (1.3)
System Service	Capacity Upgrades	Uplands MS Second Transformer	2021	$ 11.4	2021-2023	$ 14.7	$ 3.3
System Service	Capacity Upgrades	Riverdale Switchgear Upgrade	2024-2025	$ 11.8	2024-2025	$ 5.5	$ (6.3)
System Service	Capacity Upgrades	Limebank MTS 4th Transformer	2021-2022	$ 3.0	2021-2022	$ 2.8	$ (0.2)
System Service	Capacity Upgrades	Piperville Station Capacity Upgrade-New East	2025	$ 24.6	2024-2025	$ 14.7	$ (9.9)

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost	Actual In-Service Date	Actual Capital Cost	Cost Variance ($)
System Service	Capacity Upgrades	New Mer Bleue Station	N/A	-	2025	$ 6.6	$ 6.6
System Service	Grid Technologies	Advanced Distribution Management System (ADMS)	2021-2025	$ 5.0	2025	$ 17.9	$ 12.9
System Service	Field Area Network	Field Area Network	2021-2025	$ 5.0	2023-2025	$ 1.0	$ (4.0)

6. SUMMARY OF PROPOSED 2026-2030 RATE BASE

Table 17 below provides a summary of Hydro Ottawa's proposed rate base for the 2026-2030 rate period.

Table 17 – Summary of 2026-2030 Rate Base ($'000s)

	Test Years				
	2026	**2027**	**2028**	**2029**	**2030**
Opening Gross Assets	$ 1,931,368	$ 2,130,263	$ 2,401,827	$ 2,684,544	$ 2,873,562
Closing Gross Assets	$ 2,130,263	$ 2,401,827	$ 2,684,544	$ 2,873,562	$ 3,077,989
Average Gross Assets	**$ 2,030,816**	**$ 2,266,045**	**$ 2,543,186**	**$ 2,779,053**	**$ 2,975,775**
Opening Accumulated Depreciation	$ (545,380)	$ (610,419)	$ (681,734)	$ (759,398)	$ (842,230)
Closing Accumulated Depreciation	$ (610,419)	$ (681,734)	$ (759,398)	$ (842,230)	$ (930,124)
Average Accumulated Depreciation	**$ (577,899)**	**$ (646,076)**	**$ (720,566)**	**$ (800,814)**	**$ (886,177)**
Opening Net Book Value	$ 1,385,989	$ 1,519,844	$ 1,720,093	$ 1,925,147	$ 2,031,332
Closing Net Book Value	$ 1,519,844	$ 1,720,093	$ 1,925,147	$ 2,031,332	$ 2,147,865
Average Net Fixed Assets	**$ 1,452,917**	**$ 1,619,969**	**$ 1,822,620**	**$ 1,978,239**	**$ 2,089,598**
Working Capital Allowance	$ 79,540	$ 81,751	$ 84,442	$ 87,076	$ 89,773
RATE BASE	**$ 1,532,457**	**$ 1,701,720**	**$ 1,907,062**	**$ 2,065,315**	**$ 2,179,372**

Table 18 provides a comparison of Hydro Ottawa's rate base for the 2025 Bridge Year vs. the 2030 Test Year.

1 **Table 18 AS ORIGINALLY SUBMITTED – 2025 Bridge vs. 2030 Test Rate Base ($'000s)**

	2025 Bridge	2030 Forecast	Variance ($)	Variance (%)
Opening Gross Assets	$ 1,810,056	$ 2,873,562	$ 1,063,506	59%
Closing Gross Assets	$ 1,931,368	$ 3,077,989	$ 1,146,621	59%
Average Gross Assets	**$ 1,870,712**	**$ 2,975,775**	**$ 1,105,063**	**59%**
Opening Accumulated Depreciation	$ (484,565)	$ (842,230)	$ (357,665)	74%
Closing Accumulated Depreciation	$ (545,380)	$ (930,124)	$ (384,744)	71%
Average Accumulated Depreciation	**$ (514,973)**	**$ (886,177)**	**$ (371,205)**	**72%**
Opening Net Book Value	$ 1,325,491	$ 2,031,332	$ 705,841	53%
Closing Net Book Value	$ 1,385,988	$ 2,147,865	$ 761,877	55%
Average Net Fixed Assets	**$ 1,355,740**	**$ 2,089,598**	**$ 733,859**	**54%**
Working Capital Allowance	$ 75,171	$ 89,773	$ 14,602	19%
RATE BASE	**$ 1,430,911**	**$ 2,179,372**	**$ 748,461**	**52%**

2

3 **Table 18 UPDATED JUNE 4,2025 – 2025 Bridge vs. 2030 Test Rate Base ($'000s)**

	2025 Bridge	2030 Forecast	Variance ($)	Variance (%)
Opening Gross Assets	$ 1,810,056	$ 2,873,562	$ 1,063,506	59%
Closing Gross Assets	$ 1,931,368	$ 3,077,989	$ 1,146,621	59%
Average Gross Assets	**$ 1,870,712**	**$ 2,975,775**	**$ 1,105,063**	**59%**
Opening Accumulated Depreciation	$ (484,565)	$ (842,230)	$ (357,665)	74%
Closing Accumulated Depreciation	$ (545,380)	$ (930,124)	$ (384,744)	71%
Average Accumulated Depreciation	**$ (514,973)**	**$ (886,177)**	**$ (371,205)**	**72%**
Opening Net Book Value	$ 1,325,491	$ 2,031,332	$ 705,841	53%
Closing Net Book Value	$ 1,385,988	$ 2,147,865	$ 761,877	55%
Average Net Fixed Assets	**$ 1,355,740**	**$ 2,089,598**	**$ 733,859**	**54%**
Working Capital Allowance	$ 75,249	$ 89,773	$ 14,524	19%
RATE BASE	**$ 1,430,989**	**$ 2,179,372**	**$ 748,383**	**52%**

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Hydro Ottawa's rate base in 2030 is expected to be $748.4M (52%) above the 2025 Bridge Year, driven mainly by capital additions from 2026-2030.

7. SUMMARY OF SIGNIFICANT DISCRETE IN-SERVICE CAPITAL ADDITIONS (2026-2030)

Table 19 below provides an overview of significant discrete in-service capital additions proposed for the 2026-2030 rate period.

1 **Table 19 – 2026-2030 Overview of Significant In-Service Additions ($'000 000s)**

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost ($)
General Plant	CCRA	Riverdale Switchgear Upgrade	2026	$ 0.4
General Plant	CCRA	Piperville Station Capacity Upgrade-New East	2026	$ 4.7
General Plant	CCRA	New Mer Bleue Station	2027	$ 6.3
General Plant	CCRA	Hydro Road Station	2027	$ 0.8
General Plant	CCRA	CFIA Greenbank Road New Station	2028	$ 4.7
General Plant	CCRA	New Kanata Station	2028	$ 5.3
General Plant	CCRA	King Edward Cable Upgrade	2029	$ 16.4
General Plant	CCRA	Carling (secondary cable)	2026	$ 2.1
General Plant	Meter to Cash	CC&B Upgrade 2028	2028	$ 6.5
System Access	System Expansion	OC Transpo EBus St. Laurent Road	2027	$ 9.7
System Access	System Expansion	DND Dwyer Hill Expansion	2026-2027	$ 3.1
System Access	System Expansion	DND Dwyer Hill Station Upgrade	2027	$ 14.1
System Access	System Expansion	Ottawa Hospital	2030	$ 11.5
System Access	System Expansion	Hydro Road Station	2027	$ 22.7
System Renewal	Stations and Buildings Infrastructure Renewal	Longfields T2 Transformer Renewal	2027	$ 1.6
System Renewal	Stations and Buildings Infrastructure Renewal	Rideau Heights DS Switchgear Renewal	2028	$ 5.9
System Renewal	Stations and Buildings Infrastructure Renewal	Parkwood Hills DS Switchgear Renewal	2027	$ 4.2
System Renewal	Stations and Buildings Infrastructure Renewal	Hinchey TH Switchgear Renewal	2026-2027	$ 3.5
System Renewal	Stations and Buildings Infrastructure Renewal	Russell TB Switchgear Renewal	2030	$ 9.8
System Renewal	Metering Renewal	Metering Renewal AMI 2.0	2026-2030	$ 78.2
System Service	Capacity Upgrades	Riverdale Switchgear Upgrade	2026	$ 8.5

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost ($)
System Service	Capacity Upgrades	Piperville Station Capacity Upgrade-New East	2026	$ 27.6
System Service	Capacity Upgrades	New Mer Bleue Station	2027	$ 41.2
System Service	Capacity Upgrades	Greenbank Road New Station	2028	$ 38.5
System Service	Capacity Upgrades	New Kanata Station	2028	$ 44.8

8. OTHER INFORMATION

Hydro Ottawa's 2021-2025 Custom IR Application also included the following mechanisms:

- Capital stretch factor: increased annually, starting at 0% in 2021, escalating by 0.6% per year, up to 2.4% in 2025, resulting in an $8.6M[6] reduction to Hydro Ottawa's total revenue requirement over the 2021-2025 rate term.
- Performance Outcomes Accountability Mechanism (POAM): 5 outcomes-based measures and targets related to the achievement of objectives under Hydro Ottawa's 2021-2025 Distribution System Plan (DSP). The 5 performance metrics are:
  - Number of Interruptions Caused by Defective Equipment (Overhead System) - Excluding Major Event Days;
  - Number of Interruptions Caused by Defective Equipment (Underground System) - Excluding Major Event Days and Leaking Padmount Transformers;
  - System Average Interruption Duration Index (SAIDI)[7] - Excluding Major Event Days and Loss of Supply;
  - Wood Pole Replacement Unit Cost; and

[6] As presented in the 2021-2025 Settlement Agreement, Hydro Ottawa Limited, 2021-2025 Custom Incentive Rate-Setting Approved Settlement Agreement, EB-2019-0261 (September 18, 2020).
[7] The target for this metric is sourced from Table B in the response to interrogatory CCC-38, from Hydro Ottawa's 2021-2025 Custom IR Application. In addition, it is acknowledged that this approach deviates from the OEB's use of 5-year averages to calculate a distributor's SAIDI target. However, the Parties agree to the use of a 3-year average so as to maintain consistency across the 3 reliability-related performance metrics that are utilized under this accountability mechanism.

- Underground Cable Replacement Unit Cost.

In 2022 and 2023, Hydro Ottawa did not meet the SAIDI - Excluding Major Event Days and Loss of Supply or the Wood Pole Replacement Unit Cost.[8] As the outcomes of these two metrics were in the red band, the maximum annual amount of $200K was credited to the POAM Deferral Account for both of these POAM metrics in each year for a total annual credit of $400K. A total principal credit balance of $800K has been recorded into the variance account at the end of 2023. Refer to Schedule 9-1-3 - Group 2 Accounts for additional information.

- Capital Variance Accounts: designed to track, on an annual basis, the impacts on revenue requirement arising from variances between actual and forecasted cumulative capital additions as follows:
  - Symmetrical account for capital additions for which the drivers are either plant relocation requested by 3rd parties or residential subdivision expansion;
  - Asymmetrical account for capital additions for the remaining programs in the System Access investment category;
  - Asymmetrical account for the combined cumulative System Service and System Renewal Investment Categories;
  - Asymmetrical account for the General Plant investment categories; and
  - Symmetrical sub-account for capital additions variances related CCRA payments.

As of 2023, Hydro Ottawa had experienced shortfalls in actual in-service additions versus approved amounts in the asymmetrical System Access and General Plant sub-accounts, as well as the symmetrical CCRA sub-account and has recorded a total credit balance of $2.2M.

[8] For 2021 Hydro Ottawa initially reported that 1 POAM target was not met, the Wood Pole Replacement Unit Cost, which was based on preliminary numbers. When finalized, it was determined that this target was met and the credit was reversed.

After the Storm

Hydro Ottawa's response to the May 2022 derecho

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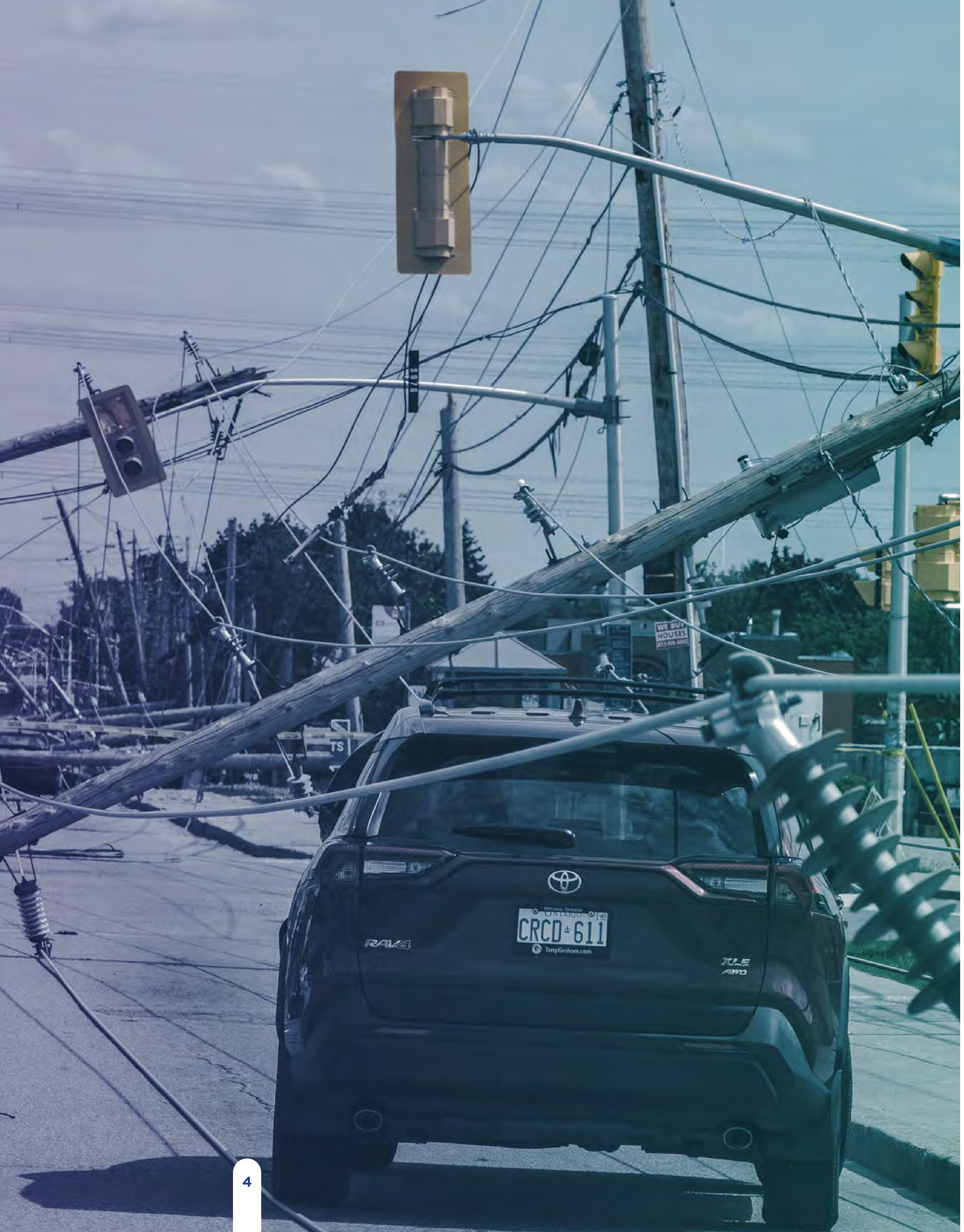
Contents



AFTER THE STORM:

A reflection from our President and CEO

From family barbecues to gardening, camping and cottaging, most Canadians associate the May long weekend with the start of summer – a pleasant time.

Our community, however, will now remember the May 2022 long weekend as the most devastating weekend our city experienced, certainly the most devastating event in Hydro Ottawa's history.

While our teams had been following the storm's path during the day, nothing could have prepared them for its impact. In the span of 15 minutes, winds of up to 190 kilometres per hour toppled transmission towers, damaged more than 500 hydro poles and downed kilometres of power lines. There were more than 1,000 simultaneous power outages across the city and 180,000 customers in the dark.

There was no illusion that restoration was going to be quick. The damage was significant and widespread, and our grid was ravaged. We swiftly mobilized additional resources and equipment through a provincial mutual-aid agreement, bolstering our efforts with an additional 335 workers from numerous utilities and contractor companies. While we were able to restore power to 50 per cent of customers within 48 hours, many were without power for days.

Like many utilities' approach to storm responses, our top priority was to restore power to first responders and essential services, followed by water treatment facilities and sewage treatment plants. We then prioritized maximizing our efforts for the greatest number of customers. **Six months post-storm, we continue to build back stronger by:**

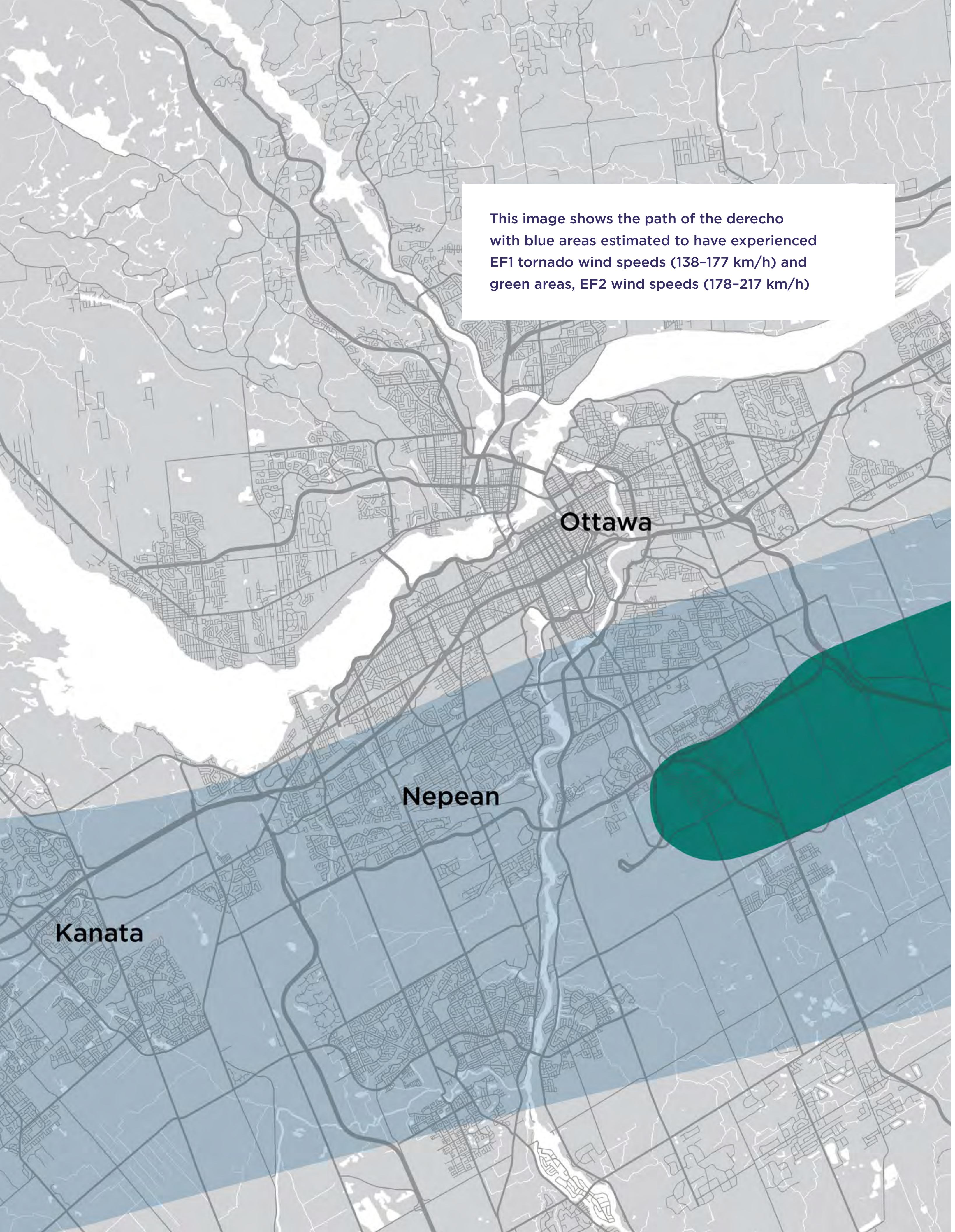
- Expanding our forestry program with shorter and enhanced tree-trimming cycles
- Increasing system inspections to find problematic equipment and make the necessary repairs
- Deploying additional resources to respond to power-outage events
- Deploying infrared scanning to preemptively identify assets at risk of failure
- Reviewing our Business Continuity Management Program, and updating our incident management and crisis communications plans to include learnings and best practices

We know that electricity is vital to our economy, public health and safety. Because of their interconnectedness, utilities and municipalities must work together to scale up solutions that can build and maintain our community's resilience, while being cost-effective for our customers.

We hope you find this report to be a helpful summary of our storm response and look forward to extending our collaboration with you to strengthen our collective emergency response for future events.

Sincerely,

Bryce Conrad
President & CEO
Hydro Ottawa



This image shows the path of the derecho with blue areas estimated to have experienced EF1 tornado wind speeds (138–177 km/h) and green areas, EF2 wind speeds (178–217 km/h)

Overview

On May 21, 2022, Ottawa experienced winds of up to 190 kilometres per hour, extensively damaging Hydro Ottawa's electrical grid. This storm cost Hydro Ottawa an estimated $23.8 million ($15.1 capital expenditures; $8.7 operating, maintenance and other costs).

Total damages in Ontario are estimated at $720 million, making this the sixth costliest weather event in Canadian history in terms of insurance claims.

Purpose

The purpose of this report is to highlight Hydro Ottawa's efforts to repair and restore the electrical distribution system damaged by the May 21, 2022, derecho storm. It also aims to identify successes, lessons learned and recommendations to strengthen our Business Continuity Management Program as well as supporting business continuity and incident management plans.

While numerous external organizations supported the response, this report focuses solely on Hydro Ottawa's role in repairing and restoring the electrical distribution system between May 21 and June 5, 2022.

Customer Impact

At the peak of the aftermath, 180,000 Hydro Ottawa customers were without power – more than half of our customer base. Unlike previous storms, damage and power outages impacted our entire service territory.

There were a total of 1,000 individual outages on the system (in comparison to 200 after the 2018 tornadoes) and more than 1,500 known or reported tree contacts or interferences.

Some of the hardest hit neighbourhoods included:

- Pineglen and Pineglen Annex
- Carlingwood and McKellar Heights
- Fisher Glen and Cityview-Skyline-Fisher Heights
- Lincoln Heights and Britannia Heights
- Parkway Park and Kenson Park
- South Keys
- Carlsbad Springs
- Blackburn Hamlet
- Riverside Park and Hog's Back
- Tanglewood
- Stittsville and surrounding areas
- Manordale and Meadowlands
- Queensway Terrace South and Ridgeview
- Bells Corners East and Lynwood Village

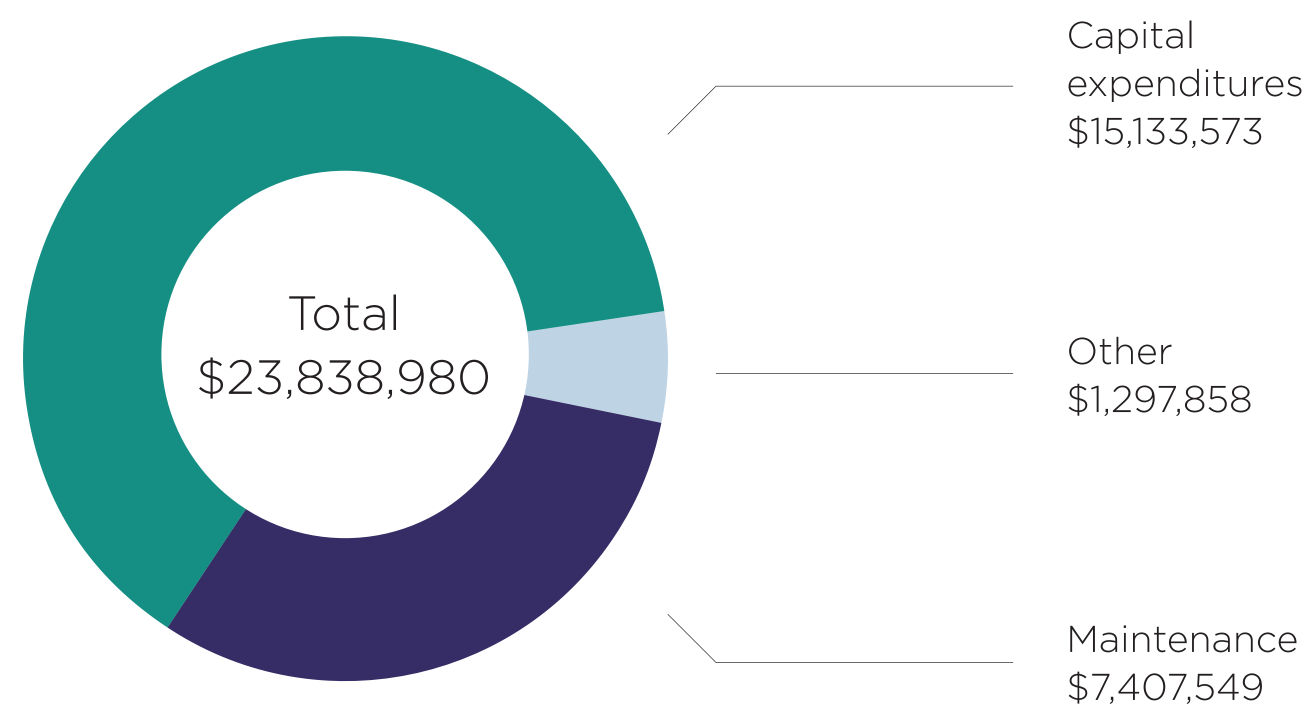
Damage Assessment

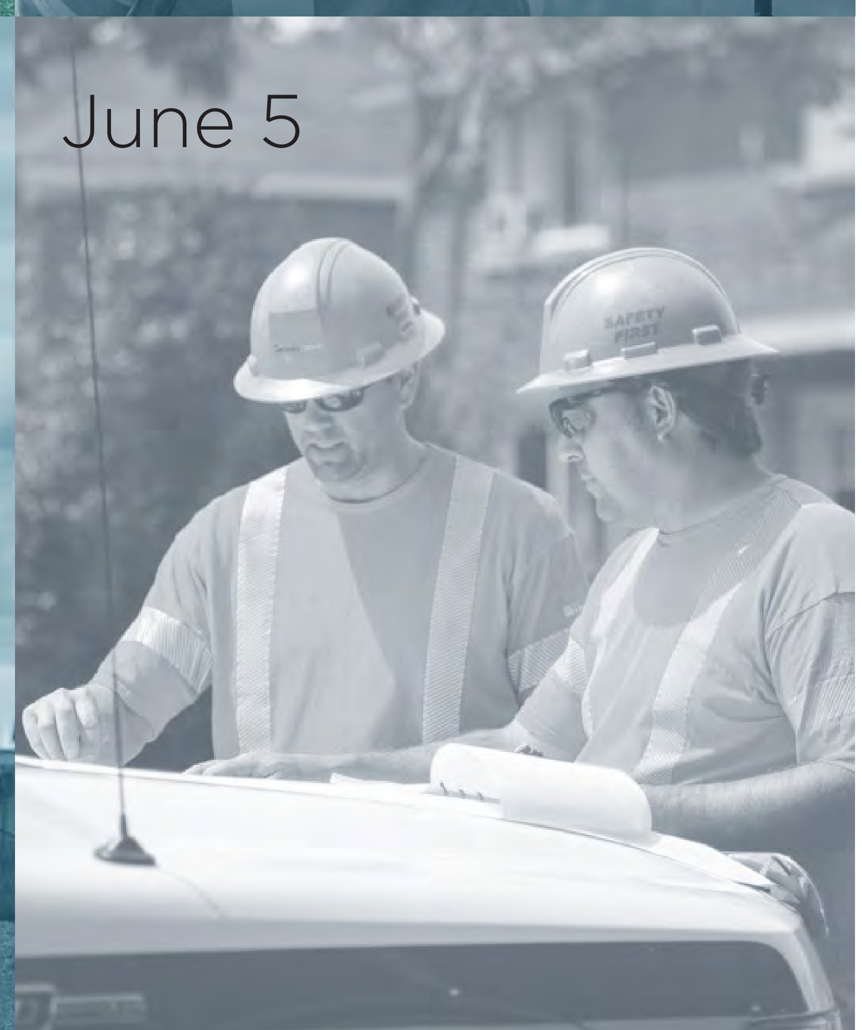
Initial damage assessments showed that more than 225 poles needed to be replaced; however, after the full extent of the damage became clear, we confirmed that number to be 540.

Property damage, downed trees and debris littered the hardest hit areas. This hampered field crews' ability to initiate restoration as traffic control and clean-up crews were required first.

The overall capital expenditure cost of the derecho to Hydro Ottawa is estimated at $15.1 million, which equates to 21.3 per cent of the 2022 system renewal and system service budget as approved by the board of directors.

Total cost of the storm to Hydro Ottawa





Response Timeline

From the beginning of our storm response, Hydro Ottawa communicated that this would be a multi-day restoration effort. We needed to take a whole-of-city approach given the widespread nature of the damage.

May 21

The derecho storm hits Ottawa

May 23

Power is restored to 50 per cent of affected customers

May 28

Most large repair projects are completed, restoring power to 90 per cent of affected customers

June 1

Power is restored to all customers except those with outstanding property/equipment damage

June 5

Power is restored to remaining customers

COMPARING OTTAWA'S BIG STORMS

SEPT 2018 TORNADOES

On September 21, 2018, a powerful storm caused tornadoes, heavy winds and lightning resulting in extensive damage to the electrical infrastructure and a major transformer station.

MAY 2022 WIND STORM

On May 21, 2022, a devastating storm caused high winds, heavy rain and lightning resulting in extensive damage to the electrical infrastructure, far worse than any other storm.

	SEPT 2018 TORNADOES	MAY 2022 WIND STORM
NUMBER OF OUTAGES	200+	1000+
CUSTOMERS WITHOUT POWER AT THE PEAK OF THE STORM	165,000	180,000
AREAS IMPACTED	SELECT AREAS	ENTIRE SERVICE TERRITORY
POLES REPLACED	88	540
CONTRACTORS WHO CAME TO ASSIST	86	335
LENGTH OF TIME TO RESTORE 50% OF OUTAGES	WITHIN 36 HRS	WITHIN 48 HRS

Lessons Learned

Hydro Ottawa's Business Continuity Management Program and supporting business continuity and incident management plans were strained due to the unprecedented nature, scope and duration of the May 2022 derecho. Since extreme weather events are occurring more frequently, we will review and enhance our plans to ensure they are scalable to events of this scope and duration.

Here's where we need to improve:

Future planning

Assumptions for future planning, design, construction and maintenance must expand to encompass the conditions experienced in this event.

Customer communication

Throughout this multi-day event, we struggled to effectively communicate estimated times of restoration and neighbourhood-specific information with customers due to the wide-spread damage, which is why we removed the outage map from our website. Recognizing that this was a critical concern for our customers, a review of our internal outage management systems and communication tools and strategies is underway in order to provide quicker and more reliable data on a continual basis moving forward.

System resilience

In addition to enhancing our storm-response capabilities, we must work to further harden our distribution system against storm damage, including, where feasible and where it makes financial sense, moving parts of our infrastructure underground.

Successes

Mutual Aid

We secured, mobilized and deployed 335 mutual-aid resources from neighbouring utilities and contractors.

Repair volume and speed

We completed the equivalent of four years of emergency asset replacements to our distribution system during the outage period.

Dedication, resilience and ingenuity

Teams worked long hours, and applied considerable ingenuity to resolving issues, and to expanding our response efforts to meet the demand of the situation.

Minimal injuries

Despite dynamic and evolving circumstances, we experienced only one medical aid injury to a contractor's employee.

Website performance

Between May 21 and June 2, 2022, our website had almost 600,000 unique visitors and 3.8 million page views.

Stakeholder communications

Daily public service announcements, memos to council and City media briefings; proactive and reactive media interviews; emails to business improvement areas and community associations; social media and website updates.

Successes

No work delays

Our procurement team ensured materials were brought in and available as needed to support all restoration efforts in spite of the long-weekend closures and existing global supply-chain issues.

24/7 fleet support

Mechanics were responsive to help with fleet-related breakdowns, including those impacting our contractors and mutual-aid crews.

Fueling efficiencies

Mobile night-time refueling of vehicles and generators ensured work staging remained and allowed crews to stay on site.

Waste-management efficiency

We provided refuse and debris bins directly to worksites for coordinated removal.

Equipment innovation

We sourced and used logging trucks and cranes creatively to handle, offload and deliver poles.

Taking care

Employees from across the organization were deployed on 720 trips to deliver 23,400 meals to worksites.

Strategic Priorities

1. OVERHEAD INFRASTRUCTURE

Hydro Ottawa has initiated plans to further storm-harden the distribution system. These plans include targeted infrastructure-hardening measures as part of the 2023 capital program, an update to the 2019 Distribution System Climate Risk and Vulnerability Assessment and the development of a Strategic Undergrounding Plan to enhance system resiliency.

2. DAMAGE ASSESSMENT

Hydro Ottawa will enhance integration of our damage assessment process and reports with our outage management system.

3. OUTAGE MANAGEMENT SYSTEM AND STORM MODE

Hydro Ottawa is establishing a process to support a systematic and simultaneous change across all systems and communication channels when "storm mode" is initiated.

4. OUTAGE MAP

Hydro Ottawa is conducting a comprehensive evaluation of the current outage map and needed features to best support customers across all scales of outages. We will implement an appropriate solution.

5. CUSTOMER-FACING TELEPHONY

Hydro Ottawa is implementing scalable telephony that leverages cloud-based technology to triage and process inbound calls to our outage centre. We will launch an SMS communication channel to support one-on-one outage reporting and restoration updates and are evaluating options to simplify outage reporting through both our website and mobile app.

6. ELECTRICITY EMERGENCY RESPONSE PLAN

Hydro Ottawa is conducting a comprehensive review and update to our Electricity Emergency Response Plan with specific considerations to ensure its scalability for large-scale, long-duration events. The review will include learnings and adaptations from the May 2022 derecho.

7. STAKEHOLDER COMMUNICATIONS

Hydro Ottawa will review and update our stakeholder communications plan to include learnings and adaptations made during the May 2022 derecho, as well as best practices used by utilities that regularly deal with large-scale weather events such as hurricanes.

8. SUPPLY CHAIN AND MATERIALS MANAGEMENT

Hydro Ottawa is conducting a thorough review of our supply chain and material management processes, including usage data from the storm. Our findings will inform our threshold inventory levels and the development of a supply-chain playbook for events of this scale.

9. BUSINESS CONTINUITY AND INCIDENT MANAGEMENT PLANS

Hydro Ottawa is reviewing and updating all business continuity and incident management plans to ensure they can scale for large-scope and long-duration events. We will be benchmarking against this storm response (e.g., city-wide impact, 500+ poles damaged, two-week response duration, mutual-aid resources required).

We will work with the City's emergency management team to review our role in the City's Emergency Operations Centre (EOC) during large-scale emergency events to ensure that we optimize communications protocols and channels with City departments, emergency services and other utilities, in support of both the restoration work, and the residents' needs.

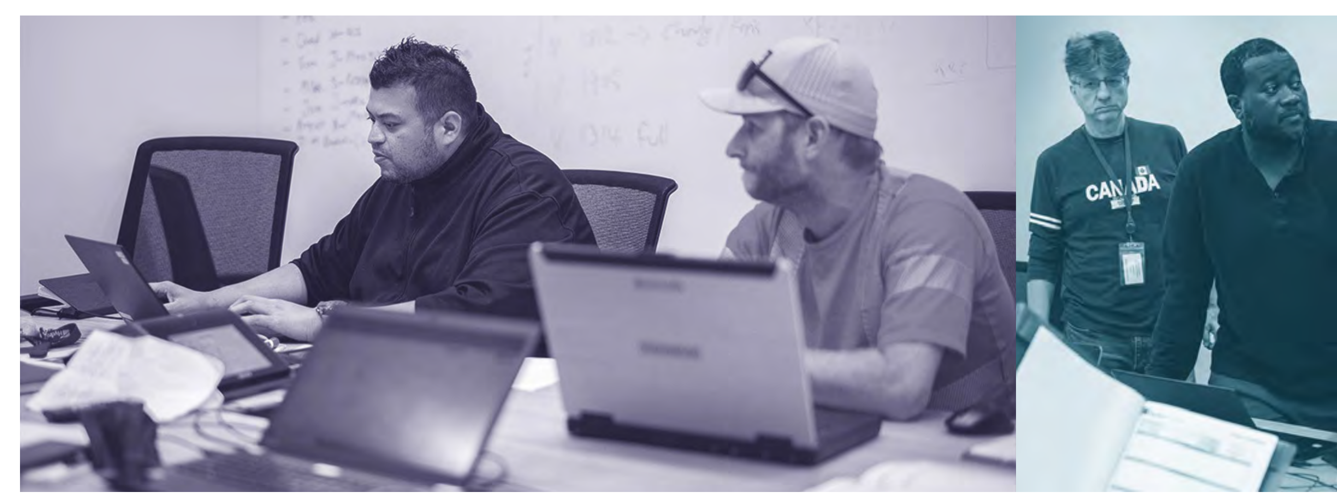
Conclusion

Adapting for the future.

Hydro Ottawa's emergency response plans are well executed and rooted in a strong foundation, as demonstrated by our day-to-day outage-response operations.

With an expected increase in more frequent and extreme weather events as a result of climate change, we're integrating learnings and focusing our efforts on both the grid and our emergency response plans to ensure scalability across our people, processes and technologies.

We're committed to keeping the lights on for our customers.



Appendix: Debrief Methodology

Debrief sessions were held during June 2022 with various divisions as well as the crisis management team, the crisis communications team and the incident command centre group. These sessions focused on identifying processes that worked well, gaps in processes and/or resources as well as opportunities for improvement.

Consultations and business continuity management program debriefs were conducted with the following:

- **Chief Information and Technology Officer Division:** infrastructure, grid technology, customer-facing technology
- **Chief Customer Officer Division:** external communications
- **Chief Electricity Distribution Officer Division:** internal contractor management team, distribution engineering and asset management team, system operations response, use of mutual aid/contractors
- **Chief Financial Officer Division:** facilities, fleet and fuel, supply chain, materials management
- **Chief Human Resources Officer Division:** human resources, safety, food, lodging
- **Executive Management Team**
- **Union Executive**

Some combined debriefs were then necessary to review the coordination among various divisions and/or groups. Information from these debriefs was consolidated and used to prepare this report.

ASSETS – PROPERTY PLANT & EQUIPMENT CONTINUITY SCHEDULE

1. INTRODUCTION

This Schedule provides information as required under section 2.2.1 of the *Chapter 2 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications*, dated December 9, 2024 (Filing Requirements). In addition, the amounts for construction work-in-progress (CWIP) have also been provided. In accordance with the Filing Requirements, appended to this Schedule are the following Excel attachments:

- Attachment 2-2-1(A) - OEB Appendix 2-BA - 2021-2025 Fixed Asset Continuity Schedule
- Attachment 2-2-1(B) - OEB Appendix 2-BA - 2026-2030 Fixed Asset Continuity Schedule

2. GROSS ASSETS BY FUNCTION

Table 1 below provides Hydro Ottawa's Approved Gross Assets balance by function for the Historical Years 2021-2023 and Bridge Years 2024 and 2025. The gross and accumulated depreciation in Table 1 below were used to calculate the settled rate base amounts per the 2021-2025 Settlement Agreement.[1] Tables 2 and 3 below provide Hydro Ottawa's actual Gross Assets balance by function for the Historical Years 2021-2023, and forecasted Gross Assets balance for Bridge Years 2024 and 2025, and Test Years 2026-2030.

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Settlement Proposal*, EB-2019-0261 (September 18, 2020).

Table 1 – OEB Approved 2021-2025 - Gross Assets Breakdown by Function ($'000s)

Gross Assets	OEB - Approved				
	2021	2022	2023	2024	2025
Transmission Plant	$ 127,104	$ 152,716	$ 156,318	$ 161,747	$ 170,971
Distribution Plant	$ 1,041,959	$ 1,119,263	$ 1,182,682	$ 1,248,693	$ 1,329,616
General Plant	$ 338,415	$ 354,173	$ 361,251	$ 369,413	$ 395,865
Subtotal	**$ 1,507,478**	**$ 1,626,152**	**$ 1,700,252**	**$ 1,779,853**	**$ 1,896,452**
Less Other Non Rate-Regulated Utility Assets	-	-	-	-	-
Total PP&E for Rate Base Purposes	**$ 1,507,478**	**$ 1,626,152**	**$ 1,700,252**	**$ 1,779,853**	**$ 1,896,452**
CWIP	$ 43,711	$ 20,576	$ 30,756	$ 43,042	$ 18,802
Accumulated Depreciation	$ (324,639)	$ (377,881)	$ (433,247)	$ (490,428)	$ (551,211)
Total PP&E	**$ 1,226,551**	**$ 1,268,846**	**$ 1,297,760**	**$ 1,332,466**	**$ 1,364,043**

Table 2 – Historical and Bridge 2021-2025 Gross Assets Breakdown by Function ($'000s)[2]

Gross Assets	Historical			Bridge	
	2021	2022	2023	2024	2025
Transmission Plant	$ 138,228	$ 155,080	$ 157,256	$ 157,962	$ 165,969
Distribution Plant	$ 1,031,034	$ 1,119,178	$ 1,190,677	$ 1,311,500	$ 1,399,660
General Plant	$ 312,400	$ 345,577	$ 356,678	$ 352,797	$ 377,943
Sub-Total	**$ 1,481,663**	**$ 1,619,835**	**$ 1,704,612**	**$ 1,822,259**	**$ 1,943,572**
Less Other Non Rate-Regulated Utility Assets	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)
Total PP&E for Rate Base Purposes	**$ 1,469,459**	**$ 1,607,631**	**$ 1,692,408**	**$ 1,810,056**	**$ 1,931,368**
CWIP	$ 60,435	$ 28,360	$ 35,342	$ 51,302	$ 75,574
Accumulated Depreciation	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)	$ (545,380)
Total PP&E	**$ 1,209,109**	**$ 1,263,444**	**$ 1,300,796**	**$ 1,376,792**	**$ 1,461,563**

[2] Totals may not sum due to rounding.

Table 3 – Test Years 2026-2030 Gross Assets Breakdown by Function ($'000s)

Gross Assets	Test Years				
	2026	2027	2028	2029	2030
Transmission Plant	$ 189,385	$ 258,770	$ 324,428	$ 325,217	$ 326,028
Distribution Plant	$ 1,539,524	$ 1,702,987	$ 1,874,795	$ 2,022,277	$ 2,205,435
General Plant	$ 413,559	$ 452,274	$ 497,525	$ 538,272	$ 558,730
Sub-Total	**$ 2,142,467**	**$ 2,414,031**	**$ 2,696,748**	**$ 2,885,766**	**$ 3,090,193**
Less Other Non Rate-Regulated Utility Assets	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)
Total PP&E for Rate Base Purposes	**$ 2,130,263**	**$ 2,401,827**	**$ 2,684,544**	**$ 2,873,562**	**$ 3,077,989**
CWIP	$ 131,106	$ 113,807	$ 42,021	$ 80,929	$ 91,698
Accumulated Depreciation	$ (610,419)	$ (681,734)	$ (759,398)	$ (842,230)	$ (930,124)
Total PP&E	**$ 1,650,950**	**$ 1,833,900**	**$ 1,967,167**	**$ 2,112,261**	**$ 2,239,562**

For detailed Fixed Asset Continuity Schedules for the years 2021-2025 and 2026-2030, please see Excel Attachments 2-2-1(A) - OEB Appendix 2-BA - 2021-2025 Fixed Asset Continuity Schedule and 2-2-1(B) - OEB Appendix 2-BA - 2026-2030 Fixed Asset Continuity Schedule. Please note the following two items related to the Fixed Asset Continuity Schedules:

- Hydro One Networks Inc. (Hydro One) actual construction costs related to the Cambrian Connection Cost Recovery Agreement (CCRA) were lower than the budgeted and invoiced amounts, leading to a refund received in 2023 of $5.7M. Hydro Ottawa had already added these costs to the asset's value based on actual payments to Hydro One when the completed line extensions were finished in 2021 and 2022. A refund for the overpayment was received by Hydro Ottawa in 2023, which reduced its asset cost base in OEB Account 1609 and is presented in the 'Asset Cost Disposals' column (which reflects reductions in asset value) in Attachment 2-2-1(A) - 2021-2025 Fixed Asset Continuity Schedule for 2023.

- In 2024 Hydro Ottawa undertook a review of its assets in OEB Accounts 1808 Buildings and Fixtures (Distribution Plant) and 1908 Buildings and Fixtures (General Plant) and identified a group of assets in Account 1908 that should have been classified in Account 1808. The transfers of asset costs and accumulated depreciation balances were completed in 2024 and are included in the asset cost additions and accumulated depreciation additions columns in Attachment 2-2-1(A) - OEB Appendix 2-BA Fixed Asset Continuity Schedule for 2024. Asset cost transfers totaled $27.3M, and asset accumulated depreciation transfers totaled $5.1M.

3. GROSS ASSETS BY MAJOR PLANT ACCOUNT

Table 4 provides Gross Assets balance by major plant account for each functionalized plant item, for Historical Years 2021-2023 and for Bridge Years 2024 and 2025.

Table 4 – 2021-2025 Gross Assets Breakdown by Major Plant Account Organized by Uniform System of Account ($'000s)

USofA	Description	Historical			Bridge	
		2021	2022	2023	2024	2025
1815	Transformer Station Equipment >50 kV	$ 138,228	$ 155,080	$ 157,256	$ 157,962	$ 165,969
Subtotal Transmission Plant		**$ 138,228**	**$ 155,080**	**$ 157,256**	**$ 157,962**	**$ 165,969**
1612	Land Rights	$ 2,731	$ 3,239	$ 3,239	$ 3,264	$ 3,289
1805	Land	$ 4,847	$ 4,847	$ 4,833	$ 10,503	$ 17,630
1808	Buildings	$ 37,561	$ 37,890	$ 37,955	$ 65,306	$ 74,900
1820	Distribution Station Equipment <50 kV	$ 132,117	$ 137,929	$ 147,685	$ 149,928	$ 150,843
1830	Poles, Towers & Fixtures	$ 154,149	$ 169,863	$ 181,005	$ 194,330	$ 208,784
1835	Overhead Conductors & Devices	$ 145,459	$ 156,265	$ 163,678	$ 176,284	$ 189,332
1840	Underground Conduit	$ 310,590	$ 350,350	$ 391,669	$ 449,745	$ 495,971
1845	Underground Conductors & Devices	$ 213,938	$ 233,255	$ 251,147	$ 278,495	$ 299,007
1850	Line Transformers	$ 113,433	$ 123,930	$ 135,537	$ 147,239	$ 158,646
1855	Services (Overhead & Underground)	$ 80,484	$ 88,045	$ 92,944	$ 100,837	$ 107,784
1860	Meters	$ 54,980	$ 57,699	$ 62,424	$ 70,494	$ 77,472
1970	Load Management Controls Customer Premises	-	-	-	-	-
1975	Load Management Controls Utility Premises	-	-	-	-	-
1980	System Supervisor Equipment	$ 19,059	$ 22,188	$ 22,927	$ 25,476	$ 26,831
1985	Sentinel Lighting Rental Units	$ 1	$ 1	$ 1	$ 1	$ 1
2440	Deferred Revenue	$ (238,313)	$ (266,323)	$ (304,366)	$ (360,402)	$ (410,831)
Subtotal Distribution Plant		**$ 1,031,034**	**$ 1,119,178**	**$ 1,190,677**	**$ 1,311,500**	**$ 1,399,660**
1609	Capital Contributions Paid	$ 63,655	$ 83,893	$ 79,137	$ 80,640	$ 80,640
1611	Computer Software	$ 74,988	$ 79,767	$ 86,031	$ 95,711	$ 102,758

USofA	Description	Historical			Bridge	
		2021	2022	2023	2024	2025
1905	Land	$ 19,740	$ 19,740	$ 19,740	$ 19,740	$ 19,740
1908	Buildings & Fixtures	$ 95,956	$ 97,473	$ 100,222	$ 75,733	$ 76,240
1915	Office Furniture and Equipment	$ 4,392	$ 4,477	$ 4,512	$ 4,688	$ 4,865
1920	Computer Equipment - Hardware	$ 11,393	$ 13,783	$ 15,970	$ 21,556	$ 34,035
1930	Transportation Equipment	$ 20,328	$ 23,734	$ 27,883	$ 30,286	$ 33,924
1935	Stores Equipment	$ 669	$ 697	$ 697	$ 697	$ 697
1940	Tools, Shop & Garage Equipment	$ 5,214	$ 5,777	$ 6,171	$ 6,845	$ 7,419
1945	Measurement & Testing Equipment	$ 209	$ 209	$ 209	$ 209	$ 209
1950	Power Operated Equipment	$ 1,330	$ 1,252	$ 1,252	$ 1,461	$ 1,421
1955	Communications Equipment	$ 14,329	$ 14,575	$ 14,654	$ 15,031	$ 15,794
1960	Miscellaneous Equipment	$ 199	$ 201	$ 201	$ 201	$ 201
Subtotal General Plant		**$ 312,400**	**$ 345,577**	**$ 356,678**	**$ 352,797**	**$ 377,943**
Subtotal		**$ 1,481,663**	**$ 1,619,835**	**$ 1,704,612**	**$ 1,822,259**	**$ 1,943,572**
Less Other Non Rate-Regulated Utility Assets		$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)
Total PP&E For Rate Base Purposes		**$ 1,469,459**	**$ 1,607,631**	**$ 1,692,408**	**$ 1,810,056**	**$ 1,931,368**
2055	Construction Work-in-Progress	$ 60,435	$ 28,360	$ 35,342	$ 51,302	$ 75,574
	Accumulated Depreciation	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)	$ (545,380)
Total PP&E		**$ 1,209,109**	**$ 1,263,444**	**$ 1,300,796**	**$ 1,376,792**	**$ 1,461,563**

Table 5 below provides Gross Assets balance by major plant account for each functionalized plant item for Test Years 2026-2030.

1 **Table 5 – 2026-2030 Gross Assets Breakdown by Major Plant Account Organized by**
2 **Uniform System of Account ($'000s)**

USofA	Description	Test years				
		2026	2027	2028	2029	2030
1815	Transformer Station Equipment >50 kV	$ 189,385	$ 258,770	$ 324,428	$ 325,217	$ 326,028
Subtotal Transmission Plant		**$ 189,385**	**$ 258,770**	**$ 324,428**	**$ 325,217**	**$ 326,028**
1612	Land Rights	$ 3,289	$ 3,289	$ 3,289	$ 3,289	$ 3,289
1805	Land	$ 17,630	$ 17,836	$ 23,576	$ 24,183	$ 25,400
1808	Buildings	$ 79,218	$ 98,695	$ 111,837	$ 113,537	$ 115,010
1820	Distribution Station Equipment <50 kV	$ 161,137	$ 178,995	$ 191,406	$ 191,708	$ 201,862
1825	Storage Battery Equipment	$ 2,400	$ 7,020	$ 14,927	$ 24,368	$ 41,120
1830	Poles, Towers & Fixtures	$ 232,472	$ 260,765	$ 284,342	$ 304,848	$ 327,138
1835	Overhead Conductors & Devices	$ 215,406	$ 247,354	$ 274,232	$ 299,258	$ 325,024
1840	Underground Conduit	$ 553,545	$ 625,637	$ 691,910	$ 755,591	$ 834,575
1845	Underground Conductors & Devices	$ 325,060	$ 356,129	$ 389,395	$ 420,220	$ 460,129
1850	Line Transformers	$ 172,901	$ 186,701	$ 200,545	$ 215,219	$ 231,440
1855	Services (Overhead & Underground)	$ 114,510	$ 121,875	$ 129,173	$ 136,532	$ 144,338
1860	Meters	$ 92,170	$ 107,236	$ 123,779	$ 142,764	$ 162,769
1970	Load Management Controls Customer Premises	-	-	-	-	-
1975	Load Management Controls Utility Premises	-	-	-	-	-
1980	System Supervisor Equipment	$ 31,115	$ 35,247	$ 38,228	$ 40,054	$ 42,382
1985	Sentinel Lighting Rental Units	$ 1	$ 1	$ 1	$ 1	$ 1
2440	Deferred Revenue	$ (461,330)	$ (543,792)	$ (601,843)	$ (649,295)	$ (709,042)
Subtotal Distribution Plant		**$ 1,539,524**	**$ 1,702,987**	**$ 1,874,795**	**$ 2,022,277**	**$ 2,205,435**
1609	Capital Contributions Paid	$ 88,337	$ 95,979	$ 106,587	$ 123,602	$ 124,626

USofA	Description	Test years				
		2026	2027	2028	2029	2030
1611	Computer Software	$ 112,452	$ 123,040	$ 134,738	$ 143,180	$ 148,917
1905	Land	$ 19,740	$ 19,740	$ 19,740	$ 19,740	$ 19,740
1908	Buildings & Fixtures	$ 77,952	$ 80,420	$ 83,612	$ 87,958	$ 95,860
1915	Office Furniture and Equipment	$ 4,865	$ 4,865	$ 4,865	$ 4,865	$ 4,865
1920	Computer Equipment - Hardware	$ 35,940	$ 37,123	$ 38,946	$ 42,346	$ 45,077
1930	Transportation Equipment	$ 44,221	$ 55,561	$ 65,758	$ 68,290	$ 67,943
1935	Stores Equipment	$ 697	$ 697	$ 697	$ 697	$ 697
1940	Tools, Shop & Garage Equipment	$ 8,246	$ 9,092	$ 9,956	$ 10,838	$ 11,739
1945	Measurement & Testing Equipment	$ 359	$ 359	$ 359	$ 359	$ 359
1950	Power Operated Equipment	$ 2,701	$ 5,046	$ 5,465	$ 5,426	$ 5,387
1955	Communications Equipment	$ 17,596	$ 19,790	$ 26,218	$ 30,387	$ 32,635
1960	Miscellaneous Equipment	$ 453	$ 564	$ 584	$ 584	$ 886
Subtotal General Plant		**$ 413,559**	**$ 452,274**	**$ 497,525**	**$ 538,272**	**$ 558,730**
Subtotal		**$ 2,142,467**	**$ 2,414,031**	**$ 2,696,748**	**$ 2,885,766**	**$ 3,090,193**
Less Other Non Rate-Regulated Utility Assets		$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)
Total PP&E For Rate Base Purposes		**$ 2,130,263**	**$ 2,401,827**	**$ 2,684,544**	**$ 2,873,562**	**$ 3,077,989**
2055	Construction Work-in-Progress	$ 131,106	$ 113,807	$ 42,021	$ 80,929	$ 91,698
	Accumulated Depreciation	$ (610,419)	$ (681,734)	$ (759,398)	$ (842,230)	$ (930,124)
Total PP&E		**$ 1,650,950**	**$ 1,833,900**	**$ 1,967,167**	**$ 2,112,261**	**$ 2,239,562**

4. RECONCILIATION OF APPENDIX 2-BA and 2-AB

Table 6 below reconciles the annual capital additions for Rate Base Purposes and the annual change in Construction Work in Progress (CWIP) in Appendix 2-BA with the annual capital spending in Appendix 2-AB. This reconciliation covers the Historical and Bridge Years 2022 and 2023.

NEW - Table 6 - Reconciliation of Appendix 2-BA and 2-AB ($'000s)

	2022	2023
Capital Additions per App 2-BA	$ 142,546	$ 86,810
Change in CWIP	$ (32,076)	$ 6,982
Sub-Total	**$ 110,471**	**$ 93,792**
Capital Spending per App 2-AB	$ 110,278	$ 93,984
Difference	**$ 192**	**$ (192)**

Reconciliation Analysis

- In 2022, Non Distribution Other Utility Plant Assets addition totaling $192K (US of A 2070) were erroneously included as Rate-Regulated Utility Assets as part of the OEB's Reporting and Record keeping Requirements, and this is reflected in additions in Appendix 2-BA. In 2023, these assets and related depreciation were corrected and were removed from Rate-Regulated Utility Assets in Appendix 2-BA.

Attachment 2-2-1(A) - OEB Appendix 2-BA - 2021-2025 Fixed Asset Continuity Schedule

(Refer to the attachment in Excel format)

Attachment 2-2-1(B) - OEB Appendix 2-BA - 2026-2030 Fixed Asset Continuity Schedule

(Refer to the attachment in Excel format)

WORKING CAPITAL REQUIREMENT

1. INTRODUCTION

This Schedule provides a summary of the Working Capital Requirement for the Historical 2021-2023, Bridge Years 2024 and 2025 and the proposed Test Years 2026-2030.

Table 1 summarizes the 2021-2025 OEB-approved working capital allowance (WCA), as per the Approved Settlement Agreement governing Hydro Ottawa's 2021-2025 rate term.[1] The values for 2022-2025 include annual adjustments using the OEB inflation factor for each applicable year and are as approved by the OEB. The 2021-2025 OEB-approved power supply expenses do not factor in the amounts for Ontario Electricity Rebate (OER).

Table 1 – OEB-Approved Working Capital Allowance 2021-2025 ($'000s)

	Approved				
	2021	2022	2023	2024	2025
Power Supply Expenses	$ 1,048,856	$ 1,083,468	$ 1,123,556	$ 1,177,487	$ 1,219,877
OM&A Expenses	$ 90,600	$ 93,590	$ 97,053	$ 101,711	$ 105,373
Total Expenses for Working Capital	$ 1,139,456	$ 1,177,058	$ 1,220,609	$ 1,279,198	$ 1,325,250
Working Capital %	7.50%	7.50%	7.50%	7.50%	7.50%
TOTAL WCA	**$ 85,459**	**$ 88,279**	**$ 91,546**	**$ 95,940**	**$ 99,394**

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Agreement,* EB-2019-0261 (September 18, 2020), page 19.

Table 2 below provides the Historical and Bridge Year WCA amounts for 2021-2025.

Table 2 AS ORIGINALLY SUBMITTED – Working Capital Allowance 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	**2022**	**2023**	**2024**	**2025**
Power Supply Expenses	$ 858,376	$ 852,835	$ 845,992	$ 871,246	$ 884,398
OM&A Expenses	$ 84,737	$ 100,536	$ 112,778	$ 114,280	$ 117,882
Total Expenses for Working Capital	$ 943,113	$ 953,371	$ 958,770	$ 985,526	$ 1,002,280
Working Capital %	7.50%	7.50%	7.50%	7.50%	7.50%
TOTAL WCA	**$ 70,733**	**$ 71,503**	**$ 71,908**	**$ 73,914**	**$ 75,171**

Table 2 UPDATED JUNE 4, 2025 – Working Capital Allowance 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	**2022**	**2023**	**2024**	**2025**
Power Supply Expenses	$ 858,376	$ 852,835	$ 845,992	$ 871,246	$ 884,398
OM&A Expenses	$ 84,737	$ 100,536	$ 112,778	$ 115,320	$ 118,922
Total Expenses for Working Capital	$ 943,113	$ 953,371	$ 958,770	$ 986,566	$ 1,003,320
Working Capital %	7.50%	7.50%	7.50%	7.50%	7.50%
TOTAL WCA	**$ 70,733**	**$ 71,503**	**$ 71,908**	**$ 73,992**	**$ 75,249**

Table 3 below provides a summary of Hydro Ottawa's proposed WCA for 2026-2030.

Table 3 – Proposed Working Capital Allowance 2026-2030 ($'000s)

	Test Years				
	2026	2027	2028	2029	2030
Power Supply Expenses	$ 920,527	$ 942,546	$ 970,565	$ 997,399	$ 1,024,647
OM&A Expenses	$ 140,010	$ 147,473	$ 155,333	$ 163,613	$ 172,333
Total Expenses for Working Capital	$ 1,060,537	$ 1,090,019	$ 1,125,898	$ 1,161,011	$ 1,196,980
Working Capital %	7.50%	7.50%	7.50%	7.50%	7.50%
TOTAL WCA	**$ 79,540**	**$ 81,751**	**$ 84,442**	**$ 87,076**	**$ 89,773**

2. WORKING CAPITAL PERCENTAGE

As part of the Chapter 2 *Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications*, dated December 9, 2024 (Filing Requirements), distributors have the ability to propose a working capital percentage by either using the OEB default allowance of 7.5% or file a lead/lag study. Hydro Ottawa has opted to use the OEB default working capital percentage of 7.5% in calculating its working capital in Table 3. This approach is consistent with what was approved as part of Hydro Ottawa's 2021-2025 rate application.

Hydro Ottawa's OEB-approved 2021-2025 WCA percentages are shown in Table 1 above. The OEB's default WCA percentage of 7.5%, as detailed in Table 3, was incorporated into Schedule 2-1-1 - Rate Base Overview for the 2026-2030 working capital requirement in Hydro Ottawa's 2026-2030 rate base. This percentage was also included in the revenue requirements and presented in Schedule 6-1-1 - Revenue Requirement and Revenue Deficiency or Sufficiency.

3. OPERATIONS, MAINTENANCE AND ADMINISTRATION

In Table 3, the Operations, Maintenance and Administration (OM&A) expense used in the WCA aligns with the proposed 2026 Test Year OM&A detailed in Schedule 4-1-1 - Operations, Maintenance and Administration Summary. For 2027-2030, Hydro Ottawa proposes the OM&A incorporated in WCA be escalated by the inflation (I) and growth factor (G), without the adjustment for productivity (X). For more details on Hydro Ottawa's proposed custom rate framework, please refer to Schedule 1-3-1 - Rate Setting Framework.

4. CALCULATION OF COMMODITY AND COST OF POWER EXPENSE

The billing determinants underpinning the estimated Power Supply Expense use the forecasted monthly purchased kWh and peak kW produced by the revenue load forecast described in Schedule 3-1-1 - Revenue Load and Customer Forecast. The Test Years calculation for commodity expense and cost of power is detailed in Appendix 2-Z, in the following Excel Attachments:

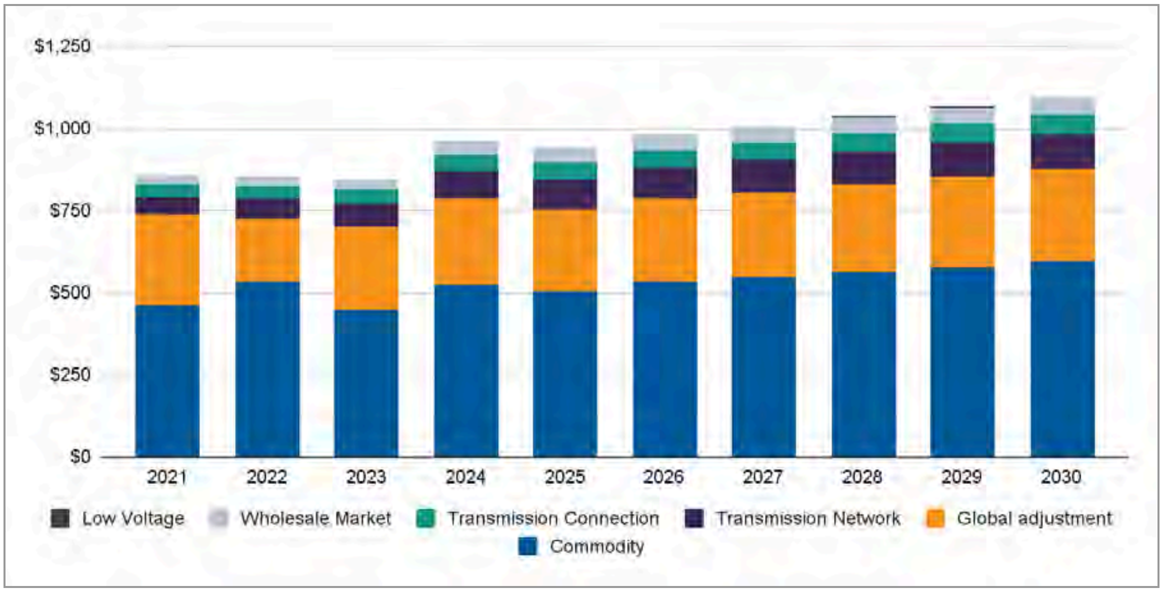
- Attachment 2-3-1(A) OEB Appendix 2-Z - 2026 Commodity Expense
- Attachment 2-3-1(B) OEB Appendix 2-Z - 2027 Commodity Expense
- Attachment 2-3-1(C) OEB Appendix 2-Z - 2028 Commodity Expense
- Attachment 2-3-1(D) OEB Appendix 2-Z - 2029 Commodity Expense
- Attachment 2-3-1(E) OEB Appendix 2-Z - 2030 Commodity Expense

Table 4 – Summary of Estimated Annual Cost of Power Expenses 2026-2030 ($'000s)

	Test Years				
	2026	2027	2028	2029	2030
Commodity	$ 787,047	$ 805,932	$ 830,311	$ 852,779	$ 875,948
Wholesale Market	$ 46,953	$ 47,878	$ 49,113	$ 50,218	$ 51,331
Transmission Network	$ 95,001	$ 97,517	$ 100,297	$ 103,467	$ 106,617
Transmission Connection	$ 53,225	$ 54,636	$ 56,193	$ 57,970	$ 59,734
Smart Meter Entity Charge	$ 1,886	$ 1,905	$ 1,969	$ 2,035	$ 2,102
Low Voltage	$ 457	$ 471	$ 483	$ 496	$ 510
OER Credit	$ (64,042)	$ (65,794)	$ (67,800)	$ (69,566)	$ (71,595)
TOTAL	**$ 920,527**	**$ 942,546**	**$ 970,565**	**$ 997,399**	**$ 1,024,647**

Figure 1 below illustrates Hydro Ottawa's annual cost of power expense from 2021-2030. Annual amounts from 2021-2023 are Historical, 2024-2025 are Bridge Years, and 2026-2030 have been forecasted using Appendix 2-Z and as described in the subsections of this Schedule.

Figure 1 – Cost of Power Expense 2021-2030 ($'000 000s)[2]



4.1. COMMODITY EXPENSE AND GLOBAL ADJUSTMENT

As per Section 2.2.5 of the Filing Requirements, Hydro Ottawa has completed Appendix 2-Z - Commodity Expense for 2026-2030.

Hydro Ottawa has used the 2023 Actual kWh and split each class by Regulated Price Plan (RPP) and non-RPP Class A and Class B customers to determine the percentage shares for the forecasted commodity and cost of power expense. The RPP Supply Cost Summary from the OEB's most recent RPP Report has been used to determine the 2025 forecast commodity price. [3] For 2026-2030 a 2.1% inflationary increase has been applied to determine the estimated RPP, Global Adjustment (GA) and Hourly Ontario Energy Price (HOEP), as described below. As noted in the most recent RPP Report,[4] the impact of the IESO's Market Renewal Program (MRP) is currently unknown. Hydro Ottawa has not factored MRP into the Test Years expense.

[2] Figure does not include Ontario Electricity Rebate amounts.
[3] Ontario Energy Board, *Regulated Price Plan Report November 1, 2024 to October 21, 2025,* (October 18, 2024).
[4] Ontario Energy Board, *Regulated Price Plan Report November 1, 2024 to October 31, 2025,* (October 18, 2024), Pages 1-2.

4.1.1. Estimated RPP Price

The commodity price for RPP customers was calculated by using the OEB's RPP Report. The 2025 RPP Rate of $99.38/MWh[5] was multiplied by a yearly inflationary factor of 2.1% to estimate the yearly RPP commodity price for 2026-2030. In addition, the annual commodity price includes an additional $1/MWh to forecast commodity price adjustments.

Table 5 – Estimated RPP Price ($/kWh)

2025	2026	2027	2028	2029	2030
$ 0.09937	$ 0.10545	$ 0.10764	$ 0.10988	$ 0.11217	$ 0.11450

4.1.2. Estimated Global Adjustment

For Class B kWh the most recent GA rate of $66.64/MWh from the OEB's RPP Report was multiplied by an annual inflationary factor of 2.1% to arrive at a yearly GA Class B rate for 2026-2030. Please see Table 6 below for the yearly rates. The Class A GA rate is based on the average $ per kWh derived from 2023 Historical Class A kWh and Class A GA expense. The 2023 rate of $51.12/MWh was multiplied by a yearly inflationary factor of 2.1% to estimate the yearly GA Class A price for 2026-2030. Please see Table 7 for yearly rates.

Table 6 – Estimated Global Adjustment Price - Class B ($/kWh)

2025	2026	2027	2028	2029	2030
$ 0.06664	$ 0.06804	$ 0.06947	$ 0.07093	$ 0.07242	$ 0.07394

Table 7 – Estimated Global Adjustment Price - Class A ($/kWh)

2025	2026	2027	2028	2029	2030
$ 0.05330	$ 0.05440	$ 0.05550	$ 0.05670	$ 0.05790	$ 0.05910

[5] Ibid, Page 3.

4.1.3. Estimated Hourly Energy Price (HOEP)

For 2026-2030, the estimated HOEP rate has been calculated by taking the estimated annual Average Supply Cost for RPP customers and subtracting the annual estimated GA and adjustment to address bias towards unfavourable variance. Table 8 identifies the estimated HOEP prices for 2026-2030.

Table 8 – Estimated HOEP ($/kWh)

2025	2026	2027	2028	2029	2030
$ 0.03566	$ 0.03641	$ 0.03717	$ 0.03795	$ 0.03875	$ 0.03956

4.2. WHOLESALE EXPENSE

The 2026 Wholesale Market Charge (WMC) is calculated by multiplying the total kWh purchased by the 2025 approved rate of $0.0041/kWh.[6] For years 2027-2030 the WMC rate is inflated by 2.1% annually.

4.2.1. Class A & B Capacity Based Recovery

The Class A Capacity Based Recovery (CBR) rate is calculated by dividing the 2023 Historical Class A CBR expense by 2023 Class A kWh. The calculated rate of $0.0004/kWh has been used for all years. The 2025 approved Class B CBR rate of $0.0004/kWh[7] is used to estimate the annual expense for 2026-2030.

4.2.2. Rural Remote Rate Protection

The Rural Remote Rate Protection (RRRP) Charge is calculated by multiplying the total kWh purchased by the 2025 approved rate of $0.0015/kWh[8] for all years.

[6] Ontario Energy Board, *Wholesale Market Services Rate and the Rural or Remote Electricity Rate Protection Charge Decision and Order for January 1, 2025*, EB-2024-0282 (December 10, 2024), Page 9.
[7] Ibid.
[8] Ibid.

4.3. TRANSMISSION EXPENSE

The forecasted kW monthly coincident peak from the revenue load and customer forecast is multiplied by 2023 Historical percentages for each transmission charge to establish the kWs for those charges. Table 9 below outlines the yearly rates calculated for Hydro One Networks Inc. (Hydro One) Retail Transmission Service Rates (RTSRs) and Uniform Transmission Rates (UTRs).

Table 9 – Retail Transmission Service & Uniform Transmission Rates ($/kW)

	2025	2026	2027	2028	2029	2030
RTSR - Network Service	$ 5.3280	$ 5.5054	$ 5.6172	$ 5.7352	$ 5.8556	$ 5.9786
RTSR - Line Connection Rate	$ 0.6882	$ 0.7111	$ 0.7255	$ 0.7407	$ 0.7563	$ 0.7722
RTSR - Transformation Connection Service Rate	$ 3.4894	$ 3.6056	$ 3.6788	$ 3.7561	$ 3.8350	$ 3.9155
UTRs - Network	$ 6.37	$ 6.58	$ 6.72	$ 6.86	$ 7.00	$ 7.15
UTRs - Line Connection	$ 1.00	$ 1.03	$ 1.05	$ 1.08	$ 1.10	$ 1.12
UTRs - Transformation Connection	$ 3.39	$ 3.50	$ 3.57	$ 3.65	$ 3.73	$ 3.80

4.3.1. HONI Transmission Rates

For 2026-2027 Hydro Ottawa has increased the 2025 OEB-approved[9] Hydro One Sub-Transmission RTSRs using the Transmission Custom Revenue Cap Index (RCI) method, as detailed in Hydro One's most recent Custom IR Transmission and Distribution Rate Application.[10] For 2028-2030 the transmission rates have been inflated by 2.1% annually.

[9] Ontario Energy Board, *Hydro One Networks Electricity Distribution Rates and other Charges beginning January 1, 2025, Decision and Order*, EB-2024-0032 (December 19, 2024), Schedule A, page 11
[10] Hydro One Networks Inc., *2023-2027 Custom Incentive Rate-setting Approved Settlement Agreement,* EB-2021-0110 (November 16, 2022), page 6.

4.3.2. Uniform Transmission Rates (UTRs)

For 2026 and 2027, the 2025 Approved UTRs[11] have been inflated by the Transmission RCI. Hydro Ottawa has increased the transmission rates for 2028-2030 based on a 2.1% inflationary factor.

4.4. LOW VOLTAGE (LV) CHARGES

To estimate the expense for 2026-2030, the forecasted kW monthly coincident peak is multiplied by Historical percentages of low voltage charges. Hydro Ottawa has adjusted the annual rates by the Distribution RCI method[12] as described in Hydro One's most recent application for 2026-2027 and applied a 2.1% inflationary factor for 2028-2030. Annual estimated LV expense is divided by total annual system unadjusted kWh to derive the $ per kWh rate. The yearly per kWh rates calculated are outlined in Table 10.

Table 10 – Low Voltage Charges ($/kWh)

	2025	2026	2027	2028	2029	2030
Low Voltage	$ 0.000059	$ 0.000061	$ 0.000063	$ 0.000064	$ 0.000065	$ 0.000067

4.5. SMART METERING ENTITY CHARGE

On September 8, 2022, the OEB approved a Smart Metering Entity charge of $0.42 per Residential and General Service <50 kW customer per month for the period January 1, 2023 to December 31, 2027.[13] This rate has been used for 2026-2027, with 2.1% adjustment for inflation annually for 2028-2030. Hydro Ottawa has used the monthly average load forecast count for Residential and General Service <50 kW customers to calculate the annual expense. Please refer to Schedule 3-1-1 - Revenue Load and Customer Forecast for 2026-2030 average number of customers by class.

[11] Ontario Energy Board, *2025 Uniform Transmission Rates Decision and Order*, EB-2024-0244 (January 21,2025), Schedule A.
[12] Hydro One Networks Inc., *2023-2027 Custom Incentive Rate-setting Approved Settlement Agreement,* EB-2021-0110 (November 16, 2022), page 8.
[13] Ontario Energy Board, Independent Electricity System Operator, Smart Metering Charge *Decision and Order for the years 2023 to 2027*, EB-2022-0137 (September 8, 2022), page 3.

4.6. ONTARIO ELECTRICITY REBATE CREDIT

For 2026-2030, yearly cost of power expenses related to RPP kWh and customers have been reduced by the current OER credit of 13.1%.

Attachment 2-3-1(A) - OEB Appendix 2-Z - 2026 Commodity Expense

(Refer to the attachment in Excel format)

Attachment 2-3-1(B) - OEB Appendix 2-Z - 2027 Commodity Expense

(Refer to the attachment in Excel format)

Attachment 2-3-1(C) - OEB Appendix 2-Z - 2028 Commodity Expense

(Refer to the attachment in Excel format)

Attachment 2-3-1(D) - OEB Appendix 2-Z - 2029 Commodity Expense

(Refer to the attachment in Excel format)

Attachment 2-3-1(E) - OEB Appendix 2-Z - 2030 Commodity Expense

(Refer to the attachment in Excel format)

CAPITAL EXPENDITURE SUMMARY

In accordance with the *Chapter 2 and Chapter 5 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications,* dated December 9, 2024, Hydro Ottawa has filed a consolidated Distribution System Plan (DSP) as Tab 2-5, specifically Schedules 2-5-1 through 2-5-9.

The nine schedules within the DSP Tab are:

- Schedule 2-5-1 - Distribution System Plan Overview;
- Schedule 2-5-2 - Coordinated Planning with Third Parties;
- Schedule 2-5-3 - Performance Measurement for Continuous Improvement;
- Schedule 2-5-4 - Asset Management Process;
- Schedule 2-5-5 - Capital Expenditure Plan;
- Schedule 2-5-6 - System Access Investments;
- Schedule 2-5-7 - System Renewal Investments;
- Schedule 2-5-8 - System Service Investments; and
- Schedule 2-5-9 - General Plant Investments.

Figure 1 shows annual capital expenditures for both the historic and forecast periods.

Figure 1 – Summary of 2021-2030 Annual Capital Expenditures ($'000,000s)

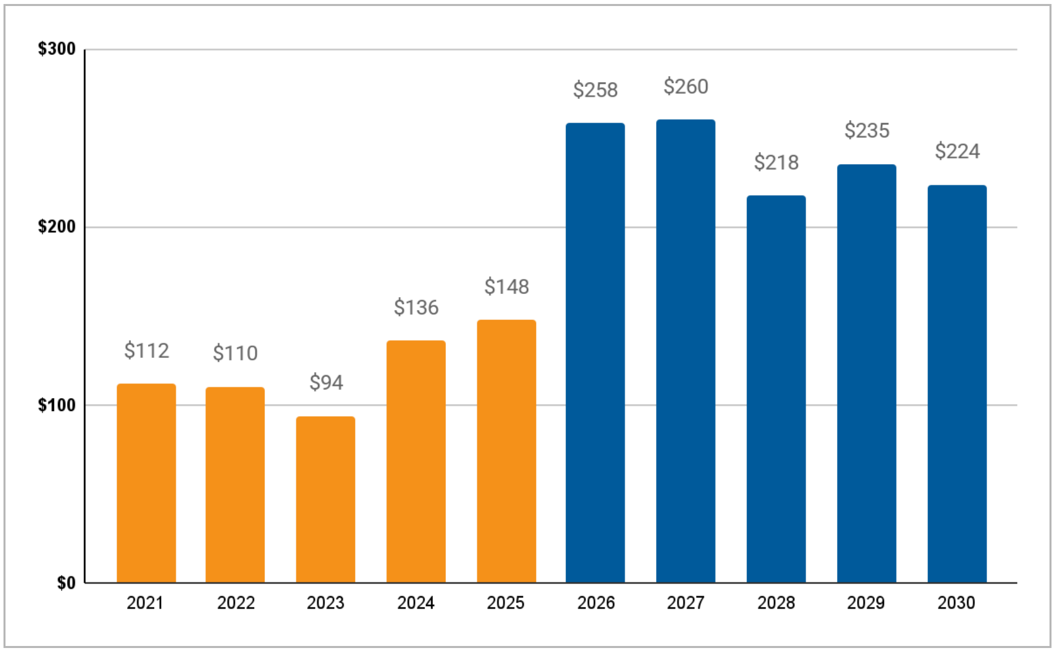


Table 1 below provides a summary of the expenditures for 2021-2025 for the Historical and Bridge years by Investment Category.

Table 1 – 2021-2025 Capital Expenditures ($'000 000s)

Investment Category	Historical Years			Bridge Years		Average
	2021	2022	2023	2024	2025	2021-2025
System Access	$ 47.7	$ 47.1	$ 53.4	$ 68.7	$ 75.8	$ 58.5
System Renewal	$ 43.3	$ 65.5	$ 40.3	$ 42.3	$ 41.0	$ 46.5
System Service	$ 24.0	$ 13.8	$ 16.6	$ 47.2	$ 59.5	$ 32.2
General Plant	$ 23.7	$ 11.4	$ 12.9	$ 15.2	$ 13.1	$ 15.3
Capital Contributions	$ (26.5)	$ (27.5)	$ (29.1)	$ (37.3)	$ (41.5)	$ (32.4)
TOTAL	**$ 112.1**	**$ 110.3**	**$ 94.0**	**$ 136.1**	**$ 147.9**	**$ 120.1**

Table 2 provides a summary of the expenditures for the 2026-2030 test years by Investment Category.

Table 2 – Summary of 2026-2030 Capital Expenditures ($'000 000s)

Investment Category	Test Years					Average
	2026	2027	2028	2029	2030	2026-2030
System Access	$ 86.2	$ 78.7	$ 66.2	$ 67.0	$ 71.5	$ 73.9
System Renewal	$ 85.3	$ 83.4	$ 80.7	$ 86.9	$ 95.3	$ 86.3
System Service	$ 99.3	$ 125.3	$ 76.1	$ 85.9	$ 86.9	$ 94.7
General Plant	$ 38.3	$ 23.6	$ 33.0	$ 27.9	$ 11.0	$ 26.8
Capital Contributions	$ (50.9)	$ (50.6)	$ (38.4)	$ (32.2)	$ (41.1)	$ (42.6)
TOTAL	**$ 258.2**	**$ 260.4**	**$ 217.5**	**$ 235.5**	**$ 223.7**	**$ 239.1**

For the capital expenditure-related appendices that electricity distributors must submit, pursuant to the Filing Requirements please see the following attachments:

- Attachment 2-5-5(A) - OEB Appendix 2-AA - Capital Programs Table
- Attachment 2-5-5(B) - OEB Appendix 2-AB - Capital Expenditure Summary

As shown in Table 3 below, for the 2021-2025 historic period, Hydro Ottawa expects that its capital expenditures will exceed the approved forecast by approximately $102.8M (net) over the five-year period.

Table 3 – 2021-2025 Capital Expenditures vs. OEB-Approved Amounts ($'000 000s)

Investment Category	2021 - 2025 OEB-Approved	2021 - 2025 Historical/Bridge	Var ($)	Var (%)
System Access	$ 203.7	$ 292.6	$ 88.9	44%
System Renewal	$ 210.0	$ 232.3	$ 22.4	11%
System Service	$ 123.1	$ 161.1	$ 38.0	31%
General Plant	$ 82.0	$ 76.4	$ (5.6)	(7)%
TOTAL OEB- APPROVED CAPITAL EXPENDITURES	**$ 618.7**	**$ 762.4**	**$ 143.7**	**23%**
Capital Contributions	$ (121.2)	$ (162.0)	$ (40.9)	34%
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 497.561**	**$ 600.4**	**$ 102.8**	**21%**

For comprehensive explanatory notes and variance analyses of Hydro Ottawa's capital expenditures, please refer to Schedule 2-5-5 - Capital Expenditure Plan.

For the special studies to support Hydro Ottawa's proposed capital expenditure plan and rate base levels for the 2026-2030, please see the following attachments:

- Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report
- Attachment 2-5-4(A) - ISO 55001 Hydro Ottawa Certificate of Conformance 2023
- Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk and Vulnerability Assessment and Climate Change Adaptation Plan
- Attachment 2-5-4(C) - Asset Condition Assessment Third Party Review
- Attachment 2-5-4(D) - Failure Curves Review
- Attachment 2-5-4(E) - Resilience Investment Business Case Report
- Attachment 2-5-4(F) - Decarbonization Study

Distribution System Plan

2026-2030

Hydro Ottawa

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		6		**Alternatives Evaluation**
			1	Alternatives Considered
			2	Evaluation Criteria
			3	Preferred Alternative
		7		**Program Execution and Risk Mitigation**
			1	Implementation Plan
			2	Risks to Completion and Risk Mitigation Strategies

DISTRIBUTION SYSTEM PLAN OVERVIEW

1. INTRODUCTION

Hydro Ottawa's Distribution System Plan (DSP) provides a comprehensive overview of how the utility manages its electricity distribution assets and plans for future investments to deliver safe, reliable, and cost-effective service to customers over the 2026-2030 period. The DSP is included in this Application as Schedules 2-5-1 through 2-5-9, and encompasses the following key areas:

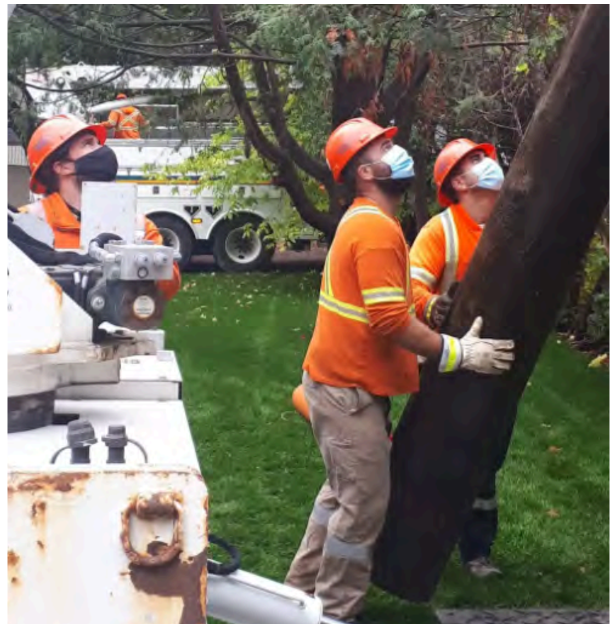
- **Coordinated Planning with Third Parties:** Details how Hydro Ottawa coordinates infrastructure planning with customers, transmitters, other distributors, the IESO and other third parties where appropriate.
- **Performance Reporting:** Outlines how Hydro Ottawa tracks key performance indicators to monitor the effectiveness of its asset management practices and ensure performance targets are met.
- **Asset Management Strategy:** Details how Hydro Ottawa identifies, assesses, and manages risks and opportunities associated with its infrastructure. This includes the utility's approach to maintenance, refurbishment and equipment replacement.
- **Capital Expenditure Plan:** Details Hydro Ottawa's planned investments in the distribution system, which includes upgrades, expansions, and new technologies aimed at improving reliability, safety, and accommodating load growth.
- **Material Investments:** Details capital expenditure projects and programs that meet Hydro Ottawa's materiality threshold. Material investments are grouped by the four investment categories identified by the OEB, namely System Access, System Renewal, System Service and General Plant.

Hydro Ottawa's 2026-2030 DSP is a comprehensive roadmap for managing and investing in the electricity distribution system. It outlines a systematic approach used to collect and analyze information on physical assets, current and future system operating conditions, and Hydro Ottawa's business and customer service goals. This thorough assessment allows Hydro Ottawa to strategically prioritize and optimize expenditures related to system upgrades, maintenance, and overall operation. The DSP ensures that Hydro Ottawa's investments are aligned with its overarching goals and the current and future needs of customers and the electricity grid.

Hydro Ottawa continuously maintains and improves its robust asset management practices. The ongoing evaluation and adjustment of the processes and information informing the DSP ensure alignment with evolving industry best practices, regulatory changes, and emerging technologies. This proactive asset management approach supports the achievement of the OEB's four RRF performance outcomes: Customer Focus, Operational Effectiveness, Public Policy Responsiveness, and Financial Performance, contributing to the safe, reliable, and sustainable electricity service essential for community growth and economic development.

The DSP was developed in alignment with the OEB's *Chapter 5 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications*, dated December 9, 2024, as well as with the *Handbook for Utility Rate Applications* issued by the OEB in 2016.

1.1. CONTEXT

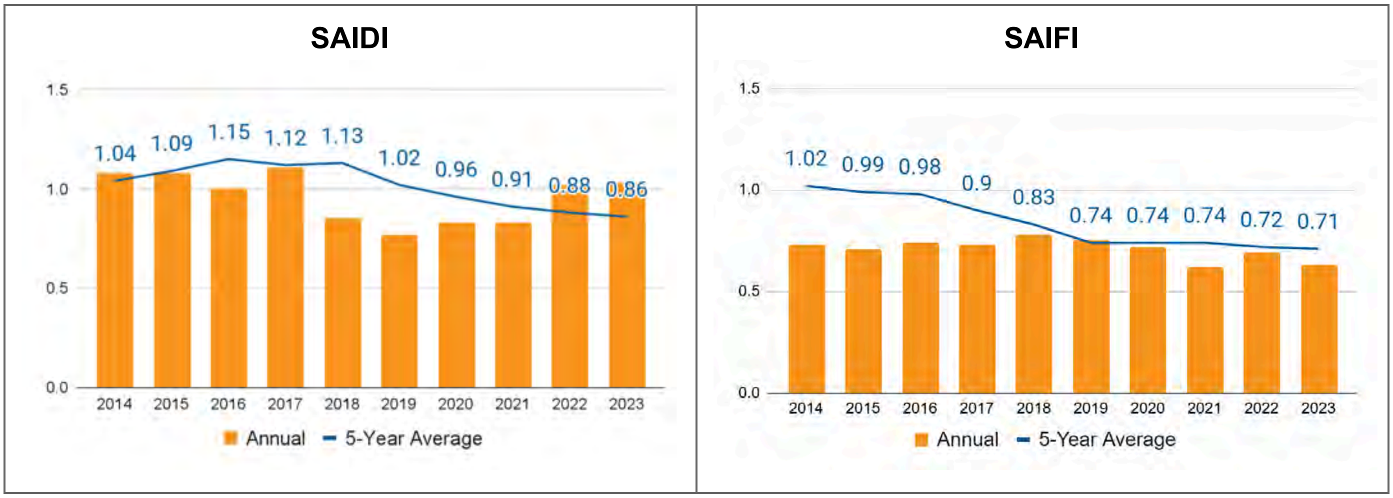

Hydro Ottawa crew during COVID-19

Between 2021 and 2024, Hydro Ottawa faced an unprecedented series of unforeseen challenges that tested its resilience. These challenges included the COVID-19 pandemic and its associated supply chain disruptions and inflationary pressures; a historic storm (the 2022 Derecho) that caused extensive damage to the electricity grid; eleven other major weather events requiring emergency response; and a 84-day strike in 2023. Despite these obstacles, Hydro Ottawa's robust systems and processes, coupled with its agile approach to adapting priorities and programs, enabled the utility to effectively assess and navigate these extraordinary circumstances. This resilience and adaptability allowed for continued progress towards the goals outlined in the 2021-2025 DSP, underscoring Hydro Ottawa's commitment to operational continuity and achieving its long-term strategic objectives.

Hydro Ottawa's 2021-2025 DSP, as filed in its 2021-2025 Custom Incentive Rate-Setting (Custom IR) Application,[1] focused on expanding system capacity and renewing aging infrastructure. This included strategic investments to increase system capacity by 160MVA (Cambrian-100MVA, Limebank-33MVA and Uplands-27MVA) through new station construction and upgrades. The distribution capacity upgrade program also significantly unlocked new distribution line capacity. Targeted infrastructure renewal projects supported the overall improvement to system reliability as evidenced by the reduction to the 5-year average SAIDI and SAIFI performance excluding Loss of Supply and Major Event Days, shown in Figure 1.

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020).

Figure 1 - SAIDI & SAIFI - Annual and 5-Year Average (Excluding Loss of Supply and Major Event Days)



Restoration work after the 2022 Derecho

Hydro Ottawa's 2026-2030 DSP outlines a comprehensive investment strategy that aligns with customer expectations and addresses the evolving needs of Hydro Ottawa's electricity grid. The updated 2026-2030 plan incorporates key improvements, including enhanced asset management processes, expanded grid modernization and resilience planning, updated system capacity assessments, and refined long-term forecasting based on customer feedback and system needs.

Hydro Ottawa has identified four strategic investment priorities for its 2026-2030 DSP. These priorities were determined through a comprehensive analysis that considered customer preferences identified through engagement activities, system needs, historical system performance, and trends identified through the business planning process.[2] The four Investment Priorities are:

1. **Growth & Electrification - Powering the Growing Community:** Focusing on expanding grid capacity to serve a growing community and ensure a reliable, resilient electricity system capable of meeting increasing demand driven by new customer connections and distributed energy resources (DERs).
2. **Renewing Deteriorating Infrastructure:** Focusing on mitigating reliability risk by strategically upgrading or replacing deteriorating and critical infrastructure, prioritizing assets with the greatest impact on system reliability and safety based on condition assessments.
3. **Grid Modernization - Enabling the Energy Transition:** Focusing on modernizing the grid through strategic technology adoption and infrastructure upgrades to enable the energy transition, facilitate customer participation, and optimize DER integration, thereby enhancing grid capabilities and efficiency.
4. **Enhancing Grid Resilience:** Focusing on enhancing grid resilience by proactively upgrading infrastructure and implementing measures to protect against increasingly frequent and intense severe weather events and cyber threats.

[2] For further details on Hydro Ottawa's business planning process, see Schedule 1-2-3 - Business Plan.

These four investment priorities address Hydro Ottawa's key distribution system planning challenges and opportunities, supported by two foundational focuses: Managing Rising Costs and Investing in the Workforce. In all aspects of planning, execution and performance monitoring, Hydro Ottawa emphasizes maintaining affordability for customers while ensuring a reliable and resilient electricity system to meet growing demand. To accomplish the priorities set out in this plan, Hydro Ottawa recognizes the importance of workforce development and safety to ensure a skilled and secure energy future.

1.2. 2026-2030 CAPITAL EXPENDITURE PLAN

Hydro Ottawa's planned capital investments for 2026-2030 represent a significant increase compared to the previous five-year period, reflecting the substantial challenge of modernizing and expanding the grid to meet the evolving needs of the community. The scale of these investments underscores Hydro Ottawa's commitment to providing safe and reliable electricity to the City of Ottawa and Municipality of Casselman while ensuring resilience in the face of climate change.

Figure 2 below provides a visual representation of 2026-2030 planned expenditures by Investment Priority.

Clearing damaged equipment after the May 2022 Derecho

Figure 2 - 2026-2030 Capital Expenditure by Investment Priority

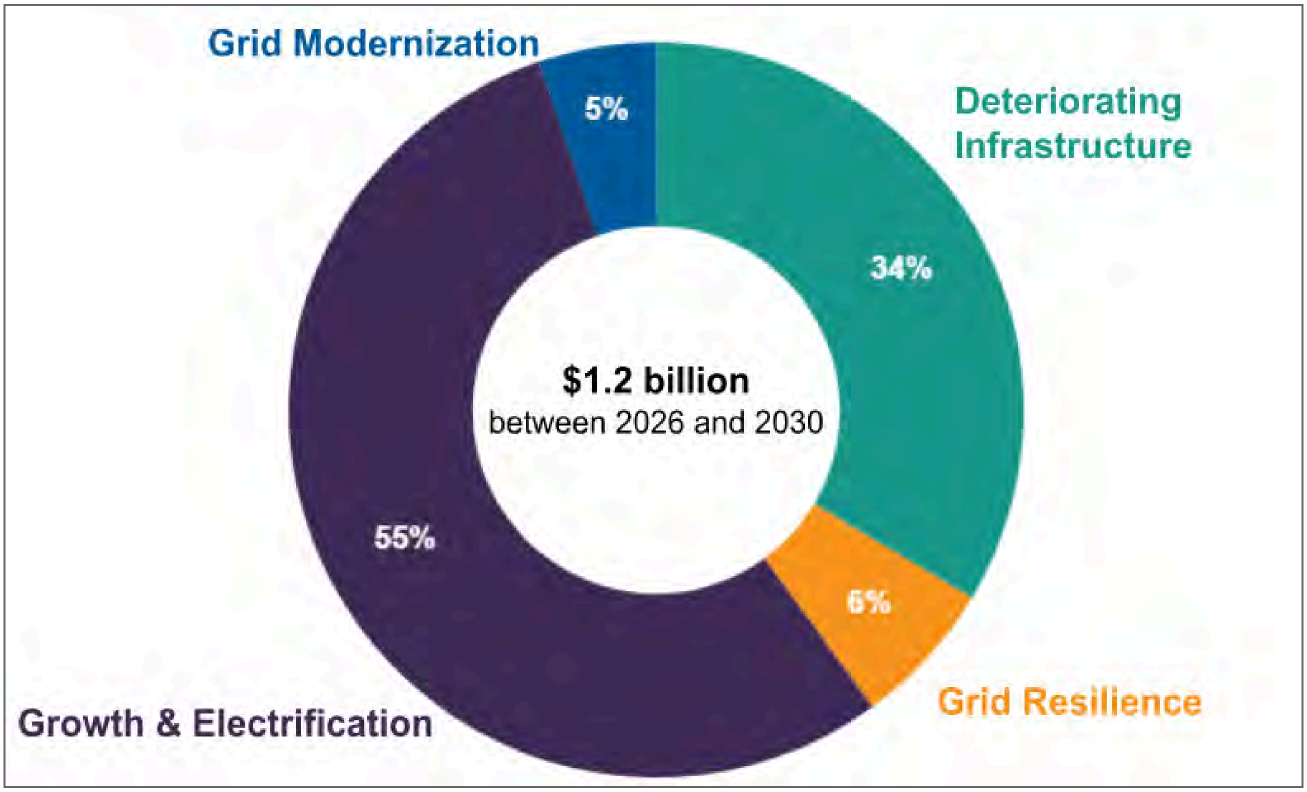


Table 1 below outlines the variance between Hydro Ottawa's 2021-2025 and 2026-2030 planned investments by investment category.

Table 1 - Capital Expenditure Variance by Investment Category - 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)

Investment Category	Historical / Bridge Years	Test Years	Variance
	2021-2025	2026-2030	
System Access	$ 293	$ 369	$ 77
System Renewal	$ 232	$ 432	$ 199
System Service	$ 161	$ 473	$ 312
General Plant	$ 76	$ 134	$ 57
Total Capital Expenditures	**$ 762**	**$ 1,409**	**$ 646**
Capital Contributions	$ (162)	$ (213)	$ (51)
Net Capital Expenditures	**$ 600**	**$ 1,195**	**$ 595**

Hydro Ottawa's 2026-2030 DSP strikes a balance between customer priorities and system needs, representing the minimum investment required to ensure a reliable, resilient and sustainable electricity grid. Through strategic planning and prudent investment aligned with customer priorities, Hydro Ottawa is committed to meeting the evolving energy needs of the community while ensuring continued safe, reliable and affordable electricity for its customers.

2. KEY ELEMENTS OF THE DSP

This section details the key elements included within the DSP. It outlines the essential components and considerations that shape the DSP's development and implementation, ensuring a robust and effective approach to managing the distribution system. Key elements of the 2026-2030 DSP include details of the updates to the DSP since filed with the 2021-2025 Rate Application, customer priorities, the challenges and trends faced by the utility, and resulting focus areas that inform investment plans.

2.1. CHANGES IN THE DSP

The following sections detail the key changes that impact the inputs into the DSP since the previous DSP submission in the 2021-2025 rate application.

2.1.1. Asset Management Process

To ensure a reliable, resilient, and customer-centric electricity grid, Hydro Ottawa has made significant enhancements to its asset management process. These improvements, centered on predictive analysis, refined testing, inspection, and maintenance, and a more robust ACA framework, reflect a forward-thinking approach that strategically aligns asset management practices with the company's broader objectives and customer needs. Hydro Ottawa has also continued to demonstrate a commitment to advanced asset management, evidenced by initially achieving ISO 55001 Asset Management Standard certification in 2020 and recertified in 2023. This certification highlights the maturity of the asset management system, which includes enhancements like a comprehensive risk register and targeted mitigation plans. These practices support strategic asset decision-making, balancing cost, risk, and performance to meet customer expectations and regulatory requirements.

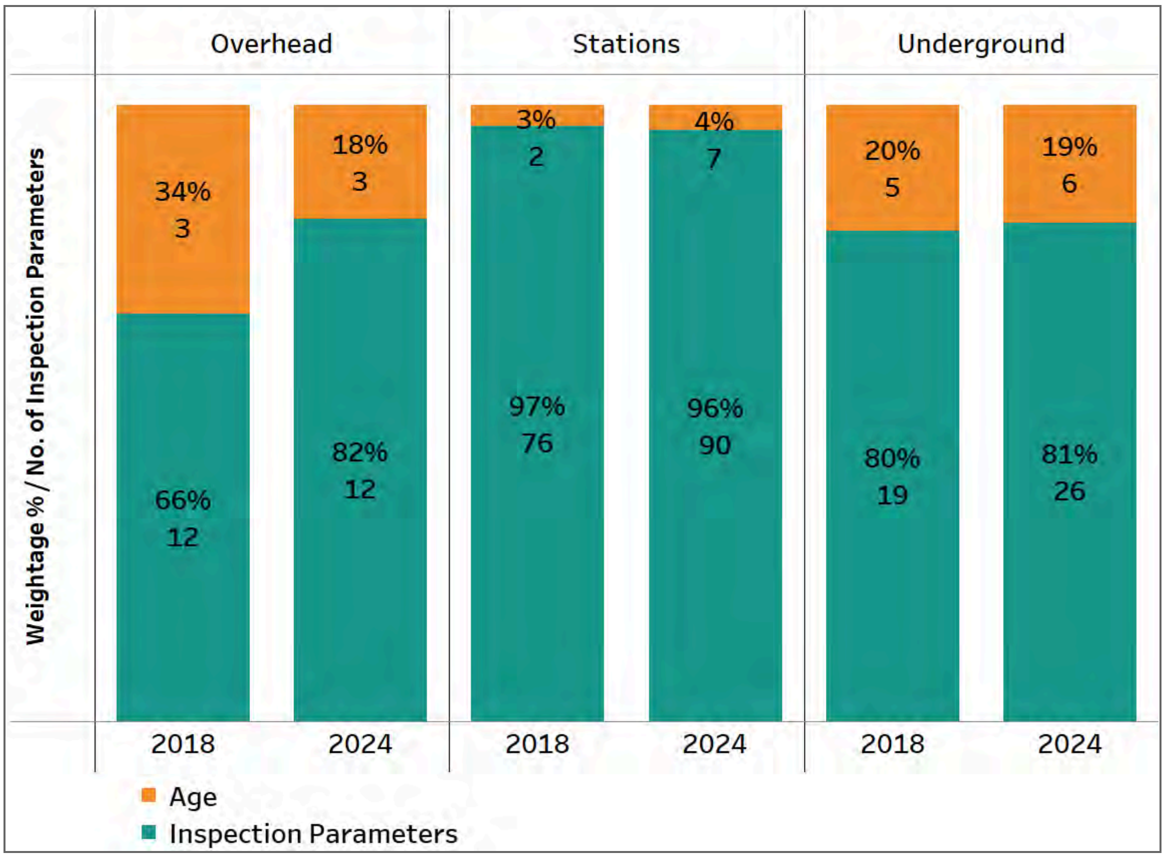
A key enhancement is the incorporation of predictive analysis into system renewal investment planning. This involves using the Copperleaf Asset Predictive Analytics (PA) module to model distribution assets and forecast system renewal needs. This predictive capability allows Hydro Ottawa to move towards a more proactive approach by predicting the effects of asset degradation over time and optimizing replacement schedules. The PA module analyzes asset data, including condition and risk information, to forecast the impact of asset degradation and inform investment decisions. This analysis helps determine the optimal timing for interventions like replacements or upgrades, considering factors such as risk mitigation and cost-effectiveness. By leveraging PA, Hydro Ottawa aims to make higher-value investment decisions, ultimately improving the management of its assets.

In addition to PA, Hydro Ottawa has also significantly refined its testing, inspection, and maintenance programs. These refinements aim to capture more detailed data on asset conditions. For instance, the overhead asset inspection program now captures information on pole-mounted transformers, switches, and related hardware at every pole inspected, rather than only when an issue is found. This provides a more comprehensive understanding of the health of these assets. For underground infrastructure, Hydro Ottawa has enhanced its cable testing methodology, incorporating advanced testing methods such as Very Low Frequency Tan-Delta, Partial Discharge, and Time Domain Reflectometry. These advanced techniques provide a deeper understanding of the condition of cable components, facilitating more targeted remediation efforts. This improved data collection allows for more precise condition assessments to inform investment planning.

Hydro Ottawa has also enhanced its Asset Condition Assessment (ACA) framework to provide a more accurate and comprehensive evaluation of asset health. A key improvement involves incorporating additional condition parameters derived from testing, inspection, and maintenance programs into the calculation of asset health index scores. This integration of diverse data sources results in a more holistic view of an asset's condition.

Hydro Ottawa's Asset Condition Assessment framework has undergone significant evolution between 2018 and 2024, as evidenced by the data presented in Figure 3 below. A notable shift from age-based to condition-based asset evaluation is demonstrated across various asset categories. For overhead assets, the reliance on age was substantially reduced due to improvements to the condition assessment framework for poles, alongside moderate improvements to condition data quality from Overhead (OH) switches and transformers through ground-based inspections. Station assets saw a significant increase in the number of parameters utilized, reflecting the integration of previously underutilized inspection data, with minimal reliance on age. Underground assets experienced an increase in assessment parameters, though the reliance on age remains comparatively higher. However, Hydro Ottawa has implemented ongoing improvements to the cable testing and vault inspection programs, demonstrating a commitment to enhancing condition data accuracy. Hydro Ottawa's strategic enhancements to the ACA framework underscore a commitment to proactive maintenance and risk management, aligning with industry best practices and emphasizing the importance of real-time, accurate condition data for informed decision-making.

Figure 3 - Hydro Ottawa’s ACA Framework Enhancements



More information on Hydro Ottawa’s ACA process can be found in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process.

These improvements collectively contribute to a more data-driven and risk-based approach to asset management, enabling Hydro Ottawa to optimize investments, enhance reliability, and ensure the long-term sustainability of its electricity grid. More details on the improvements that Hydro Ottawa made to its Asset Management Process are provided in Section 4.4 of Schedule 2-5-4 - Asset Management Process.

2.1.2. Grid Modernization

Grid Modernization Strategy & Roadmap Creation

Recognizing the challenges and opportunities of the evolving energy landscape, Hydro Ottawa engaged Hatch in 2022 to develop a comprehensive Grid Modernization Strategy and Roadmap. This initiative prioritized enhancing grid reliability, flexibility, resilience, and sustainability through a methodical, two-phased approach.

The first phase began with establishing a baseline maturity level by completing an assessment of Hydro Ottawa's existing grid infrastructure and operational capabilities. This evaluation was then compared against a desired future state vision across various time horizons, which revealed key areas for improvement. The second phase of the project used these key findings to develop the Grid Modernization Strategy, also drawing upon existing corporate directives, operational plans, ongoing initiatives, and industry best practices to ensure alignment and efficacy. This structured approach was designed to ensure that Hydro Ottawa's grid modernization efforts are strategically aligned, operationally sound, and effectively address the evolving demands of the energy landscape.

The Grid Modernization Strategy translates the corporate priorities into actionable objectives, which are then translated into investment plans by informing the objectives of both the Asset Management and Digital strategies. For more information, please see Section 3.4 of Schedule 2-5-4 - Asset Management Process. This ensures coordinated investment and avoids duplicated effort or inefficiencies that could arise from shared asset accountabilities. Specifically, it allows for sole oversight and coordination of distribution assets under the Asset Management framework and information technology assets under the Digital framework.


April 2023 Ice Storm

The Grid Modernization Roadmap operationalizes the Grid Modernization Objectives in conjunction with the Capital Expenditure plan. The Strategy defines the needs, which are then translated through the Asset Management and Digital Strategies into concrete investment plans. These plans are consolidated within the capital expenditure planning process and monitored through the Grid Modernization Roadmap to ensure the Grid Modernization Objectives are achieved.

More details on the Grid Modernization Strategy are available in Section 3.4.2 of Schedule 2-5-4 - Asset Management Process.

2.1.3. Resilience

As part of Hydro Ottawa's ongoing commitment to grid resilience and service reliability, a 2023 Climate Study Reaffirmation and the Resilience Investment Business Case assessments were undertaken. See Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan and Attachment 2-5-4(E) - Resilience Investment Business Case Report, respectively. These assessments support planning to enhance grid resilience and prioritize system reliability in the face of increasingly frequent severe weather events and growing dependence on stable power. The Climate Study Reaffirmation reconfirmed the necessity of continued adaptation and mitigation strategies, while the Resilience Investment Business Case Report offered a data-driven approach to identify and prioritize areas for strategic undergrounding of overhead lines.

Hydro Ottawa's resilience assessment aligns with the OEB's new and ongoing Vulnerability Assessment and System Hardening (VASH) framework, which intends to set out how distributors should incorporate climate resilience into their asset and investment planning to mitigate climate-related vulnerabilities. Hydro Ottawa uses an asset-based approach, leveraging climate forecast data from models developed by Burns & McDonnell's subsidiary 1898 & Co. by quantitatively comparing asset threshold criteria with the probability of extreme weather events during the project evaluation stage, Hydro Ottawa ensures investments enhance climate resilience within the distribution system.

Assessing Damage after the 2022 Derecho

Climate Study Reaffirmation

In 2023, Hydro Ottawa commissioned Stantec Consulting Ltd. to conduct a study to update the 2019 climate risk assessment,[3] incorporating the latest climate projection data and factoring in recent extreme weather events, including the 2022 Derecho storm. This comprehensive assessment utilized updated climate models and regional projections to refine the probability estimations of extreme weather events. Notably, two new wind speed thresholds, exceeding 130 km/h and 180 km/h, were introduced based on updated criteria and empirical observations from the 2022 Derecho storm. This led to a reassessment of potential high-wind impacts on infrastructure, resulting in elevated consequence ratings.

Despite the increased risk scores associated with severe wind events, the overall risk level for the majority of Hydro Ottawa's infrastructure remains unchanged. This finding indicates that the adaptation and mitigation measures outlined in the 2019 plan retain their efficacy. Consequently, the primary areas of vulnerability within Hydro Ottawa's system, namely overhead assets, remain consistent with previous assessments.

As a result, Hydro Ottawa commissioned a further study to explore strategic opportunities for undergrounding vulnerable sections of overhead lines to enhance the overall resilience of the electricity distribution system. Further details on the study's findings can be found in Section 4.4.8 of Schedule 2-5-4 - Asset Management Process.

Resilience Investment Business Case

Hydro Ottawa engaged 1898 & Co. to conduct a comprehensive assessment and develop a Resilience Investment Business Case for strategically burying vulnerable sections of the overhead distribution system. Refer to Attachment 2-5-4(E) - Resilience Investment Business Case Report. The report emphasizes the growing importance of grid resilience, highlighting the

[3] See Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020), Attachment 2-5-4(B): Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan.

increasing frequency of severe weather events and the community's dependence on reliable service. Employing a data-driven model, the study identified and prioritized resilience investments, focusing on the strategic conversion of overhead lines to underground systems.

Hydro Ottawa integrated the study's findings with empirical evidence from recent storm events to proactively incorporate resilience investments into the capital plan. The resulting Distribution System Resilience program encompasses a multi-faceted approach, including:

- Strategic undergrounding of vulnerable overhead lines;
- Reinforcement of existing overhead infrastructure;
- Feeder reconfiguration;
- Undergrounding of station egress points; and
- Relocation of lines.

April 2023 Ice Storm

These investments are designed to mitigate system disruptions caused by severe weather events, ultimately minimizing restoration costs, customer outage durations, and overall system recovery time.

A detailed description of the Distribution System Resilience program is provided in Section 3 of Schedule 2-5-8 - System Service Investments.

2.1.4. System Planning

Decarbonization Study

Decarbonization targets set out by federal and municipal bodies are increasingly impacting Hydro Ottawa's distribution system. Traditional forecasting methods which primarily rely on historical consumption patterns and projected growth based on known and observable trends fail to capture the uncertainties introduced by decarbonization goals and the resulting electrification of building, water heating and transportation. Recognizing this gap, the IESO created a Decarbonization Sub-Working Group to support studying the impacts of electrification on regional forecasts. In support of this sub-working group, Hydro Ottawa commissioned Black & Veatch in 2023 to conduct a Decarbonization Study, included in this Application as Attachment 2-5-4(F) - Decarbonization Study. This study evaluates the potential impacts of societal electrification trends on Hydro Ottawa's distribution system out to 2050 with a scenario-based approach. Five scenarios with varying assumptions of decarbonization initiatives on the distribution system are assessed in the Study with refinement from the Decarbonization Sub-Working Group. More details about this group are provided in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Hydro Ottawa is utilizing the Decarbonization Study's Reference Scenario forecast to inform its Integrated Regional Resource Plan (IRRP) forecast. This alignment is crucial for long-term regional transmission planning, given the extended lead times of transmission grid investments. Recognizing the uncertainties associated with government policies and technological advancements, Hydro Ottawa leveraged the forecast derived from the Decarbonization Study's

Reference scenario to augment its own investment decisions. Hydro Ottawa's 2026-2030 capital expenditure plans balance investment needs with affordability by prioritizing a mix of wire and Non-Wire Solutions (NWSs). Investments are focused on already constrained regions and areas with immediate, confirmed, and committed load requirements necessary to meet customer service obligations. These infrastructure investments were sized to accommodate demand growth projections in the IRRP forecast through 2035 to ensure efficient capital deployment. The most notable examples of projects, programs or updates that were informed by the decarbonization study include (a) the decision to increase the capacity of the Hydro Road, Cyrville, Kanata North and Greenbank stations to align with Hydro Ottawa's standard 100MVA design, (b) the decision to convert voltage levels to 13kV when replacing deteriorated 4kV station assets to support intensification and other known large projects such as the New Ottawa Hospital and (c) the reaffirmation of Hydro Ottawa's residential transformer sizing guideline. This strategic approach balances immediate operational demands with long-term sustainability goals thereby optimizing capital allocation and asset utilization. By leveraging decarbonization projections to inform the mid to long term outlook (beyond 2030) and aligning investments with both near-term (until 2030) and future needs, Hydro Ottawa ensures the development of a reliable, resilient, and cost-effective power grid capable of supporting the transition to a sustainable, net-zero energy future.

Further details on the Decarbonization Study are available in Section 9 of Schedule 2-5-4 - Asset Management Process, and Attachment 2-5-4(F) - Decarbonization Study.

2.2. CUSTOMER PRIORITIES

Hydro Ottawa prioritizes ongoing customer engagement as a core component of its business operations. This commitment is reflected in various initiatives and channels designed to gather customer feedback, understand evolving needs, and ensure a customer-centric approach to service delivery. For details on Hydro Ottawa's ongoing customer engagement initiatives, please see Schedule 1-4-1 - Customer Engagement Ongoing. Hydro Ottawa's 2026-2030 DSP was developed with extensive and targeted customer input gathered in two phases in collaboration with Innovative Research Group Inc, a national consulting firm with extensive expertise in public opinion research and specifically in the context of energy policy and utility operations. Phase I focused on strategy, and sought input aimed at understanding customer needs and preferences. This was distilled into priorities and principles that Hydro Ottawa planners and subject matter experts were guided by in developing the draft distribution system and business plans (as reflected in the "Needs and Preferences Planning Placemat" in Appendix.08 of the consolidated Customer Engagement Report found in Attachment 1-4-2(A) - Customer Engagement Report on Hydro Ottawa's 2026-2030 Rate Application). In Phase II, the Customer Engagement process focused on gathering customer feedback on Hydro Ottawa's proposed investment plan. This was achieved through an online survey that presented the plan's four key categories: Growth and Electrification, Aging Infrastructure, Grid Modernization, and Grid Resilience. The survey aimed to gauge customer investment preferences across these categories and assess the overall level of support for the proposed plan by outlining priority investment options with varying paces and cost impacts, enabling them to directly influence the final plan by providing feedback on their preferred balance of cost, timing, and system outcomes (reliability, resilience, renewable integration).

Key Findings:

- **Strong Support for the Plan:** The results demonstrated strong overall support for the plan, particularly among commercial customers who recognize the value of a reliable and modern electricity grid. An average of 87% of customers, across all rate classes, gave Hydro Ottawa social permission to proceed with its draft plan. These customers provided social permission by indicating either:
    - 16% think Hydro Ottawa should accelerate spending beyond the level in the draft plan to deliver better system outcomes.
    - 28% support the proposed rate increase that is reflected in the draft plan, or
    - 43% feel that the proposed rate increase in the draft plan is necessary, even though they don't like the proposed rate increase.

- **Acceptance of Necessary Increases:** While many customers expressed a general dislike for bill increases, a majority within each customer category acknowledged the necessity of these increases to fund critical system investments.
- **Desire for Accelerated Investment:** A significant minority of respondents favored an even faster pace of investment, indicating a willingness to absorb higher near-term costs to expedite system upgrades and realize their associated benefits sooner.

A summary of Hydro Ottawa's customer engagement on the 2026-2030 Application priorities are summarized below, with fulsome details available in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

Phase I

Phase I took place from February to May 2024 and focused on understanding customer needs through focus groups and interviews. This comprehensive approach ensured that diverse customer perspectives were gathered and analyzed to shape Hydro Ottawa's investment plan from its early stages.

Engagement results and key findings from Phase I, in relation to satisfaction and general priorities, include:

- Customer satisfaction has improved relative to 2019 for residential and small business customers.
- Residential and small business customers prioritize very similar general outcomes, with both ranking "maintaining reliable electricity service" as their top priority.
- Commercial and industrial and key account customers have more distinctive prioritizations, with reliable service being important, but outranked by the related and more specific objective of hardening the grid to withstand severe weather. Capacity to meet future demand was also a high-ranked priority of these customer classes.

Phase II

Phase II was conducted from September to October 2024 through an online survey to gauge customer investment preferences across four investment priorities that were identified throughout Phase I. These four priorities are: Growth and Electrification, Aging Infrastructure, Grid Modernization, and Grid Resilience. The majority of customers across all categories supported the proposed plan, with many even encouraging Hydro Ottawa to exceed it. Feedback was obtained from 21,8399 customers during this phase. Table 2 outlines the identified priority rankings by customer class.

Table 2 - Customer Priority Ranking by Category[4]

Investment Priority	Customer Category		
	Residential	Small Business	Commercial & Industrial and Key Account
Grid Resilience	1	1	2[5]
Grid Modernization	2	2	2
Aging Infrastructure (replacing equipment)	3	3	1
Metering Renewal	4	5	5
Growth and Electrification	5	4	4

In Phase II customers reviewed a draft plan outlining the four identified priority investment categories, presenting various options with different paces and cost implications. This allowed customers to directly influence the final plan by providing feedback on their preferences regarding the balance between cost, timing, and system outcomes (i.e. reliability, resilience, renewable integration).

2.3. INVESTMENT PRIORITIES

Through business planning and asset management processes, Hydro Ottawa has identified four

[4] Customer priority ranking was determined by adding support for Accelerated Pace and Draft Plan
[5] Grid Resilience and Grid Modernization received the same ranking

strategic Investment Priorities in this DSP. These priorities have been validated through customer engagement, ensuring that investments address the most pressing needs of both the community and the electricity grid, and are aligned with customer's top concerns: resilience against severe weather, reliability, reasonable rates, and grid capacity expansion. By focusing on these key areas, Hydro Ottawa aims to create a resilient and sustainable electricity system that can meet the evolving demands of the community while ensuring service remains safe, reliable, and affordable.

The four Investment Priorities are:

- **Growth & Electrification:** Powering a Growing Community
- **Renewing Deteriorating Infrastructure**
- **Grid Modernization:** Enabling the Energy Transition
- **Enhancing Resilience**

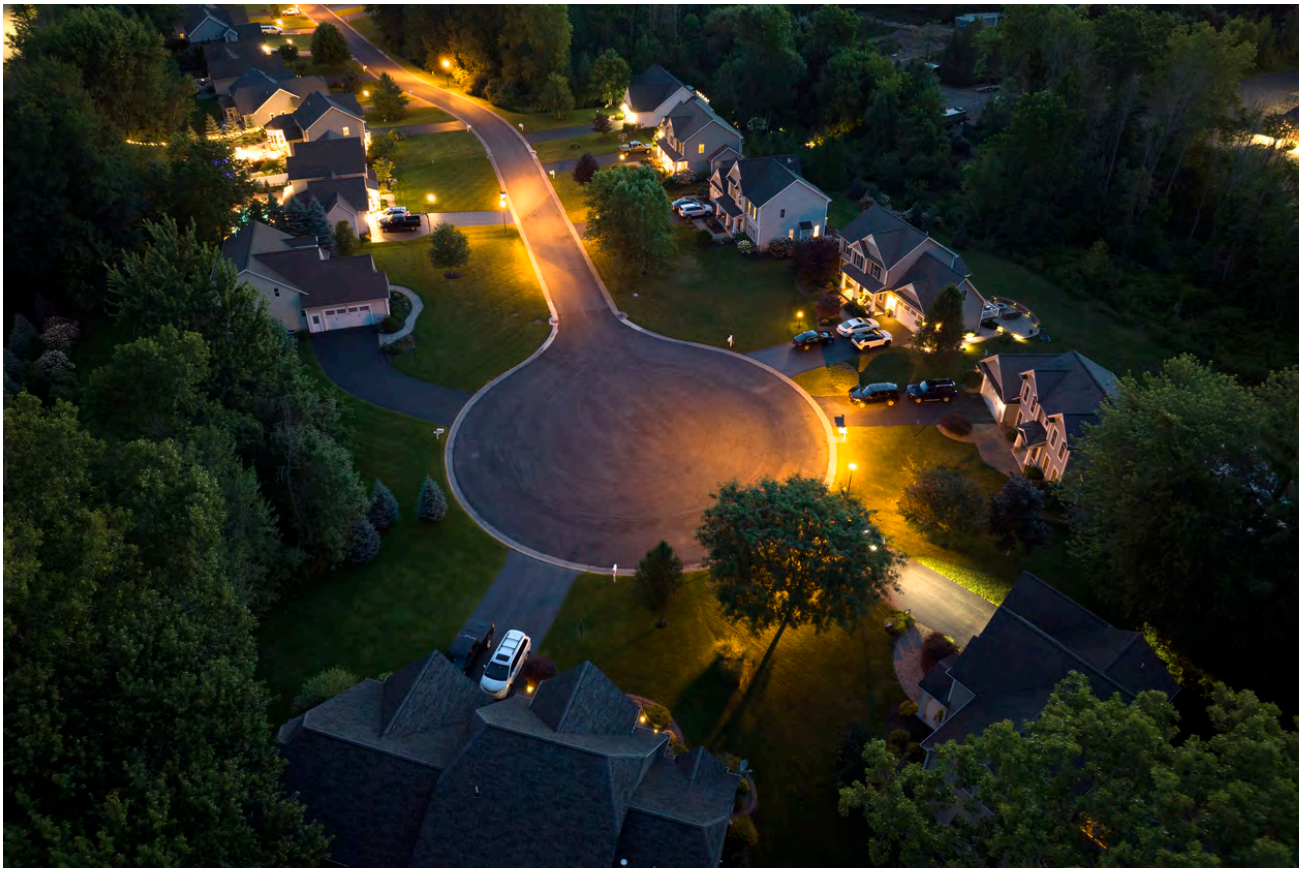
These Investment Priorities are underpinned by two Focus Areas:

- **Managing Rising Costs:** Ensuring customer affordability amidst economic uncertainties.
- **Investing in the Workforce:** Developing a robust and skilled workforce to navigate the evolving energy landscape.

By strategically balancing system upgrades with affordability and investing in its workforce, Hydro Ottawa is building a resilient and sustainable electricity system. Customer surveys, detailed in Section 3.3 of Schedule 2-5-4 - Asset Management Process, demonstrate strong support for the capital plan, confirming the effectiveness of this customer-centric approach.

2.3.1. Growth & Electrification - Powering a Growing Community

Focusing on expanding grid capacity to serve a growing community and ensure a reliable, resilient electricity system capable of meeting increasing demand driven by new customer connections and distributed energy resources (DERs).



To meet Ottawa's growing energy needs driven by electrification and expansion, Hydro Ottawa is strategically evolving its infrastructure and operations through 2030.

The City of Ottawa is experiencing consistent expansion, with ongoing residential development driving increasing demands on Hydro Ottawa. The utility's residential customer connection volumes illustrate this growth. These volumes have increased from a budgeted annual average of 3,190 to actuals of 6,067 over the 2021-2023 period. This upward trend is projected to continue, fueled by the City of Ottawa's forecasted population growth at a rate of 1.3% CAGR[6] over the 2026-2031 period and provincial emphasis on new housing development, as evidenced by the *More Homes Built Faster Act, 2022.*[7] For details on this, see Section 3.5.1, Schedule 2-5-6 - System Access Investments.

Electrification is also profoundly influencing electricity demand, adding significant pressure to the system. And this trend is expected to continue as Federal Government legislation requires 60% of all light duty vehicles sold in Canada to be electric vehicles by 2030 and 100% by 2035, compared to 9% of vehicles sold in 2021.[8] The increasing adoption of electric vehicles represents a substantial load growth factor, with the electrical demands of EV charging, particularly when concentrated and simultaneous, requiring robust grid reinforcement, especially around public charging facilities. For example, Hydro Ottawa has planned grid infrastructure investments to support the City of Ottawa's plan to procure 354 electric buses by 2027 and a full transition to electric buses by 2036[9]. Refer to Section 4.3.2, Schedule 2-5-6 - System Access Investments for additional details.

Similarly, the growing adoption of electric space heating contributes to increased electricity consumption, particularly during peak winter demand periods. These trends necessitate infrastructure upgrades to accommodate higher loads and maintain system reliability with heat pumps projected to provide more than 50% of residential space heating needs by 2050, up from 6% in 2021.[10]

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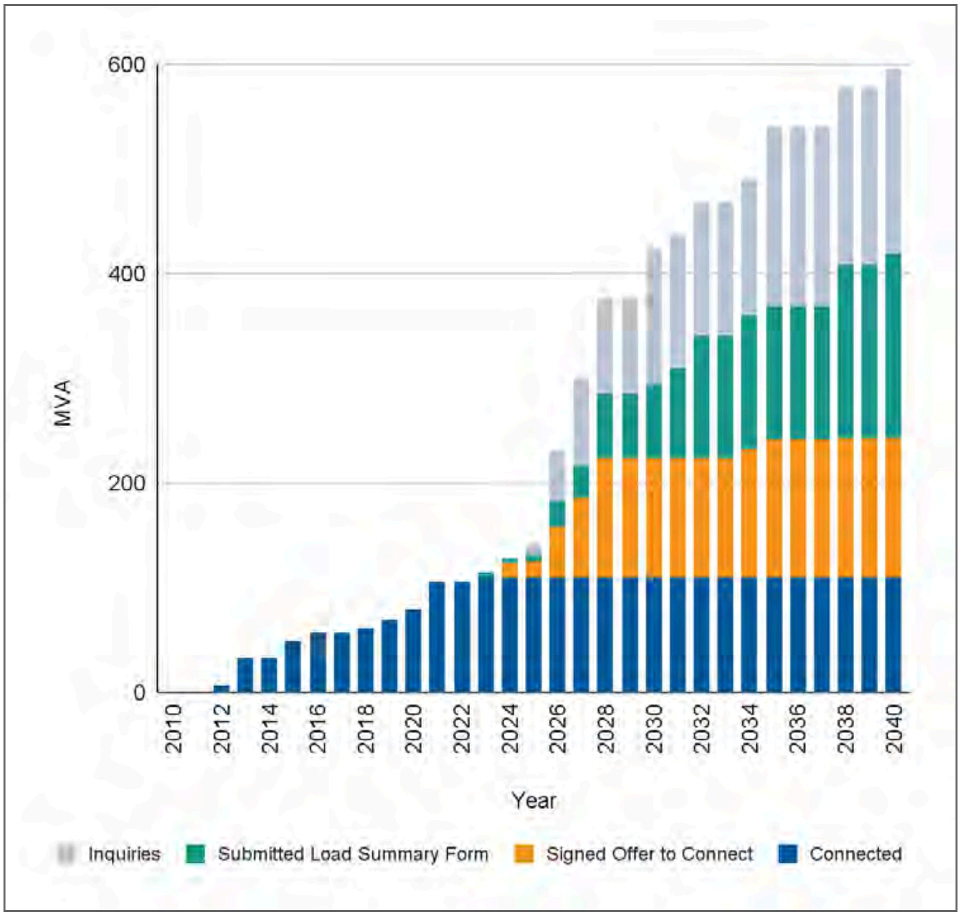
[6] City of Ottawa, "Growth projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93
[7] Legislative Assembly of Ontario, "Bill 23, *More Homes Built Faster Act, 2022.*"
[8] Statistics Canada, "Watt's up? Electric Vehicles and future electricity generation needs," https://www.statcan.gc.ca/o1/en/plus/5497-watts-electric-vehicles-and-future-electricity-generation-needs
[9] Ottawa-Carleton Transportation, "Zero-Emission Bus," https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/
[10] Canada Energy Regulator, "Canada's Energy Future 2023: Energy Supply and Demand Projections to 2050," https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/

Hydro Ottawa is witnessing a significant escalation in large load requests, exceeding 5 MVA, fueled by the accelerating trend of electrification. Since 2018, the utility has recorded a marked upswing in large load connection requests and inquiries, and the pace of demand notably quickened from 2023 onwards. This burgeoning load profile is clearly depicted in Figure 4, which breaks down 110 MVA of large loads successfully integrated into the grid between 2010 and 2023 (blue), 113 MVA of confirmed customer commitments, secured through signed Offers to Connect and slated for completion by 2028 (orange), and a further 199 MVA of potential load requests, encompassing preliminary inquiries through to formal load summary submissions (grey and green). Should these potential requests materialize by 2030, Hydro Ottawa anticipates an unprecedented 312 MVA increase in its total load demand over the 6 year span of 2024-2030; a three-fold increase from the 110MVA connected in the previous 10 years.

Figure 4 - Large Load Connections, Commitments, Requests & Inquiries



If all these requests materialize, this would represent an increase of 312 MVA by 2030, tripling the amount connected during the previous 14-year period.

Key examples of the projects driving these large load requests include the Ottawa Hospital's New Campus, OC Transpo's Zero Emission Buses, Department of National Defence Dwyer Hill Training Center Upgrade, new laboratory facilities for the Regulatory and Security Science Main Project (located at the Canadian Food Inspection Agency's Ottawa Laboratory), and the TerraCanada National Capital Area project (located at the National Research Council of Canada facilities).

To effectively address these converging challenges—increased residential connections, the electrification surge, and escalating demand from large-load customers—Hydro Ottawa is pursuing strategic and substantial investments, with a focus on:

Capacity Expansion: Investments in new substations, upgrades to existing facilities, and expansion of the distribution network to effectively manage increased load and ensure service reliability.

Grid Modernization: Initiatives to modernize the grid to better accommodate the dynamic load profiles associated with EV charging and electric heating, enhance grid flexibility and responsiveness, and DERs and integrate smart grid technologies.

Non-Wires Solutions (NWSs): Strategic implementation of NWSs, such as utility-owned battery energy storage systems and a Non-Wires Customer Solutions Program, to proactively manage peak demand, defer or avoid traditional infrastructure investments, and enhance grid reliability.

With anticipated growth and rapid rate of change across the City of Ottawa, Hydro Ottawa is committed to collaboration, working with developers and the City of Ottawa through various working groups, including the Utility Coordinating Committee, Energy Evolution, and the Decarbonization Working Group. These partnerships are essential to developing well-informed grid capacity enhancement plans and ensuring the continued provision of reliable electricity services to a dynamic and expanding community. This collaborative approach aims to support ongoing residential and commercial development, facilitate urban intensification initiatives, and enable major infrastructure projects within the community in a cost-effective manner.

2026-2030 Capital Expenditure Overview

Hydro Ottawa's proposed capital investments are driven by the need to adapt to the evolving energy landscape that is being reshaped by Growth & Electrification. The portfolio of investments under Growth & Electrification focuses on expanding the electricity system to accommodate customer connections, forecasted demand and support the integration of DERs. This is achieved through investments in the System Access category, which includes programs like Customer Connections to facilitate new residential and commercial developments, System Expansion to address major infrastructure projects like new stations, and Generation Connections to enable the connection of customer-owned DERs. It is also achieved through investments in the System Service category where although the primary driver is dealing with capacity constraints it also allows efficient investment in programs that prepare the grid for the projected impacts of decarbonization and integration of distributed renewable energy resources. These proactive initiatives are essential to ensure the continued provision of reliable and sustainable electricity services, effectively managing the challenges and opportunities presented by these transformative trends, and ultimately, enabling a robust energy transformation in Ottawa.

2.3.2. Renewing Deteriorating Infrastructure

Focusing on mitigating failure risk by strategically upgrading or replacing deteriorating and critical infrastructure, prioritizing assets with the greatest impact on system reliability and safety based on condition assessments.

To ensure continued, safe, and reliable electricity delivery to its customers, Hydro Ottawa must proactively invest in renewing its deteriorating infrastructure.

Hydro Ottawa's enhanced asset management process, detailed in Section 4.4 of Schedule 2-5-4 - Asset Management Process, includes comprehensive ACAs to determine asset health and facilitate holistic risk assessment. These assessments reveal that 54% of Hydro Ottawa's assets have reached the end of their typical useful life (TUL) as shown in Figure 5 below, and 6% are in degraded (Poor or Very Poor) condition as shown in Figure 6 below.

Without intervention, these figures will worsen significantly. By 2030, the proportion of assets beyond their TUL is projected to increase to 67% as shown in Figure 7, and the percentage in degraded condition will rise to 10%, see Figure 8. This presents a growing and immediate risk of asset failure, with the potential to disrupt electricity service. Hydro Ottawa estimates that replacing all assets projected to be in degraded condition by 2030 would cost $862M, as shown in Table 4.

Figure 5 - 2024 Overall Asset Age Demographics (Current State)

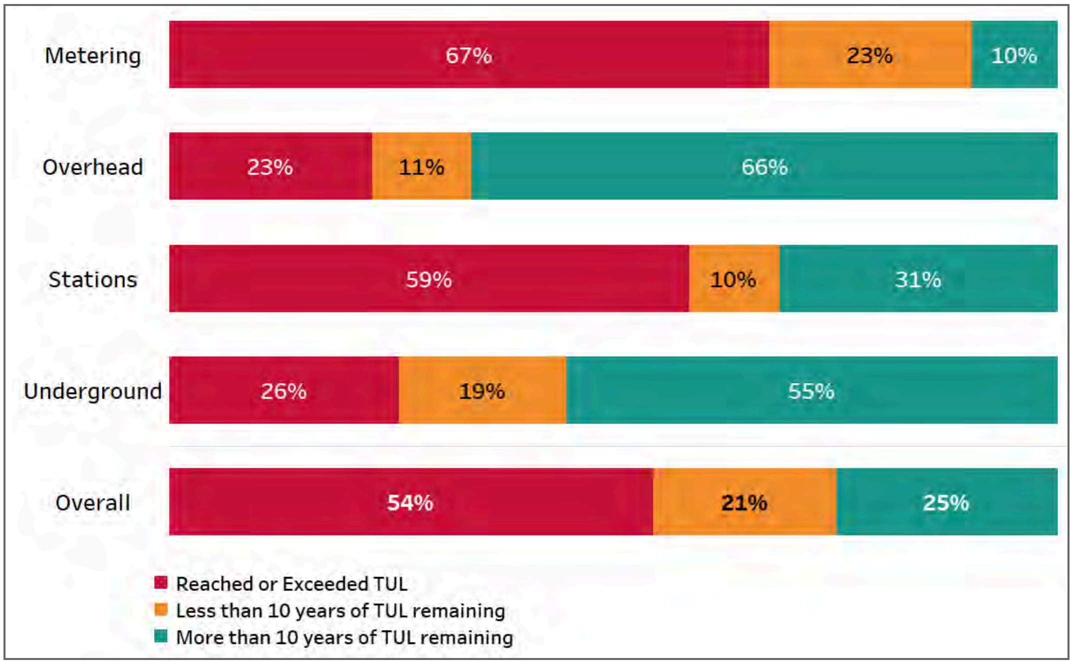
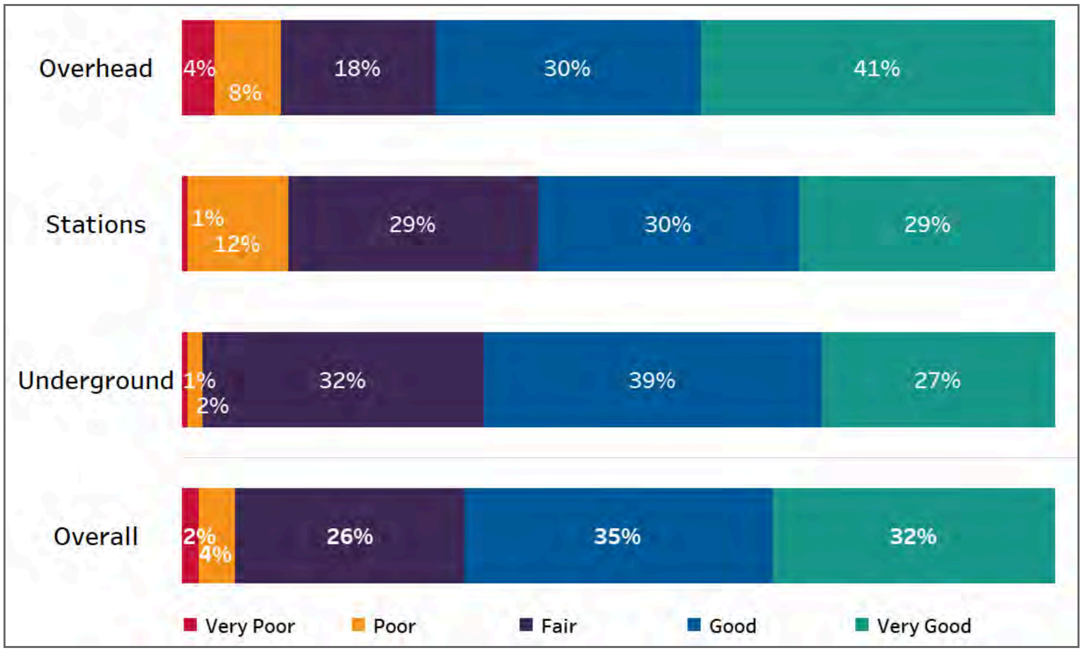


Figure 6 - 2024 Overall Asset Condition Profile (Current State)



1 **Figure 7 - 2030 Overall Projected Asset Age Demographics - 2030 (No Investment)**

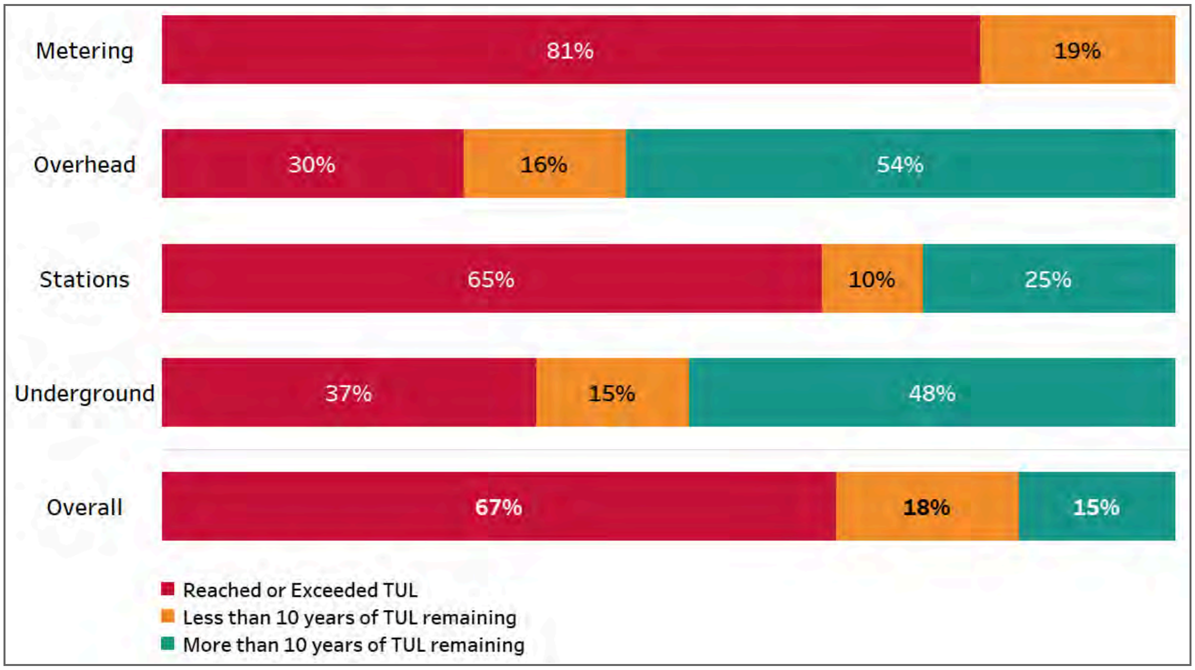
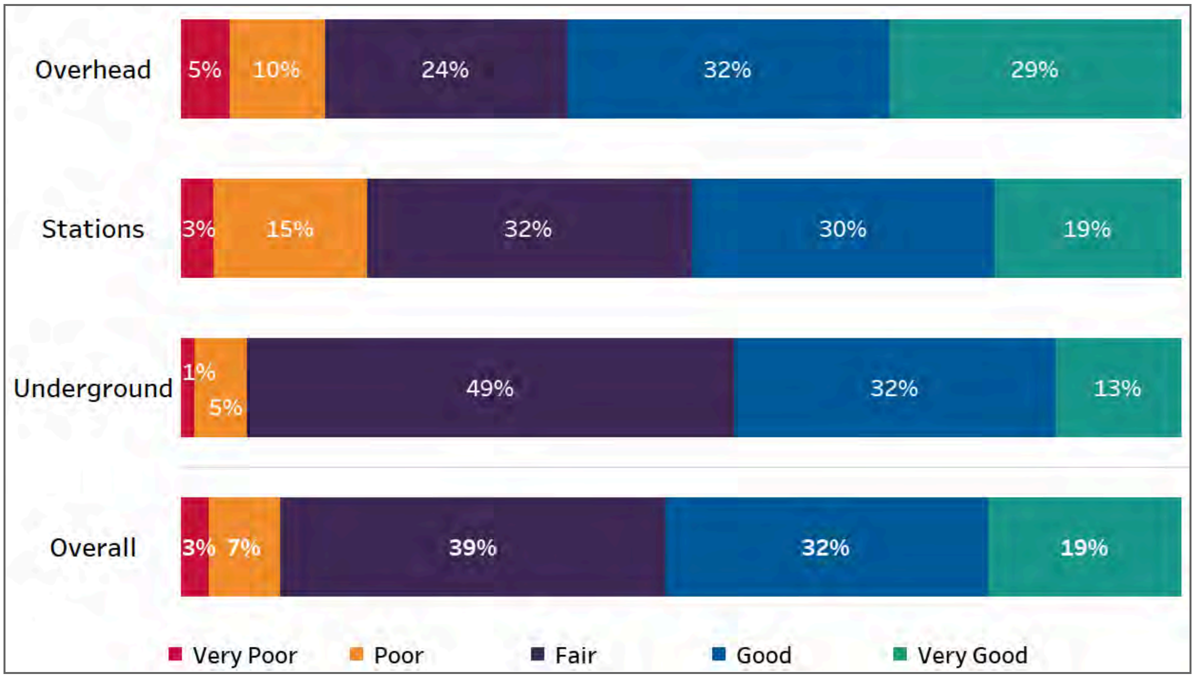
2 

Figure 8 - 2030 Overall Projected Asset Condition Profile - 2030 (No Investment)

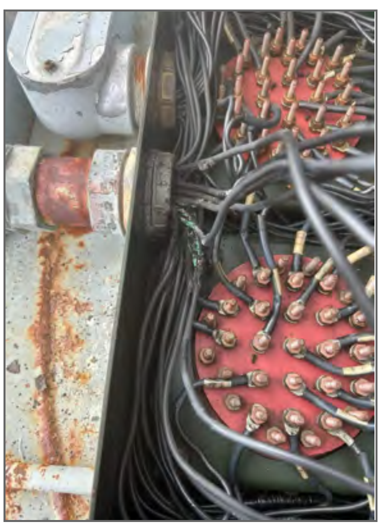


Figures 9 to 11 illustrate examples of deteriorating asset infrastructure found through inspection and maintenance programs.

Figure 9 - Examples of Station Asset Deterioration

(a) Station transformer corrosion and leaks

(b) Switching equipment lubrication leaks



(c) Corroded connections and burnt wiring

(d) Switchgear failure and fire

(e) Station outdoor infrastructure deterioration

(f) Pothead failure connected to station bus

Figure 10 - Examples of Underground Distribution Asset Deterioration

(a) Underground transformer corrosion

(b) Underground cable failure

Figure 11 - Examples of Overhead Distribution Asset Deterioration

(a) Pole decay

(b) Overhead switch operational defect

Hydro Ottawa's asset renewal strategy is to replace assets at a pace which maintains a consistent percentage of assets in degraded condition with the aim of maintaining overall system reliability. Hydro Ottawa prioritizes replacement of assets that pose the highest overall system risk by leveraging Predictive Analytics to forecast asset degradation based on the age and condition of assets. While safety, financial, environmental, and compliance risks are considered, reliability is the primary driver of the overall risk value.

Table 3 demonstrates the outcomes of the risk mitigation approach proposed by Hydro Ottawa for the 2026-2030 period. As outlined in the table, the investment required to replace all assets that are projected to be in degraded condition by 2030 is estimated at $862M - this would effectively reduce the percentage of assets in degraded condition to 0% by 2030. Competing financial priorities, notably growth, electrification, grid modernization, and resilience, render this investment level impractical. Alternatively, Hydro Ottawa is proposing an investment of $261M over the 5-year period, which is projected to result in 8% of the overall assets being in degraded condition by 2030, a 2% increase compared to 2024. Hydro Ottawa has demonstrated strong reliability results through the 2021-2025 period, see Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Despite the increase forecasted in overall percentage of assets in degraded condition, Hydro Ottawa expects to maintain the same level of service over the 2026-2030 period due to the improved risk prioritization stemming from the use of Predictive Analytics and the enhancements to the inspection and maintenance programs. Details of Hydro Ottawa's proposed System Renewal investments are provided in Schedule 2-5-7 - System Renewal Investments.

Table 3 - 2024 and 2030[11] Asset System Renewal Needs by Condition

Asset System	Hydro Ottawa's Current (2024) % of Assets in Degraded Condition	Investment Required to Replace all Assets Projected to be Degraded by 2030 (in 2024 dollars)	Hydro Ottawa's 2026-2030 Proposed System Renewal Investment	Hydro Ottawa's 2030 Projected Outcome for % Assets in Degraded Condition (after investment)
Overhead	12%	80 Overhead (OH) Switches, 5,737 Poles **$199M**	340 OH Switches, 1,975 Poles **$68M**	10%
Stations[12]	13%	53 Station Batteries,177 Station Breakers, 12 Station Transformers **$205M**	14 Station Batteries, 83 Station Breakers, 11 Station Transformers **$90M**	15%
Underground	3%	114 Cable Chambers, 28 Underground (UG) Switchgear, 336 km XLPE Cable, 1,972 Vault Transformers, 18 Vault Switchgear **$458M**	30 Cable Chambers, 30 UG Switchgear, 61 km XLPE Cable, 90 Vault Distribution Transformers, 30 Vault Switchgear **$103M**	6%
Total	**6%**	**$862M**	**$261M**	**8%**

[11] All costs are in 2024 dollars

[12] For Stations, the dollars shown don't consider relays, RTUs, station minor assets, buildings/facilities and transfer trip installations, as these asset types don't have condition information associated with them. These specific station assets follow an age-based replacement criteria and Hydro Ottawa has considered them in the 2026-2030 system renewal investment plans.

Hydro Ottawa's risk-mitigation asset renewal strategy relies heavily upon condition information from maintenance inspections. This necessitates adjustments to both the frequency and scope of the distribution and stations testing, inspection, and maintenance programs. To improve data accuracy, Hydro Ottawa will implement advanced inspection technologies, including drone inspections for overhead assets, enabling targeted maintenance and improved asset health assessments. For underground assets, advanced techniques like Very Low Frequency Tan-Delta, Partial Discharge, and Time Domain Reflectometry will identify vulnerabilities and optimize investments. Cost-effective refurbishment, such as cable accessory replacement, will extend underground asset life. Hydro Ottawa’s asset renewal strategy does not prioritize replacing assets that have reached or exceeded their typical useful life (TUL). As such, an increase in the frequency of inspections of assets that have reached TUL is also proposed for certain assets. Details of Hydro Ottawa Operations & Maintenance plans are provided in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

In addition to its distribution assets, Hydro Ottawa relies on a diverse fleet of 237[13] vehicles and 44 other units of transportation equipment to support its operations, maintenance and administration (OM&A) and capital work programs. The vehicles and equipment are essential for providing efficient and reliable customer service including timely power restoration, efficient distribution system construction and maintenance, and ensuring worker and public safety. Of the 281 vehicles and equipment, 154 (55%) will be at or beyond their replacement criteria age in the 2026-2030 rate period. More details on the Fleet strategy and capital investment plan can be found in Section 3.4.5 of Schedule 2-5-4 - Asset Management Process and Section 11 of Schedule 2-5-9 - General Plant Investments.

2026-2030 Capital Expenditure Overview

Recognizing the importance of maintaining a reliable and safe electricity network, Hydro Ottawa prioritizes Renewing Deteriorating Infrastructure. This involves dedicating a substantial portion

[13] As of September 30, 2024

of the capital investment plan to the System Renewal category, which focuses on replacing deteriorating assets and upgrading critical infrastructure components. Key programs within this category include Stations and Buildings Infrastructure Renewal to replace deteriorating station assets, UG Distribution Assets Renewal to address deteriorating underground assets, OH Distribution Assets Renewal to renew deteriorating overhead infrastructure, Metering Renewal to modernize metering infrastructure, and Corrective Renewal to enable rapid response to unexpected failures. The capital investment plan for Fleet is included under the General Plant investment category.

2.3.3. Grid Modernization - Enabling the Energy Transition

Focusing on modernizing the grid through strategic technology adoption and infrastructure upgrades to enable the energy transition, facilitate customer participation, and optimize DER integration, thereby enhancing grid capabilities and efficiency.

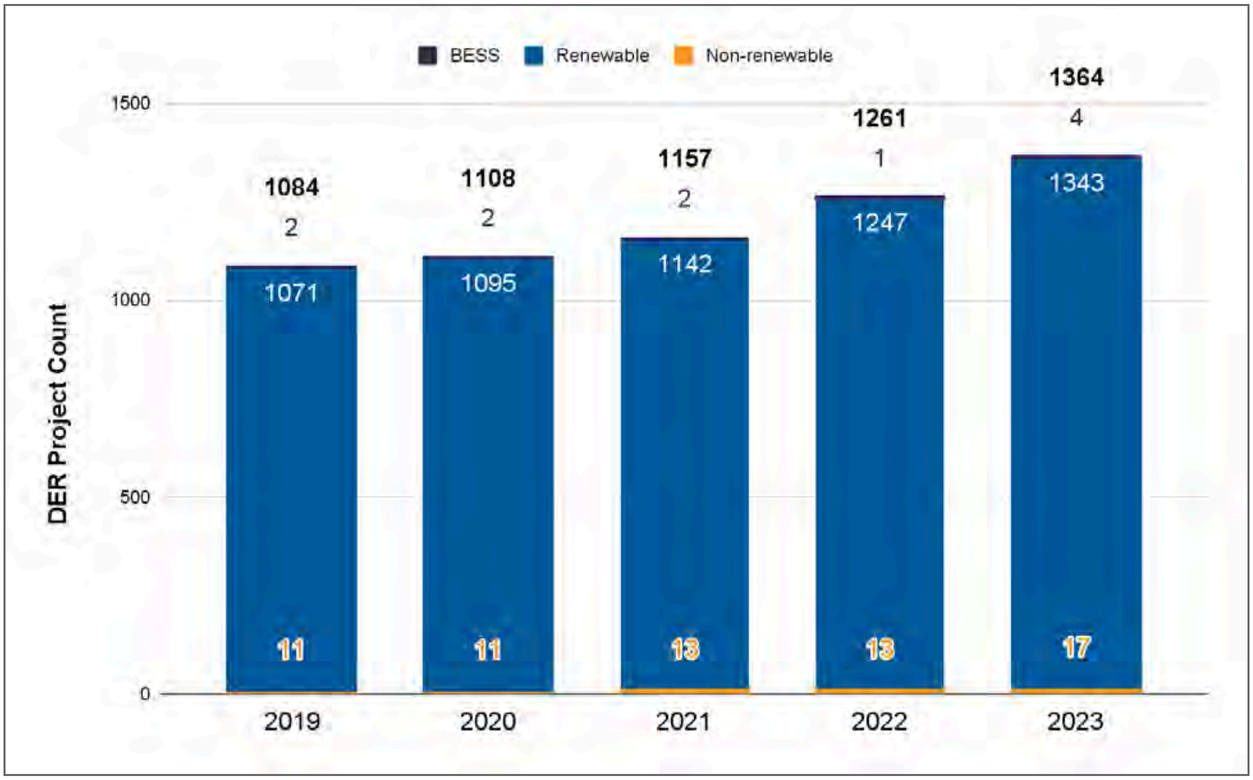
Hydro Ottawa is committed to enabling the energy transition by modernizing the grid to facilitate customer participation, enable widespread electrification, and optimize the penetration and integration of DERs.

Market forces, regulatory drivers, and funding opportunities are converging to create a compelling case for grid modernization to enable the energy transition. This need is underscored by Ontario's own energy policies, such as the recently released *Ontario's Affordable Energy Future: The Pressing Case for More Power,*[14] which explicitly identifies the need to modernize distribution grids to facilitate active monitoring of systems, build better resilience, and provide customers the energy and services they will need into the future.

Customer demand for DERs within Hydro Ottawa's territory is increasing. Electricity Canada engaged Innovative Research Group Inc. to conduct a national Behind the Meter (BTM) Survey in 2021 to explore Canadian attitudes towards new technologies designed to help consumers better manage their energy use and enable the energy transition. The survey showed that 14% of respondents already had, or would actively take steps to acquire solar panels. Please refer to Attachment 1-4-1(F) - Behind the Meter Survey. To illustrate, from 2019 to 2023, the number of connected DERs on Hydro Ottawa's grid increased by over 25% as per Figure 12. See Schedule 2-5-4 - Asset Management Process for more details.

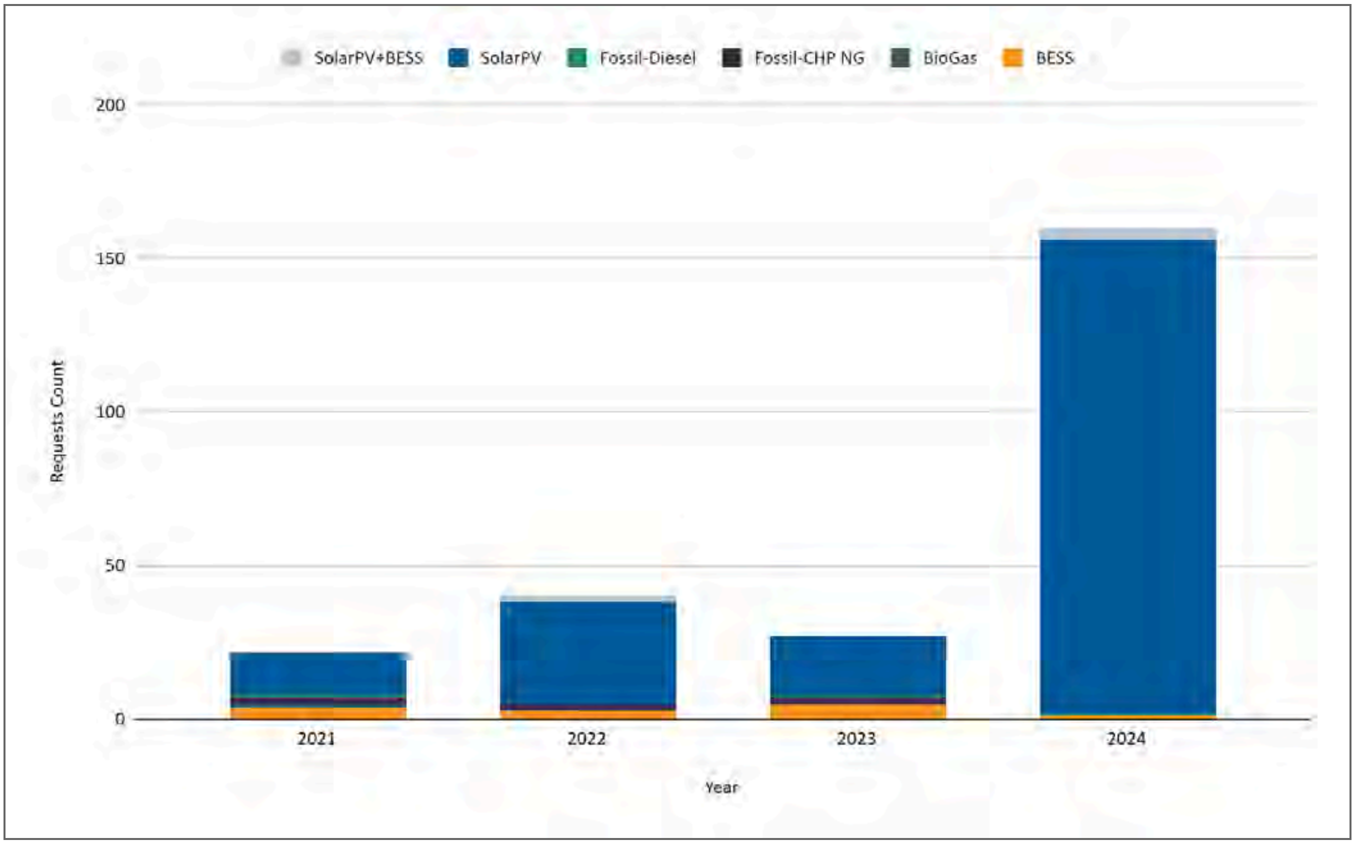
[14] Ministry of Energy and Electrification, *Ontario's Affordable Energy Future: The Pressing Case for More Power*, https://www.ontario.ca/page/ontarios-affordable-energy-future-pressing-case-more-power

Figure 12 - Total System Generator Count 2019-2023



Hydro Ottawa has seen a steady rise in preliminary connection impact assessment requests for DERs, alongside the growing number of annual DER connections. This is particularly evident in 2024, with a significant surge in requests attributed to the IESO's Ottawa DER Large Solar PV Funding Incentive program launched in January 2024, see Figure 13. The program's expansion to province-wide customers in January 2025 suggests that this trend will likely persist, although not all inquiries result in actual projects. These incentive programs are clearly stimulating public interest and participation in DER.

Figure 13 - DER Annual Requests Count 2021-2024



This surge, coupled with customer expectations for enhanced reliability during extreme weather events and a growing interest amongst customers to store energy for their own use and potentially for system benefit, necessitates a more flexible and responsive grid. As outlined in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application, a majority of customers surveyed across all customer classes support Hydro Ottawa's proposed investment plan, citing the need for the utility to prepare its grid for the future.

"Ontario's Affordable Energy Future: The Pressing Case for More Power"[15] and the 2024 Minister of Energy and Electrification's Letter of Direction to the OEB[16] emphasize the critical role of grid modernization in achieving Ontario's energy goals. This includes meeting growing electricity demand, integrating renewable energy, and enabling the energy transition by advancing NWSs, customer enabled solutions, and future utility business models. The OEB, which is also prioritizing grid modernization in its strategic planning,[17] has streamlined DER connection processes, and is encouraging innovation through its regulatory frameworks and Innovation Sandbox. Although policy and regulatory frameworks must continue to adapt to support customer choice, address barriers to DER adoption, and optimize the use of DERs to meet energy demands, the grid modernization investments Hydro Ottawa is implementing are crucial for facilitating this transition to a more distributed grid.

Further bolstering these efforts, Natural Resources Canada (NRCan) has provided substantial financial support to the utility sector through programs like the Smart Renewables and Electrification Pathways Program and the Energy Innovation Program's Smart Grid Call. This confluence of customer needs, provincial policy alignment, OEB regulatory support, and Federal funding creates a clear and compelling market signal supporting strategic investments in grid modernization for a sustainable energy future. By responding to these drivers, Hydro Ottawa is proactively building a grid that can meet the evolving needs of its customers, support the energy transition, and contribute to a more reliable and resilient electricity system.

To achieve this objective, Hydro Ottawa is focusing on:

- **Amplifying Grid Observability:** Increasing visibility and understanding of the grid's operational status, including constraints, to enhance operational decision making and to inform targeted system upgrades. Hydro Ottawa will achieve this by investing in AMI 2.0, advanced sensors, monitoring systems, and data analytics.

[15] https://www.ontario.ca/page/ontarios-affordable-energy-future-pressing-case-more-power
[16] Ministry of Energy and Electrification, *Letter of Direction to the OEB* (December 19, 2024).
[17] OEB, *Strategic Plan 2021/22 - 2025/26* (April 30, 2021).

- **Improving Grid Controllability:** Improved grid controllability will focus on increasing the level of control Hydro Ottawa has over the grid. This will allow for more dynamic operation, facilitating optimized performance and improving reliability and resilience through redundancy. These capabilities will be unlocked by investing in remotely operable control devices, advanced control systems, and observability enhancements.
- **Meeting Electrification Capacity Needs:** Hydro Ottawa has integrated electrification demand projections into its investment planning framework to strategically address the anticipated increase in electricity demand associated with a decarbonized future. This forward-looking approach ensures the efficient deployment of capital to ensure that grid upgrades provide the necessary foundation for growth and a sustainable electricity grid.
- **DER Enablement:** Hydro Ottawa is committed to enabling the widespread adoption and utilization of DERs by connecting customers to available financial incentives, see further details in Section 2.4.3 of Schedule 1-4-1 - Customer Engagement Ongoing, fostering collaborative partnerships, and implementing strategic programs. This increased integration of DERs, NWSs combined with advancements in grid observability and controllability, will allow Hydro Ottawa to accommodate two-way flow of electricity generated by these sources and leverage DERs and other controllable devices to reduce peak load and integrate local renewable energy sources within its service territory, enhancing operational flexibility.

Through strategic investments in grid modernization, Hydro Ottawa is building a foundation for a more sustainable and resilient energy future. This will enable greater customer participation, support the widespread adoption of electric vehicles and other technologies, and facilitate the integration of DERs.

2026-2030 Capital Expenditure Overview

Grid Modernization is a key focus of Hydro Ottawa's investment plan, with initiatives spread across multiple categories. These initiatives aim to leverage technologies and enhance grid capabilities to enable DER connections, improve efficiency, reliability, and resilience. This includes Capacity Upgrades to increase capacity through various means, including NWSs, Distribution Enhancements to improve system observability through initiatives like advanced grid monitoring, Grid Technology to enable enhanced monitoring and control, cyber security and IT Infrastructure to strengthen IT systems and protect against cyber threats, and Data and System Integrations to consolidate data systems and improve decision-making.

2.3.4. Enhancing Resilience

Focusing on enhancing grid resilience by proactively upgrading infrastructure and implementing measures to protect against increasingly frequent and intense severe weather events and cyber threats.

Performing restoration work in the Pineglen neighbourhood post May 2022 Derecho

Extreme Weather

As noted in Hydro Ottawa's Customer Engagement survey, which can be found in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application, Ottawa has become the weather-alert capital of Canada.[18] Extreme weather events such as high heat, high winds, flooding and ice storms are increasingly straining and damaging the electricity grid.

[18] Environment and Climate Change Canada

The City of Ottawa, in partnership with the National Capital Commission and Environment and Climate Change Canada developed climate projections for the National Capital Region which were published within *"The Climate Change Vulnerability & Risk Assessment"*[19]. The report states:

> "People are feeling the impacts of climate change globally and locally. Research predicts these impacts will intensify and affect the National Capital Region for decades to come. As such, the region will experience more extreme weather events like floods, wildfires, droughts, heatwaves, freeze-thaw spells and tornadoes."

The OEB is also addressing climate-related challenges by focusing on enhancing distribution sector resilience, responsiveness, and cost efficiency. Following the Minister of Energy's 2022 Letter of Direction, the OEB released a report on June 29, 2023, outlining actions to mitigate vulnerabilities to severe weather events. The OEB is now implementing these recommendations and pursuing policy consultations, including the Distribution Sector Resilience, Responsiveness & Cost Efficiency (EB-2023-0003), which has led to further work in the Reliability and Power Quality Review (EB-2021-0307) and the Vulnerability Assessment & System Hardening Project (EB-2024-0199).

[19] National Capital Commission, Climate Change Vulnerability & Risk Assessment (June 2022), page i.

City of Ottawa Climate Resiliency - What will Ottawa's climate look like in the future?[20]

Hydro Ottawa has experienced firsthand the impact of these events, with a series of severe storms in recent years causing significant damage and disruption to the electricity grid.

[20] City of Ottawa, "Climate Resiliency," https://ottawa.ca/en/climate-resiliency

The effects of the May 2022 Derecho on Hydro Ottawa equipment

Recent events, as detailed in Table 4 below, include:

- 2017: Freezing rain, heavy snow, flooding, and a severe thunderstorm which impacted thousands of customers.
- 2018: Tornadoes, freezing rain, and high winds caused widespread outages, impacting over 200,000 customers.
- 2019: A flash storm, flooding, lightning strikes, and high winds which caused repeated disruptions throughout the year.
- 2021: Lightning strikes caused further outages.

- 2022: The devastating Derecho, with record-breaking wind speeds, which impacted over 180,000 customers and became the 6th costliest natural disaster in Canada's history. This was followed by a bomb cyclone in December, causing further outages.
- 2023: Tornadoes, an ice storm, freezing rain, and multiple lightning strikes continued the trend of severe weather impacts.

Downed poles after the May 2022 Derecho

Table 4 - Historical Weather Events & Impacts

Year	Severe Weather Event	Description & Impacts
2017	Freezing rain & heavy snow (January)	• 19,130 customers (6% of customer base)
	Flooding (May)	• 1-in-100-year flood levels for Ottawa River
	Thunderstorm (September)	• 11,391 customers (3% of customer base)
2018	Freezing rain (April)	• 55,101 customers (17% of customer base)
	High winds (May)	• 63,869 customers (19% of customer base)
	Tornadoes (September)	• 216,000 customers (65% of customer base) • Class EF-2 and EF-3 tornadoes; 260 km/h winds • 90% of customers restored within 2.5 days
2019	Flash storm (April)	• 44,511 customers (13% of customer base) • Loss of supply and substation flooding
	Flooding (May)	• 1-in-1000-year flood • Highest water levels on record for Ottawa River
	Lightning (July)	• 70,069 customers (21% of customer base) • Four separate loss of supply outages
	High winds (November)	• 14,228 customers (4% of customer base)
2021	Lightning (June)	• 17,441 customers (5% of customer base) • Lightning and loss of supply
2022	Derecho (May)	• 180,946 customers (52% of customer base) • Highest wind speeds on record in Ottawa & Ontario • Severity of wind speeds greatly exceeded forecast • 6th costliest natural disaster in Canada's history • $24M in restoration costs for Hydro Ottawa • 90% of customers restored within seven days
	Bomb cyclone (December)	• 67,710 customers (19% of customer base) • Intense freezing rain and snow; loss of supply
2023	Ice storm and freezing rain (April)	• 163,448 customers (45% of customer base) • 90% of customers restored within two days
	Lightning (June)	• 15,413 customers (4.25% of customer base) • Loss of supply
	Tornados, lightning, hail and wind (July)	• 37,821 customers (10.4% of customer base) • >6,000 total lightning strikes during month of July 2023 (8 times as many as July 2022)

These events have contributed to increased spending on emergency asset replacement and have significantly impacted the system reliability performance, see Figure 14, underscoring the need for proactive investment in grid resilience.

Figure 14 - Weather Related Reliability Impact

To combat the growing risks associated with major events, Hydro Ottawa is focusing on proactive measures such as strategic undergrounding of overhead lines, increasing tree trimming, strengthening the grid through infrastructure upgrades, and hardening assets. These measures are aimed at reducing the likelihood of storm damage, thereby enhancing resilience against extreme weather events.

Cyber security

In response to the rising threat of cybercrime impacting Canadian organizations, and the strategic importance of Ottawa as a G7 capital, Hydro Ottawa maintains a strong focus on strengthening cyber security protections and controls for its essential assets and networks. Moreover, cybercrime is on the rise across Canada. As the capital city of a G7 country which is a high-value target for malicious actors, investing in grid resilience is essential to protect the community's electrical system from the increasing frequency and intensity of cyber threats. This focus is essential to prevent compromises that could impact reliability and put customers at risk. As is highlighted in the National Cyber Threat Assessment 2025-2026 (NCTA) published by the Canadian Centre for Cyber Security, Ransomware is the top cybercrime threat facing Canada's critical infrastructure, including the energy sector[21]. From 2021-2024, Ransomware incidents saw a 26% year-over-year growth with predictions of this to continue to trend upwards.[22] Statista's Market Insight also predicts that from 2024 to 2028, the global cost of cybercrime will rise from $9.22 trillion to $13.82 trillion[23]. The NTCA also emphasizes threats from nation states as geopolitical events will continue to impact critical infrastructure as well as the continued rise of an expanded attack surface that will exponentially grow as more connected devices are brought online and require access to the OT infrastructure. This further enforces the need for a holistic cyber security approach towards key investment priorities such as Grid Modernization and Grid Resilience.

These areas of focus align with industry standards and regulatory requirements for grid resilience, including compliance with the OEB's Vulnerability and System Hardening requirements. Hydro Ottawa is also actively implementing measures outlined as in Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan and Attachment 2-5-4 (E) - Resilience Investment Business Case Report to enhance resilience against future extreme weather events.

[21] Canadian Centre for Cyber Security, "National Cyber Threat Assessment 2025-2026," https://www.cyber.gc.ca/sites/default/files/national-cyber-threat-assessment-2025-2026-e.pdf
[22] *Ibid*
[23] Statista, "Cybercrime Expected To Skyrocket in Coming Years" (February 22, 2024)

By focusing on grid resilience, Hydro Ottawa is taking proactive steps to protect its customers and ensure a reliable and resilient electricity supply for the future, despite the growing challenges posed by a changing climate and increasing cyber threats.

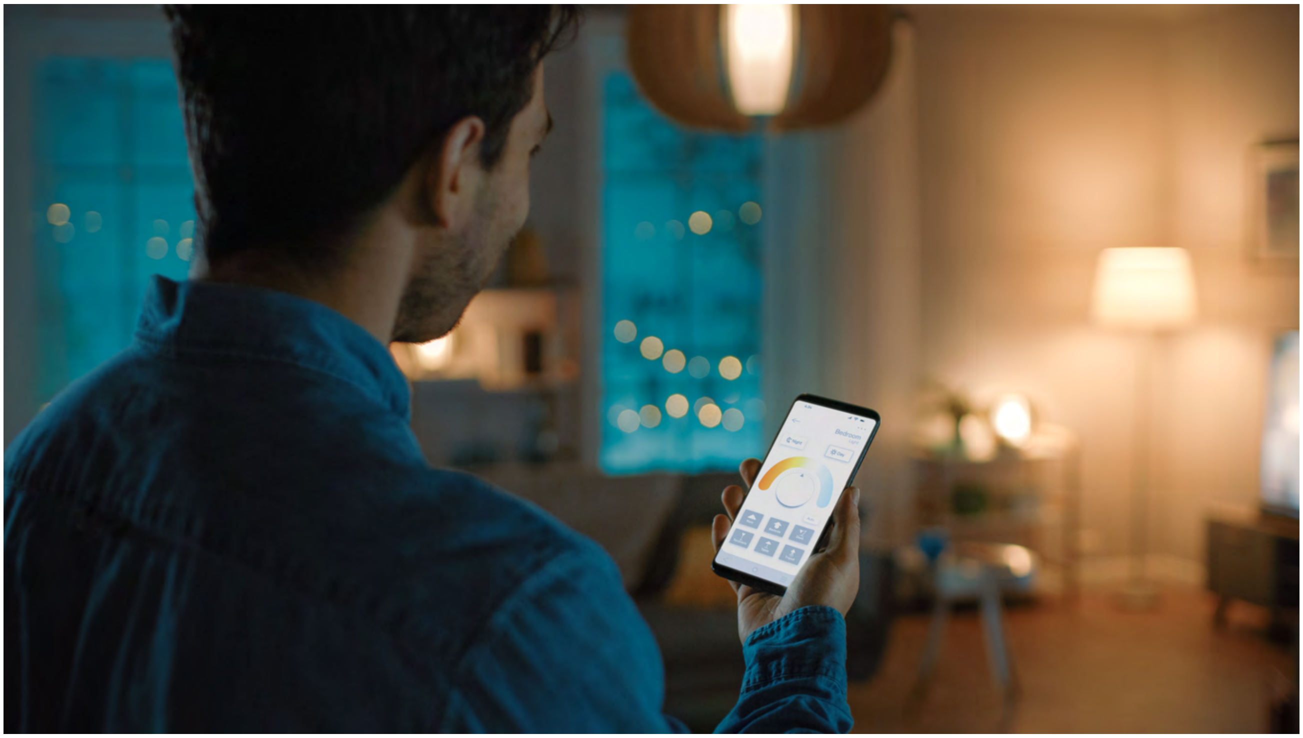
2026-2030 Capital Expenditure Overview

Grid Resilience is a priority embedded throughout Hydro Ottawa's investment plan. Initiatives focus on strengthening the grid against various threats, including extreme weather events, equipment failures, and cyberattacks. This is achieved through System Renewal to replace deteriorating infrastructure and improve reliability, Distribution Enhancements to implement initiatives like strategic undergrounding of overhead lines and storm hardening initiatives, control and optimization to improve grid flexibility through advanced monitoring and control capabilities, cyber security and IT Infrastructure to enhance IT security measures, and Grid Technology to focus on improving resilience to extreme weather events and integrating new technologies.

2.3.5. Focus Areas

Hydro Ottawa's investment planning for the 2026-2030 period is fundamentally anchored in two critical focus areas: ensuring customer affordability amidst economic uncertainties, and investing in a robust and skilled workforce to navigate the rapidly evolving energy landscape. These dual priorities are essential for maintaining service reliability and facilitating the necessary infrastructure upgrades and grid modernization, all while mitigating the impact on customer rates.

Managing Rising Costs



Focusing on managing rising costs to maintain affordability for customers while ensuring a reliable and resilient electricity system to meet growing demand.

Hydro Ottawa is operating within a complex landscape characterized by heightened customer sensitivity to electricity costs, persistent inflationary pressures, elevated interest rates, and an increasing reliance on an uninterrupted power supply. The period from 2021 to 2025 was particularly challenging for Hydro Ottawa, marked by the COVID-19 pandemic, the highest inflation in 40 years, a weakened Canadian dollar, supply chain disruptions, and extreme weather events, including the devastating May 2022 Derecho storm. These compounding factors placed considerable financial strain on the company, yet it prioritized customer affordability by forgoing a Z-factor application which would have allowed Hydro Ottawa to recover approximately $8.7M in OM&A costs and depreciation up to the end of 2025 associated with $15.1M in Derecho capital additions. This decision reflected a commitment to supporting customers during difficult times.

Furthermore, Hydro Ottawa strategically managed its capital expenditures by deferring planned projects, resulting in a $44.2M budget adjustment. Please refer to Table 4 in Section 4.1.2 of Schedule 2-5-5 - Capital Expenditure Plan for additional information. This proactive approach mitigated further financial variances and demonstrated a commitment to responsible fiscal management despite these challenging circumstances. To achieve this outcome, Hydro Ottawa relied heavily upon its robust asset management framework for decisions around investment priorities. The company's strong project and program oversight, alongside stringent budgetary controls refined during the 2021-2025 period, will continue to guide the company in mitigating rising costs and optimizing capital expenditures throughout the next rate period. Furthermore, the operational efficiencies achieved through targeted process improvements and digital transformation will be systematically maintained, ensuring sustained service reliability and cost-effectiveness for customers. Please refer to Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement, for details on these efficiencies and improvements.

Looking ahead to the 2026-2030 period, Hydro Ottawa faces continued economic uncertainties, including high inflation and the general tariff related uncertainty, and must address the urgent need to renew deteriorating infrastructure, modernize the grid, and add significant capacity due to increased growth and electrification and ensure the resilience of the system. To address these challenges while maintaining customer affordability, Hydro Ottawa has implemented a comprehensive cost management strategy that includes:

- **Advanced Asset Management:** Implementing an Enterprise Asset Management (EAM) system to further optimize investment prioritization through integrations with Predictive Analytics and to optimize maintenance schedules through Condition-Based Monitoring.
- **Proactive Risk Management:** Implementing strategies to minimize project delays and disruptions.

- **Benchmarking:** Conducting comparative analysis to identify improvement opportunities.
- **Continuous Improvement and Innovation:** Modernizing the grid and operations by leveraging digital tools and automation.
- **Digital Transformation:** Enhancing service delivery through technology.
- **Infrastructure Efficiencies:** Optimizing asset utilization and leveraging NWSs.
- **Process Improvements:** Investing in workforce development and operational effectiveness.

Hydro Ottawa is also actively considering the impact on costs and affordability by increasing System O&M programs with more frequent inspections, testing, and maintenance to mitigate the risk associated with the deferral of near-term capital investments.

Hydro Ottawa's planning is rooted in a thorough analysis of the risks posed by deteriorating infrastructure, increasing electricity demand, and the imperative for grid modernization and resilience. Recognizing the critical importance of aligning with customer priorities, the utility proactively sought feedback through a comprehensive engagement survey. The survey confirmed that, even with a clear understanding of the associated bill impacts, customers overwhelmingly support the proposed plan for essential grid investments and infrastructure renewal as outlined in Section 2.2 - Customer Priorities. This valuable insight directly informs our investment decisions, reinforcing our commitment to balancing necessary upgrades with affordability. Cost control and efficiency remain paramount, with a focus on continuous improvement across all operations and capital projects. To minimize rate impacts, Hydro Ottawa will carefully prioritize and phase investments, addressing the most critical system risks first. This approach ensures that all decisions are guided by cost consciousness, customer value, and the long-term reliability of our electrical system.

Investing in the Workforce

Focusing on workforce development and safety to ensure a skilled and secure energy future.

While maintaining a relatively stable headcount over the past two rate periods, Hydro Ottawa now faces a confluence of escalating operational demands, rapid technological advancements, and the intensifying impacts of climate change, necessitating a strategic and significant investment in its workforce. This investment is not merely a reactive measure to address immediate pressures, but a proactive and crucial step to ensure long-term resilience, maintain service reliability, and effectively navigate the complex and evolving energy landscape. The need for specialized skills, expanded capacity, and enhanced responsiveness is paramount to meet the growing demands of the customer base and to safeguard the critical infrastructure upon which the community depends.

Hydro Ottawa recognizes that investments in both assets and a skilled workforce are paramount. While investments in infrastructure and maintenance are critical, the company acknowledges that during challenging times – such as storms, pandemics, and labour disruptions – it is the dedication and expertise of its workforce that is essential to maintain reliable service and ensure the continued provision of electricity to its customers. The challenges of recent years have underscored the critical importance of a well-resourced and resilient workforce. Hydro Ottawa has faced an unprecedented series of challenges, including:

- A near-strike in 2021 and an 84-day strike in 2023, which disrupted operations and highlighted the need for robust contingency planning and workforce stability. These disruptions also reflected, among other factors, underlying staffing concerns.
- Increasingly frequent and severe weather events, with storm after storm demonstrating the vulnerability of the electricity grid and the essential role of skilled personnel in rapid restoration efforts.
- Deteriorating infrastructure and evolving customer energy demands are driving the need for grid modernization, enhanced resilience, and the integration of new technologies.

In addition to the aforementioned, in 2021-2023, Hydro Ottawa experienced an unforecasted surge in customer-driven growth projects, encompassing unforeseen large-scale developments and a residential subdivision boom. This growth significantly amplified the demand for technical and trade staff. Concurrently, engineering resources faced escalating pressure due to the rising complexity and volume of large load and Distributed Energy Resource (DER) connection requests, requiring specialized engineering expertise. Moreover, the implementation of the Advanced Distribution Management System (ADMS) and the broader Grid Modernization Strategy highlighted the need for new engineering roles to manage advanced technologies. Finally, the need for enhanced oversight of larger, more complex projects, combined with a less tenured workforce, strained Hydro Ottawa's leadership and data analytics capabilities. In response to these immediate and escalating pressures, Hydro Ottawa could not defer action and added 50 new positions to its workforce in 2024.

Looking ahead to 2026-2030, in order to support the proposed capital and OM&A program investments, and to navigate the rapidly evolving utility landscape driven by grid modernization and the energy transition, Hydro Ottawa must continue to strategically expand its workforce. To determine headcount needs for its direct-labour workforce, Hydro Ottawa's employed a robust, data-driven workforce planning model, ensuring staffing levels are strategically aligned with operational needs and objectives. This model, detailed in Attachment 4-1-3(B) - Workforce Planning Strategy, systematically analyzes current and projected workloads, including capital project volumes, maintenance requirements, and customer growth, to identify required skills and competencies. By assessing the existing workforce and identifying gaps, the model facilitates the development of targeted hiring, training, and development initiatives. This comprehensive approach ensures that workforce needs are addressed proactively, rather than reactively.

For workforce needs not directly attributed to the capital and OM&A projects, Hydro Ottawa took the approach of engaging senior leadership to assess current and future skill requirements, particularly in emerging technological areas. All identified needs were then consolidated, rigorously reviewed, and challenged by executive management. This systematic approach ensures that workforce needs are not addressed in an ad hoc manner, but rather through a comprehensive and data-driven process. The combination of these assessments resulted in a proposed staffing plan that includes the addition of 127 new headcount over the 2026-2030 period. The increased headcount is primarily driven by the following key factors:

Significant Capital Program Growth: A near doubling of capital investment necessitates a substantial increase in skilled trades and technical staff to execute projects related to growth and electrification, infrastructure renewal, grid modernization, and resilience. This includes additional workforce to substantiate substation construction, battery energy storage system installations, and the replacement of deteriorating assets.

Increased Complexity and Volume of Projects: The rising complexity of projects, especially those involving grid modernization and the integration of Distributed Energy Resources (DERs), demands specialized engineering and technical expertise. This includes roles focused on new technologies, standards development, and advanced grid operations.

Deteriorating Infrastructure and Enhanced Maintenance: The need to renew deteriorating infrastructure and implement enhanced testing, inspection, and maintenance programs requires additional resources, particularly in skilled trades and technical positions.

Enhanced Oversight and Support Functions: The growth in project volume and workforce size requires strengthening support functions such as system operations, contractor management, project execution planning, and leadership to ensure efficient and safe operations.

Technological Advancement and Digital Transformation: The increasing complexity of IT and OT systems, cyber security needs, and digital customer experience enhancements drive the demand for specialized IT expertise.

Increased Regulatory and Compliance Demands: Growing safety training, business continuity, sustainability initiatives, and complex regulatory requirements necessitate dedicated compliance and policy resources.

Strengthening Internal Support Structures: Increased recruitment, HR technology evolution, and complex financial reporting drive the need for expanded HR and finance support.

As highlighted in Schedule 4-1-3 - Workforce Staffing and Compensation, the percentage of work being completed by external contractors has remained relatively stable at 44-46% of total gross capital expenditures, from 2021-2025 through to the 2026-2030 projections. This consistency indicates that Hydro Ottawa is effectively managing its contractor usage while prioritizing the addition of permanent staff to address both immediate and long-term needs. It is anticipated that this increased staffing will be necessary not only for the next few rate cycles, but also in the decades beyond, as these challenges are expected to persist and evolve.

3. CAPITAL EXPENDITURE PLAN

Hydro Ottawa is embarking on a period of transformative growth, with a proposed capital expenditure plan for 2026-2030 that nearly doubles the investment of the previous five years. This plan prioritizes system capacity enhancements, the renewal of deteriorating infrastructure, grid modernization, and bolstering overall resilience. Please refer to Table 5 for details on the historical Capital Expenditure Plan and Table 6 for details of the 2026-2030 proposed Capital Expenditure plan. Refer to Schedule 2-5-5 - Capital Expenditure Plan for further details on the historical and planned capital expenditures. The $102.8M variance between Hydro Ottawa's expected net capital expenditures and the OEB-Approved amounts is explained in Section 4 of Schedule 2-5-5 - Capital Expenditure Plan.

Table 5 - Capital Expenditure Historical Year Summary ($'000 000s)

Investment Category	Historical Years			Bridge Years		Total
	2021	2022	2023	2024	2025	2021-2025
System Access	$ 48	$ 47	$ 53	$ 69	$ 76	$ 293
System Renewal	$ 43	$ 65	$ 40	$ 42	$ 41	$ 232
System Service	$ 24	$ 14	$ 17	$ 47	$ 60	$ 161
General Plant	$ 24	$ 11	$ 13	$ 15	$ 13	$ 76
TOTAL CAPITAL EXPENDITURES	**$ 139**	**$ 138**	**$ 123**	**$ 173**	**$ 189**	**$ 762**
Capital Contributions	$ (27)	$ (28)	$ (29)	$ (37)	$ (41)	$ (162)
NET CAPITAL EXPENDITURES	**$ 112**	**$ 110**	**$ 94**	**$ 136**	**$ 148**	**$ 600**

Table 6 - Capital Expenditure Test Year Summary ($'000 000s)

Investment Category	Test Years					Total
	2026	2027	2028	2029	2030	2026-2030
System Access	$ 86	$ 79	$ 66	$ 67	$ 71	$ 369
System Renewal	$ 85	$ 83	$ 81	$ 87	$ 95	$ 432
System Service	$ 99	$ 125	$ 76	$ 86	$ 87	$ 473
General Plant	$ 38	$ 24	$ 33	$ 28	$ 11	$ 134
Total Capital Expenditures	**$ 309**	**$ 311**	**$ 256**	**$ 268**	**$ 265**	**$ 1,409**
Capital Contributions	$ (51)	$ (51)	$ (38)	$ (32)	$ (41)	$ (213)
Net Capital Expenditures	**$ 258**	**$ 260**	**$ 218**	**$ 235**	**$ 224**	**$ 1,195**

The largest variance between the 2021-2025 and 2026-2030 plans is seen in the increased investment in System Service, driven primarily by capacity upgrades. This is followed by increased investment in System Renewal, primarily for station equipment renewal. System Access also sees increased investment, driven by rising customer connections. Finally, General Plant expenditures are higher, primarily due to Connection and Cost Recovery Agreements for capacity upgrades and Fleet Replacement. The following sections provide a detailed breakdown of the changes in expenditures, summarizing the investment by category and capital program.

3.1. SYSTEM ACCESS

Spending on System Access, necessary to support growth and electrification, is expected to increase during the 2026-2030 period by 26% compared to the 2021-2025 timeframe. Projected capital investments are expected to rise from $293M in the 2021-2025 period to $369M in the 2026-2030 period, excluding Capital Contributions as shown in Table 7. This increase is primarily attributed to the growing number and complexity of customer connections, reflected in the higher expenditures for the Customer Connections and System Expansion Capital programs. This growth in expenditures is partially offset by a projected decrease in Plant

Relocation costs. See Schedule 2-5-5 - Capital Expenditure Plan and Schedule 2-5-6 - System Access Investments for further breakdown of the System Access capital investments.

Table 7 - System Access Capital Expenditure Variance by Capital Program 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)

Capital Program	Historical / Bridge Years 2021-2025	Test Years 2026-2030	Variance
Plant Relocation	$ 45	$ 35	$ (10)
System Expansion	$ 89	$ 108	$ 19
Customer Connections	$ 157	$ 221	$ 64
Generation Connections	$ 1	$ 4	$ 4
Metering	$ 2	$ 2	-
Total Capital Expenditures	**$ 293**	**$ 369**	**$ 77**
Capital Contributions	$ (158)	$ (196)	$ (38)
Net Capital Expenditures	**$ 134**	**$ 173**	**$ 39**

The Capital Programs encompassed within the System Access investment category are detailed below.

Plant Relocation & Upgrade

The capital investment for this program is detailed in Section 2 of Schedule 2-5-6 - System Access Investments. This program funds the relocation or upgrade of Hydro Ottawa-owned or joint-use overhead or underground equipment for third-party infrastructure projects, primarily by the City of Ottawa. This is driven by road widening and other development projects that conflict with existing Hydro Ottawa infrastructure. The program aims to meet regulations, improve system efficiency, and enable economic development. Spending from 2026-2030 is projected to decrease relative to 2021-2025, due to the completion of the City of Ottawa's Light Rail Transit

Phase II project. The 2026-2030 program is budgeted based on planned road widening projects outlined in the City of Ottawa's Transportation Master Plan[24].

System Expansion

The capital investment for this program is detailed in Section 4 of Schedule 2-5-6 - System Access Investments. System expansions are initiated when capacity constraints in Hydro Ottawa's infrastructure necessitate upgrades or additions to accommodate new customers or support existing customer service upgrades. Investments may involve upgrading feeders, transformers, or substations to ensure reliable power supply. Driven by customer service requests, particularly the growing number of large load requests, and Hydro Ottawa's legal obligation to fulfill connection requests, this program aims to ensure timely and efficient customer connections.

The System Expansion program is experiencing significant growth due to the current expansion efforts focused on major infrastructure projects such as the Hydro Road substation for OC Transpo's Zero Emission Buses, the Richmond South substation upgrade to support the DND Dwyer Hill Training Center, and feeder expansions for projects including the Ottawa Hospital's new campus, among others. These projects highlight the growing complexity and scale of distribution system expansion required to meet community energy demands.

Customer Connections

The capital investment for this program is detailed in Section 3 of Schedule 2-5-6 - System Access Investments. This program ensures new and modified customer connections, including residential subdivisions (townhomes, semi-detached, singles, or mixed), commercial developments (underground or vault equipment service), and infill services, are seamlessly integrated into the distribution grid, fulfilling mandated service obligations. The program involves

[24] City of Ottawa, "Transportation Master Plan, Exhibit 7.2: 2031 Affordable Road Network- Project By Phase- https://documents.ottawa.ca/sites/default/files/documents/tmp_en.pdf

installing transformers, lines, switchgear, and metering infrastructure, and may require roadwork and civil works.

The projected increase in this program is a direct result of sustained regional growth and development. This growth is fueled by residential subdivision expansion, commercial development aligned with transit-oriented projects and large load requests, and ongoing infill projects. Key factors to the increase include the City of Ottawa's intensification policies, the energy transition, and the rise of large-scale laboratory developments, all contributing to more complex and larger connection requests. The program focuses on meeting customer connection timelines while adhering to regulations. Two examples of budgeted large and complex commercial customer connections are the Regulatory and Security Science main project at the CFIA facility and the TerraCanada National Capital Area project at the National Research Council facilities.

Generation Connections

The capital investment for this program is detailed in Section 5 of Schedule 2-5-6 - System Access Investments. Hydro Ottawa's Generations Connections program facilitates integrating customer owned DERs into the distribution grid, complying with regulations and ensuring system reliability and safety. The program covers infrastructure upgrades and streamlined connection processes.

The increase in spending is planned to support the anticipated rise in DER adoption driven by enablement programs between 2026 and 2030 as well as the growing number of committed and planned customer generation projects. Notably, there is one large DER connection (over 500 kW) forecasted each year from 2026-2030 in support of the increasing trend of DER connections, see Figure 13 - DER Annual Requests Count 2021-2024. The IESO's DER Market Vision and Design Project[25] is expected to explore, design and implement foundational

[25] DER Market Vision and Design Project, https://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Distributed-Energy-Resources-Market-Vision-and-Design-Project

participation models for DERs in Ontario's electricity market and other IESO programs, such as the Save On Energy Home Renovation Savings Program[26] and the Save On Energy Retrofit Program[27] now include incentives for DERs. All these initiatives are expected to contribute to DER growth. The projected trend of accelerated DER adoption is further detailed in Section 9.3.2 of Schedule 2-5-4 - Asset Management Process.

Metering

The capital investment for this program is detailed in Section 6 of Schedule 2-5-6 - System Access Investments. Hydro Ottawa's Metering Program invests in metering technology, including Suite Metering for multi-unit buildings. The projected investment in revenue meter installations and retrofits is consistent with historical investment levels. Hydro Ottawa anticipates no substantial alterations to customer-initiated installations of new and retrofitted suite metering.

3.2. SYSTEM RENEWAL

The System Renewal investment category allocates spending to mitigate critical system risks stemming from aging and deteriorating assets. This includes replacing assets that pose significant reliability risks, upgrading systems, and replacing obsolete equipment to maintain system reliability, enhance efficiency and resilience, and ensure the continued delivery of safe and reliable electricity service.

Projected capital investment for System Renewal is expected to increase by 86% compared to the $232M in the 2021-2025 period, vs. $432M in the 2026-2030 timeframe. The significant increase in capital investment is primarily driven by the investments in station equipment renewals, guided by Predictive Analytics-driven risk assessments and the strategic replacement of the obsolete metering fleet.

[26] Save On Energy, "Home Renovation Savings Program, "https://www.saveonenergy.ca/For-Your-Home/Home-Renovation-Savings
[27] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

The implementation of Predictive Analytics and improved asset failure curves have resulted in a more comprehensive assessment of system risk associated with the deteriorating asset condition, please refer to Section 4.4 of Schedule 2-5-4 - Asset Management Process for additional information. This has informed the need for increased investment to renew high-risk station assets, followed by underground and overhead assets. The staged renewal of the obsolete metering population is the second highest contributor to the increased investment under System Renewal. Table 8 outlines the System Renewal program expenditures by the five associated capital programs. See Schedule 2-5-5 - Capital Expenditure Plan and Schedule 2-5-7 - System Renewal Investments for further breakdown of the System Renewal capital investments.

Table 8 - System Renewal Capital Expenditure Variance by Capital Program 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)

Capital Program	Historical / Bridge Years	Test Years	Variance
	2021-2025	2026-2030	
Stations & Bldgs Infra Renewal	$ 31	$ 108	$ 76
OH Distribution Asset Renewal	$ 43	$ 68	$ 25
UG Distribution Assets Renewal	$ 63	$ 103	$ 40
Corrective Renewal	$ 83	$ 67	$ (16)
Metering Renewal	$ 12	$ 86	$ 75
Total Capital Expenditures	**$ 232**	**$ 432**	**$ 199**
Capital Contributions	-	-	-
Net Capital Expenditures	**$ 232**	**$ 432**	**$ 199**

The Capital Programs encompassed within the System Renewal investment category are detailed below.

Stations and Buildings Infrastructure Renewal

The capital investment for this program is detailed in Section 2 of Schedule 2-5-7 - System Renewal Investments. Hydro Ottawa's Station and Buildings Infrastructure Renewal Program invests in upgrading and replacing deteriorating assets for stations and station buildings to maintain system reliability and safety. These assets include station transformers, station switchgear, batteries, protection and control systems (Relays and Remote Terminal Units (RTUs)), and other minor assets such as reclosers, insulators, arresters, online monitoring equipment and station building roofs. The Stations and Buildings Infrastructure Renewal program investments are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

The primary cost driver for the 2026-2030 Stations and Buildings Infrastructure Renewal program is the decommissioning of five high-risk 4kV substations through voltage conversion, undertaken to accommodate anticipated system growth. A secondary, yet significant, cost driver is the renewal of high-risk station breakers at four locations, identified through Predictive Analytics. Deteriorating substation assets within the Stations and Buildings infrastructure represent the most substantial risk to system performance. These critical assets serve a large customer base and provide essential system flexibility and backup capacity. Proactive asset replacement is therefore imperative to mitigate the elevated costs and risks associated with reactive repairs. This is particularly crucial within the 4kV system, where the radial distribution network configuration severely limits restoration capabilities in the event of substation asset failures.

OH Distribution Assets Renewal

The capital investment for this program is detailed in Section 3 of Schedule 2-5-7 - System Renewal Investments. This program focuses on the renewal of overhead distribution infrastructure, which encompasses poles, OH transformers, OH switches and OH reclosers. The investments in the Overhead Distribution Assets Renewal program are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics, as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

The expected increase to the pole renewal cost supports the annual replacement of 395 poles, aligning with the 2021-2025 period replacement rate of 400 poles. This projection reflects the increased cost per pole observed in the previous period and incorporates system resilience improvements within the renewed design. Overhead transformer replacement costs are also included in this program.

The expected costs for OH Switch/Recloser Renewal is a direct response to the deteriorating infrastructure, which has resulted in elevated outage rates and corrective maintenance costs during the 2021-2025 period, as detailed in Section 3.3.4 of Schedule 2-5-7 - System Renewal Investments. Project scoping within the OH Switch Renewal Program will also contemplate incremental investments that enhance the observability of the system.

UG Distribution Assets Renewal

The capital investment for this program is detailed in Section 4 of Schedule 2-5-7 - System Renewal Investments. This program replaces deteriorating underground distribution assets, including cables, UG transformers, and UG switchgear, civil infrastructure and vault equipment. Investments in this area are essential for maintaining the reliability and resilience of the underground network and are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

The increased capital investment within this program is primarily attributed to escalating per-unit costs associated with the cable replacement program. Despite a slight decrease in the projected cable units to be replaced compared to the previous period, significant price increases are anticipated due to forecasted material and external service costs. The impacts of the inflationary pressures on Hydro Ottawa are detailed in Schedule 1-2-5 - Impacts of Inflationary Pressure.

Corrective Renewal

The capital investment for this program is detailed in Section 6 of Schedule 2-5-7 - System Renewal Investments. This program addresses the replacement of assets that have degraded to a point of functional failure and pose an imminent failure risk, or have been damaged by third parties. While prioritizing proactive renewal, Hydro Ottawa also recognizes the need for reactive measures to maintain system integrity and address unexpected failures.

The drastic variance in capital investment for the 2026-2030 period compared to the actual expenditures in 2021-2025 period, is primarily attributed to the unusually high number and severity of Major Event Days (MEDs) experienced in the 2021-2025 period. It is assumed that the 2021-2025 MED frequency and intensity represents an anomaly. Therefore, the 2026-2030 forecast is more accurate compared to the 2021-2025 OEB-Approved amount.

A net increase in spending is observed in the 2026-2030 budget relative to the 2021-2025 OEB-Approved budget, due to cost escalations and the increasing impact of climate change on the electrical distribution system. While a discrete event of the magnitude of the 2022 Derecho is not explicitly forecast, the growing frequency and intensity of severe weather events necessitate sustained and strategic investment in infrastructure resilience. This imperative is reflected in the 2026-2030 forecasted capital investment in this program.

Metering Renewal

The capital investment for this program is detailed in Section 5 of Schedule 2-5-7 - System Renewal Investments. This program involves upgrading and replacing functionally obsolete metering infrastructure to support advanced metering functionality and improve system monitoring capabilities. The increase in spending in this category as compared to the previous period is to begin upgrading the metering fleet to Advanced Metering Infrastructure (AMI) 2.0 meters.

Hydro Ottawa's AMI 2.0 Metering Renewal Project aims to replace end-of-life meters with technology to empower customers with data-driven insights and tools for greater engagement and control over their energy usage. This initiative aligns to grid modernization objectives by facilitating improved grid visibility and interoperability, which is a key to enhancing reliability and efficiency. The project encompasses the replacement of existing meters, upgrades to the head-end system and data management platform, and potential deployment of complementary grid-edge devices. Phased over 2026-2035, the project begins with comprehensive planning and vendor selection, emphasizing open standards and interoperability. Rigorous testing and cyber security measures will ensure a smooth transition. Deployment will be phased, integrating with existing systems and prioritizing staff training. Ongoing evaluation will identify optimization opportunities, maximizing the system's benefits while ensuring cost-effectiveness. Risk mitigation strategies addressing reliability, safety, financial, environmental, and compliance concerns will be implemented throughout the project.

3.3. SYSTEM SERVICE

The System Service investment category allocates spending to increase capacity of the distribution system to meet forecasted demand, improve system reliability and resilience, and increase grid modernization in the distribution system.

Spending under this investment category is escalating by 194% from $161M in the 2021-2025 period to $473M in the 2026-2030 timeframe. The increase is primarily driven by the Capacity Upgrades program, which addresses growing capacity needs due to customer growth and electrification. Increased spending in the Distribution Enhancements program also contributes, with a focus on two new budget programs for Distribution System Observability and Distribution System Resilience. Finally, the Field Area Network Program drives further increases with investments in fiber extensions and wireless communication, as detailed in Table 9. See

Schedule 2-5-5 - Capital Expenditure Plan and Schedule 2-5-8 - System Service Investments for further breakdown of the System Service capital investments.

Table 9 - System Service Capital Expenditure Variance by Capital Program 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)

Capital Program	Historical / Bridge Years	Test Years	Variance
	2021-2025	2026-2030	
Capacity Upgrades	$ 108	$ 347	$ 239
Stations Enhancements	$ 3	$ 3	$ 0
Distribution Enhancements	$ 28	$ 93	$ 65
Grid Technologies	$ 21	$ 6	$ (14)
Control and Optimization	-	$ 4	$ 4
Field Area Network	$ 2	$ 21	$ 19
Total Capital Expenditures	**$ 161**	**$ 473**	**$ 312**
Capital Contributions	-	$ (4)	$ (4)
Net Capital Expenditures	**$ 161**	**$ 469**	**$ 308**

The Capital Programs encompassed within the System Service investment category are detailed below.

Capacity Upgrades

The capital investment for this program is detailed in Section 2 of Schedule 2-5-8 - System Service Investments. The capacity upgrades program addresses system capacity needs through station capacity, distribution capacity and non-wire capacity upgrades. System capacity needs and required upgrades are determined through the System Capacity Assessment as outlined in Section 9 of Schedule 2-5-4 - Asset Management Process and Integrated Regional Resource Planning as detailed in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Station capacity upgrades, designed to meet forecasted demand, focus on expanding existing Hydro Ottawa substations or the construction of new facilities. The primary reason for the increase to the Capacity Upgrades program capital budget is the planned investment in Station Capacity Upgrades for the 2026-2030 period. This need has been identified through Regional Planning, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties, and is based on forecasted system requirements. The 2026-2030 plan includes the construction of four new stations: Piperville, Mer Bleue, Greenbank, and Kanata North, and upgrading three existing stations: Riverdale, Cyrville, and Bronson.

To fully utilize the increased capacity provided by the station projects, the distribution capacity upgrades program will enhance the electrical distribution network through feeder expansion and upgrades. This program accounts for the second largest increase in the Capacity Upgrades program budget for 2026-2030. This increase is primarily driven by a greater number of feeder integration projects required to support the planned construction of the four new stations and the planned upgrade of three existing stations identified previously.

The Non-Wires Capacity Upgrade is a new program which accounts for the remaining expected increase in the Capacity Upgrades program for 2026-2030. It aims to improve grid capacity and reliability by implementing alternatives to traditional infrastructure upgrades, such as utility owned battery energy storage solutions (BESS) and Non-Wires Customer Solutions Program. The program's primary focus is on five constrained regions utilizing four BESS in combination with the Non-Wires Customer Solutions Program. These solutions are being strategically deployed in areas that meet one of the following criteria: stations requiring near-term capacity risk mitigation, distribution-connected stations with forecasted overloads of less than 7.5MVA by 2030, or areas projected to exceed capacity by 2030 and are experiencing transmission system constraints, please see Section 9.2 of Schedule 2-5-4 - Asset Management Process.

Based on a thorough analysis of the needs identified for each of the Hydro Ottawa planning regions described in Section 9.1.4 of Schedule 2-5-4 - Asset Management Process it has been determined that the majority of these needs will require wire solutions, meaning upgrades and expansions to the physical grid infrastructure. While NWSs are not expected to cause substantial avoidance or deferral of the identified wire capacity investment needs, they will play a crucial role in moderating the pace of system demand growth and enhancing reliability in the 2026-2030 period, while continuing to support the grid in the long term. This moderation will provide Hydro Ottawa with the lead time to construct the necessary long-term grid infrastructure solutions that are in harmony with the evolving system demand. There are three scenarios identified where NWSs would have the greatest potential in supporting capacity needs: please refer to Section 9.2 of Schedule 2-5-4 - Asset Management Process for more information.

Stations Enhancements

The capital investment for this program is detailed in Section 4 of Schedule 2-5-8 - System Service Investments. This program will improve distribution system observability and operability through cyber security investments and station modifications, including enhanced monitoring. Specifically, online transformer monitoring will proactively identify faults, improving asset observability and reliability by reducing unexpected failures. Addressing vulnerabilities, the program will also bolster cyber security at substations, improving threat detection and response to prevent disruptions and maintain reliable power delivery.

Distribution Enhancements

The capital investment for this program is detailed in Section 3 of Schedule 2-5-8 - System Service Investments. The Distribution Enhancement program modernizes the grid and addresses climate change risks through four programs: Distribution System Reliability, Distribution System Enhancements, Distribution System Resilience and Distribution System Observability. The Distribution System Reliability program improves efficiency and reliability through feeder reconfiguration and phase balancing. The Distribution System Enhancements program supports DER integration through infrastructure upgrades and pilot projects, leveraging federal funding for innovation. The Distribution System Resilience program strengthens weather resilience with strategic undergrounding, storm hardening, and line relocation, aligning with the

OEB's VASH initiative. The Distribution System Observability program enhances grid management through real-time data and remote switching improving reliability and flexibility.

The increased investment compared to the total in the 2021-2025 period is driven by the creation of the new Distribution System Observability and Distribution System Resilience programs. The Distribution System Observability program aims to enhance system reliability and reduce outage times by investing in new assets that provide real-time data on system conditions, loading, and fault locations, enabling proactive maintenance and faster response to issues. The Distribution System Resilience program focuses on mitigating the impact of adverse weather events through strategic undergrounding of lines, reinforcement of existing infrastructure, reconfiguration of feeders, and relocation of lines to less vulnerable areas.

Grid Technologies

The capital investment for this program is detailed in Section 5 of Schedule 2-5-8 - System Service Investments. This program modernizes grid management by enhancing observability and controllability through data acquisition, monitoring, and control capabilities. Focusing on ADMS, it enhances grid troubleshooting and asset monitoring, supporting data-driven decisions for preventative and predictive maintenance, and integrating with other systems. Driven by system efficiency, it addresses integration complexities, optimizes data handling, enhances reliability and security, and improves performance through a unified platform, seamless data exchange, and simplified maintenance. This upgrade reduces single points of failure, strengthens cyber security, and enables advanced analytics for better grid management.

Control and Optimization

Capital investment details are available in Section 7 of Schedule 2-5-8 - System Service Investments. This program focuses on Distributed Energy Resources Management Systems (DERMS) implementation to manage the growing complexity of DERs, improving grid stability, reliability, efficiency, and resilience. This program aims to improve operational effectiveness by increasing DER visibility and control, and improving grid efficiency. The Control and

Optimization program is a new capital program under System Service supporting grid modernization efforts by enhancing the Advanced Distribution Management System (ADMS) with new modules like the Distributed Energy Resource Management System (DERMS). These upgrades enable several grid modernization functionalities in tandem with observability and controllability devices facilitating the improvement of grid stability, efficiency, and resilience, enabling better grid management and real-time outage restoration.

Field Area Network

The capital investment for this program is detailed in Section 6 of Schedule 2-5-8 - System Service Investments. The Field Area Network (FAN) program is essential for Hydro Ottawa's digital and grid modernization, providing the communication backbone for grid devices and central systems.

Four key initiatives—Optical Transport Network (OTN) Fiber Network Resilience, Wireless Communication Private Long-Term Evolution (PLTE) pilot), Intelligent Electronic Device Management, and OTN cyber security—enhance reliability, security, and efficiency. Driven by system efficiency, the FAN enables real-time data access for grid modernization and DER integration, strengthens cyber security, and improves outage response by providing grid visibility and control.

3.4. GENERAL PLANT

The General Plant category encompasses a diverse set of capital programs essential for maintaining and advancing Hydro Ottawa's IT and facility infrastructure, operational capabilities, and customer service excellence. These investments address areas such as facility infrastructure, fleet renewal, IT and cyber security infrastructure, and customer engagement. By upgrading deteriorating systems, introducing advanced technologies, and enhancing operational facilities, these programs ensure Hydro Ottawa remains well-equipped to meet evolving industry demands, regulatory requirements, and customer expectations. The planned initiatives support strategic goals like grid modernization, sustainability, and workforce readiness while promoting efficiency, innovation, and resilience in Hydro Ottawa's operations.

Expenditure under this investment category is increasing by 75% from $76M in the 2021-2025 period to $134M the 2026-2030 period. The primary driver for this increase is due to increased funding under the Connection Cost Recovery Agreement (CCRA) program required to support the increased number of transmission upgrades required to service new and upgraded stations. An increase in the Fleet Replacement program is driven by the need to replace vehicles that have reached end of useful life and for additional vehicles required to support the increase in planned workforce, as indicated in Table 10. See Schedule 2-5-5 - Capital Expenditure Plan and Schedule 2-5-9 - General Plant Investments for further breakdown of the General Plant capital expenditure program.

Table 10 - General Plant Capital Expenditure Variance by Capital Program 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)[28]

Capital Program	Historical / Bridge Years	Test Years	Variance
	2021-2025	2026-2030	
CCRA	$ 17	$ 46	$ 29
Fleet Replacement	$ 18	$ 41	$ 23
Tools Replacement	$ 3	$ 5	$ 2
Buildings - Facilities	$ 7	$ 7	$ (1)
Grid Technology	$ 2	$ 4	$ 2
Meter to Cash	$ 4	$ 9	$ 5
Customer Engagement Platform	$ 7	$ 3	$ (5)
Enterprise Solutions	$ 6	$ 1	$ (4)
Infrastructure and Cyber Security	$ 11	$ 15	$ 4
Data and System Integrations	$ 2	$ 3	$ 2
Total Capital Expenditures	**$ 76**	**$ 134**	**$ 57**
Capital Contributions	$ (4)	$ (13)	$ (9)
Net Capital Expenditures	**$ 73**	**$ 121**	**$ 48**

The Capital Programs encompassed within the General Plant investment category are detailed below.

CCRA - Connection Cost Recovery Agreement

The capital investment for this program is detailed in Section 7 of Schedule 2-5-9 - General Plant Investments. The CCRA program funds Hydro Ottawa's share of transmission infrastructure upgrades, determined through system capacity assessments. These upgrades include connections for new and upgraded stations and addressing equipment limitations at Hydro One Networks Inc. (Hydro One)-owned stations. Hydro Ottawa contributes to the costs of these upgrades, ensuring grid reliability and supporting growth. Key projects include new

[28] Totals may not sum due to rounding.

stations (Hydro Road, Mer Bleue, Kanata North, Greenbank) and upgrades to existing stations (Cyrville, Bronson, Carling, King Edward, Hinchey). This investment will increase station capacity by over 811MVA, improving DER hosting capacity and reliability, and supporting customer growth. Driven by the need to address capacity constraints, the CCRA program responds to load requests and without these investments Hydro Ottawa may not be able to meet future demand.

Fleet Replacement

The capital investment for this program is detailed in Section 11 of Schedule 2-5-9 - General Plant Investments. This program plans for additional vehicles required for increased staffing needs as well as replacing aging vehicles with modern, efficient alternatives to support safety and operational needs and to reduce carbon emissions. Over the 2026-2030 rate period, a total of 140 vehicles at a cost of $41M are planned to be purchased in order to replace vehicles at the end of their useful lives and account for additional vehicles required to support workforce growth.

Tools Replacement

The capital investment for this program is detailed in Section 9 of Schedule 2-5-9 - General Plant Investments. This program updates and replaces outdated equipment and tools to enhance operational efficiency, support field staff, and improve safety. The program ensures workforce readiness and aligns with modern operational standards.

Buildings - Facilities

The capital investment for this program is detailed in Section 10 of Schedule 2-5-9 - General Plant Investments. This program focuses on maintaining and upgrading office and administrative facilities to support workforce needs, improving energy efficiency, and providing a safe working environment. These investments also align with Hydro Ottawa’s sustainability goals and level of organizational growth.

Grid Technology

The capital investment for this program is detailed in Section 6 of Schedule 2-5-9 - General Plant Investments. This program addresses the maintenance and upgrade of tools and software that support modernization of grid operations, integrate new technologies like DERs and support grid planning. The program focuses on network visualization and management, data collection and network modelling and simulation.

Meter to Cash

The capital investment for this program is detailed in Section 2 of Schedule 2-5-9 - General Plant Investments. This program supports critical business functions such as billing, meter reading, collections, and reporting. Upcoming upgrades to systems like Oracle's Customer Care & Billing (CC&B) and AMI aim to ensure compliance, improve customer self-service options, and address end of life infrastructure.

Customer Engagement Platform

The capital investment for this program is detailed in Section 3 of Schedule 2-5-9 - General Plant Investments. This program encompasses tools such as MyAccount, outage communication systems, Hydro Ottawa's website, and energy management tools. It prioritizes enabling intuitive self-service, delivering detailed energy insights, and enhancing customer satisfaction through seamless digital experiences. Furthermore, these digital platforms enable Hydro Ottawa to gather valuable customer insights that can also be used to enhance customer experience, inform grid planning, and identify opportunities for future NWSs and customer programming.

Enterprise Solutions

The capital investment for this program is detailed in Section 4 of Schedule 2-5-9 - General Plant Investments. This program focuses on maintaining and upgrading applications such as Enterprise Resource Planning (ERP) and IT Service Management systems. These enhancements ensure business continuity, streamline workflows, and reduce cyber security risks. Over the rate period, the program includes business continuity software and expanding self-service HR capabilities.

Infrastructure & Cyber security

The capital investment for this program is detailed in Section 8 of Schedule 2-5-9 - General Plant Investments. This program invests in strengthening IT systems to protect against cyber threats, maintain data integrity, and support business continuity. The program aims to ensure systems are secure, scalable, and aligned with industry best practices to safeguard critical infrastructure.

Data and System Integrations

The capital investment for this program is detailed in Section 5 of Schedule 2-5-9 - General Plant Investments. This program consolidates fragmented data systems to create an integrated, reliable, and efficient framework. It aims to reduce manual interventions, enable real-time decision-making, and ensure compatibility across platforms to support both operational and strategic initiatives.

4. OUTCOMES AND PERFORMANCE MEASURES

Hydro Ottawa's proposed performance framework for the 2026-2030 DSP emphasizes a direct and transparent approach to monitoring and reporting. The framework aligns with the OEB performance outcomes:

- **Customer Focus:** Prioritizing connection efficiency, grid reliability, customer engagement, and technological advancements to enhance customer satisfaction.
- **Operational Effectiveness:** Leveraging grid modernization, asset management, customer-centric operations, and workplace safety to optimize performance.
- **Public Policy Responsiveness:** Ensuring regulatory compliance, grid modernization planning, safety, and reliability to meet public policy goals.

- **Financial Performance:** Focusing on resource optimization, grid reliability with integrated DERs, data-driven decision making, and long-term financial sustainability.

Hydro Ottawa will measure performance through specific outcomes linked to Material Investment Plans (MIPs) in four investment categories: System Access, System Renewal, System Services, and General Plant. This approach ensures that investments and initiatives are strategically aligned, customer-focused, and financially responsible. The framework will enable Hydro Ottawa to effectively track progress, evaluate planning, improve operations, and identify areas for enhancement, ultimately delivering better service to customers. Refer to Schedule 2-5-3 - Performance Measurement for Continuous Improvement for full details on outcomes and performance measures.

5. OVERVIEW OF DOCUMENTS

The complete 2026-2030 DSP is included in Schedules 2-5-1 to 2-5-9 of this Application submission. It consists of nine schedules, which are outlined below and mapped back to the Chapter 5 Filing Requirement as shown in Table 11.

Table 11 - DSP Schedules Mapping to OEB Chapter 5 Filing Requirements

OEB Chapter 5 Filing Requirements- Sections	DSP Schedule
5.2.1 – Distribution System Plan Overview	2-5-1
5.2.2 – Coordinated Planning with Third parties	2-5-2
5.2.3 – Performance Measurement for Continuous Improvement	2-5-3
5.3 – Asset Management Process	2-5-4
5.4 – Capital Expenditure Plan	2-5-5 2-5-6 2-5-7 2-5-8 2-5-9

DSP Schedules:

- **Schedule 2-5-1 - Distribution System Plan Overview**
  This schedule provides a comprehensive overview of the DSP, including an outline of the key elements of the plan, and highlights important changes. It also details the 2026-2030 capital expenditure plan, aligned with Investment Priorities, and how customer preferences and expectations were incorporated into forming the Focus Areas and validating the Investment Priorities. The chapter also provides an overview of the outcomes and performance measures used to track the plan's progress and outlines the structure of the DSP documents, period, and vintage of information.

- **Schedule 2-5-2 - Coordinated Planning with Third Parties**
  This schedule examines how the DSP coordinates with customers and stakeholders. It covers:

- Customer Coordination: Outlines the various methods of customer engagement, including consultations, requests, and open houses, used to inform investment planning and ensure the DSP reflects customer priorities.
- Regional Planning: Details the collaborative regional planning process among the IESO, Hydro Ottawa, and Hydro One to ensure a reliable, cost-effective, and sustainable electricity supply for the region.
- Telecommunication Entities: Explains Hydro Ottawa's relationship with telecommunication companies, focusing on the attachment process and agreements for infrastructure sharing.
- Other Utility and Stakeholder Coordination: Describes Hydro Ottawa's coordination with various utilities and stakeholders, including the City of Ottawa, contractors, and industry groups, to ensure efficient and safe operations.
- Planning Coordination Effects on DSP: Discusses how effective planning coordination among various stakeholders is crucial for the successful planning of the distribution system, ensuring alignment, minimizing conflicts, and addressing diverse needs.

- **Schedule 2-5-3 - Performance Measurement for Continuous Improvement**

  This schedule outlines Hydro Ottawa's performance measurement framework, aligned with the OEB guidelines. It covers:

  - Historic (2021-2025) DSP Performance: Presents historical KPI data and explains the results of performance across customer, costs, asset, and system operations.
  - Historical Reliability Performance: Provides a detailed analysis of Hydro Ottawa's reliability performance trends, including SAIDI and SAIFI.
  - Continuous Improvement: Discusses ongoing efforts to enhance performance based on data analysis and feedback.

- Performance Measurement Framework: Details the framework used to measure and monitor the performance across various system areas of the DSP.

- **Schedule 2-5-4 - Asset Management Process**

  This schedule provides an in-depth look at asset management within the DSP. It covers:

  - Planning Process: Describes Hydro Ottawa's integrated business planning process, including strategic objectives, customer engagement, and the development of core business strategies that guide investment plans.
  - Asset Management Overview: Presents Hydro Ottawa's Asset Management System, its certification, scope, strategy, objectives, process overview, and process enhancements.
  - Asset Management Process: Explains the detailed, four-stage asset management process (prepare, plan, optimize, execute) used by Hydro Ottawa to manage its assets and planned expenditures.
  - Overview of Assets Managed: Details the various assets managed by Hydro Ottawa, including their demographics, condition, failure rates, risk profiles, and system utilization.
  - Asset Lifecycle Optimization: Describes the policies and practices used by Hydro Ottawa to optimize asset lifecycles, including typical useful life (TUL), replacement/refurbishment policies, and testing inspection and maintenance programs.
  - System Capacity Assessment: Presents Hydro Ottawa's comprehensive assessment of system capacity needs, including load forecasting, NWSs, and the integration of renewable energy resources.

- **Schedule 2-5-5 - Capital Expenditure Plan**

  This schedule provides a comprehensive analysis of capital investments within the DSP, focused on the 2026-2030 period. It covers:

  - Forecast Expenditure: Presents the 2026-2030 forecasted expenditures by investment category, driven by Hydro Ottawa's investment strategy.
  - Historical and Forecast Expenditure Overview: Outlines the variance between the total of 2021-2025 timeframe vs. OEB-Approved amounts, and compares them to the 2026-2030 Capital Expenditure plan.
  - Capital Expenditure Summary: Details the historical performance and forecasted expenditures by investment category, further divided by Capital Program and Budget Program.
  - Impact on Operation and Maintenance Costs: Discusses how capital expenditures affect routine system operation and maintenance costs, including cost reductions.

  Additionally, Capital Programs are described under the following schedules for each Investment Category:

  - Schedule 2-5-6 - System Access Investments
  - Schedule 2-5-7 - System Renewal Investments
  - Schedule 2-5-8 - System Service Investments
  - Schedule 2-5-9 - General Plant Investments

6. DSP PERIOD

The DSP provides capital expenditure plans and supporting information for the 2026-2030 Test Year period, along with Historical and Bridge Year information for 2021-2023 and 2024-2025, respectively.

7. VINTAGE OF INFORMATION

Unless otherwise stated, the information and details provided are based on actual numbers as of December 31, 2023.

COORDINATED PLANNING WITH THIRD PARTIES

1. OVERVIEW

Hydro Ottawa's Distribution System Plan (DSP) relies heavily on input achieved through collaboration. The utility prioritizes integrated planning, ensuring alignment with customers, the transmitter and IESO through regional planning, and the community. Customer engagement on an ongoing basis is achieved through open houses, presentations, and a formal consultation process that directly shaped the DSP's strategic focus and investment priorities. Hydro Ottawa works with the IESO and Hydro One Networks Inc. (Hydro One), providing planning forecasts and exploring solutions to address capacity needs, with a particular focus on the complexities of decarbonization and electrification. Hydro Ottawa also coordinates with telecommunication companies regarding infrastructure attachments, the City of Ottawa on development and utility projects (including the LRT and "Energy Evolution" strategy), and contractors and developers to streamline projects. Participation in industry working groups provides access to shared knowledge and cost-effective technology. This multi-faceted coordination is crucial for a successful and responsive DSP.

2. INTRODUCTION

This Schedule of the DSP explains how Hydro Ottawa coordinates its plans with third parties and how the results of this planning have been factored into the proposed DSP.

Hydro Ottawa operates within the majority of the City of Ottawa and the Municipality of Casselman, and has effectively coordinated with third party stakeholders, grouped in three major categories in regards to coordinated planning:

1. **Customers:** Grouped by residential, small commercial, commercial & industrial (C&I), and key accounts customers;
2. **Regional Planning Authorities:** IESO and Hydro One; and

3. **Community Stakeholders:** Including Telecommunication Entities, Enbridge Inc. (Enbridge), City of Ottawa, City of Ottawa Utilities Committee, and Ottawa Light Rail Transit (LRT).

Coordination with third-party stakeholders has resulted in a comprehensive, efficient, and well-integrated DSP. This integrated planning process ensures that Hydro Ottawa's strategy is aligned with its customers' needs, the plans and objectives of the regional electrical system, and the needs of other stakeholders in the community. This approach fosters optimized resource allocation, streamlined processes, shared infrastructure, and the avoidance of redundant investment, contributing to a cost-effective plan. Ultimately, this strategy enables Hydro Ottawa to deliver reliable and resilient access to electricity and meet the ever-growing needs of customers in Ottawa and Casselman.

3. CUSTOMER COORDINATION

Customer coordination is a key input into the planning process. Hydro Ottawa utilizes a mix of ongoing and specific engagements with customers to inform investment planning and coordinate the work undertaken within its plans. For example, Hydro Ottawa regularly conducts customer engagement through open houses and community presentations. These meetings give customers and Hydro Ottawa employees a chance to discuss upcoming projects, emergency preparedness, and other topics of interest or concern. Additionally, customers are engaged through their many daily interactions with company staff. Schedule 1-4-1 - Customer Engagement Ongoing outlines a comprehensive summary of the tools, activities, and interactions which comprise Hydro Ottawa’s customer engagement as part of its normal course of business. In addition, a two-phase customer consultation was conducted as a part of the 2026-2030 Rate Application planning process, as described in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

This multi-faceted approach to customer coordination ensures that Hydro Ottawa’s DSP reflects the needs and priorities of its customers.

3.1. CUSTOMER CONSULTATION

Customer consultation is crucial to Hydro Ottawa's business strategies and investment plans. Accordingly, Hydro Ottawa has implemented several methods of engaging customers related to its Asset Management Process, including activities that are integrated into normal business operations. Feedback from customers has been instrumental in shaping this DSP, demonstrating Hydro Ottawa's commitment to understanding and meeting customer needs and preferences. Customer consultations related to Asset Management which are part of Hydro Ottawa's ongoing customer engagement activities are described in more detail in Schedule 1-4-1 - Customer Engagement Ongoing. Three main categories of this customer engagement are as follows and described below:

1. Customer Requests and Engagement
2. Keeping Ottawa Connected
3. Project Open Houses

3.1.1. Customer Requests and Engagement

Hydro Ottawa handles a wide range of customer requests daily, from new service connections and upgrades to major infrastructure relocations. The utility uses online service request forms to efficiently manage these requests and ensure they reach the appropriate team. In addition, in 2024, Hydro Ottawa established a project intake group responsible for ensuring customer requests are more effectively tracked, that resources are appropriately assigned and that service levels related to responses are adhered to. Additional information related to the intake initiative is provided in Section 4 of Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement.

For smaller requests, like connecting a new home or upgrading an existing service, Hydro Ottawa's service desk and layout groups work collaboratively to review the request and create a design if needed. Larger projects, such as those involving significant new loads or relocating existing equipment, are handled by the distribution design group, which conducts a more in-depth review to assess the impact on the electrical grid.

When these larger projects require upgrades to Hydro Ottawa's infrastructure, the utility looks for opportunities to integrate them with planned system expansions. This approach allows Hydro Ottawa to share costs and use resources more efficiently, ultimately benefiting all of its customers.

For major projects involving large commercial or Key Account customers, such as the LRT, or Ottawa Community Housing, Hydro Ottawa assigns dedicated contacts within its project management teams, and utilizes existing relationships with the Key Accounts team. This provides these customers with personalized support and coordination throughout their projects.

Hydro Ottawa's goal is to provide a seamless and responsive experience for all its customers, whether they're connecting a new home or undertaking a major development project. The utility is committed to meeting customer needs efficiently and effectively while ensuring the reliability, safety, and sustainability of the electrical grid.

The outcomes and feedback from external requests are integrated into Hydro Ottawa operations to support continuous learning, and the number and scope of requests are used to support growth forecasting in the DSP.

3.1.1.1. *Key Accounts*

As outlined in Section 2.3 of Schedule 1-4-1 - Customer Engagement Ongoing, Hydro Ottawa’s Key Accounts team regularly and proactively engages with Hydro Ottawa’s largest customers. One key function of this engagement is identifying upcoming work that might impact the utility, such as large load requests, customer distributed energy resource (DER) projects, and electrification goals. Identifying large and potentially impactful projects early on helps Hydro Ottawa’s planning and forecasting. The Key Accounts team is also able to guide customers on the proper process to submit formal requests, helping ensure that the required and correct information is provided to Hydro Ottawa in a timely manner.

3.1.2. Keeping Ottawa Connected

After the 2022 Derecho storm, Hydro Ottawa developed "Keeping Ottawa Connected," a community presentation focusing on emergency preparedness, power restoration, vegetation management, and generator safety. Since launching in 2023, Hydro Ottawa has delivered 20 of these presentations to nearly 750 people. Participants come away with a better understanding of their role in emergency preparedness, Hydro Ottawa's restoration process, efforts to enhance grid resilience, and the communication tools available. Customer engagement during these sessions has also provided the company with insights into evolving customer needs, informing future services and delivery. The outcomes and feedback of Keeping Ottawa Connected are integrated into Hydro Ottawa operations to support continuous learning. Although the outcomes of these consultations do not directly impact the DSP, they are factored into Hydro Ottawa’s day to day processes.

3.1.3. Project Open Houses

Hydro Ottawa regularly holds open houses to consult with customers regarding major projects. In 2021, due to the pandemic, Hydro Ottawa moved to a virtual format to ensure public safety. This shift allowed for greater flexibility in scheduling and resulted in increased customer participation. As restrictions eased, Hydro Ottawa adopted a hybrid approach, offering both virtual and in-person sessions.

Open houses cover a range of topics, including the project overview, rationale, anticipated benefits, impacted areas, timelines, scope of work, and site restoration plans. Customers are given the opportunity to ask questions and provide feedback directly to the Hydro Ottawa employees that are involved in the project. This direct engagement strategy has often led to improvements in project design and scheduling. For more information regarding the open house process and examples of integrated customer feedback, please refer to Section 2.5.1 of

Schedule 1-4-1 - Customer Engagement Ongoing. The outcomes of project open houses are constantly reviewed and integrated into Hydro Ottawa operations to support continuous learning, although the outcomes of these consultations do not directly impact the DSP, they are factored into Hydro Ottawa's day-to-day processes.

4. REGIONAL PLANNING

The IESO regional planning process in the Greater Ottawa Area involves collaboration among the IESO, Hydro Ottawa, and Hydro One. This collaborative effort helps identify the current and future capacity needs of the electrical system and ensures a reliable, cost-effective, and sustainable electricity supply for the region.

As part of this planning process, Hydro Ottawa provides a comprehensive long-term planning load forecast, the Integrated Regional Resource Planning (IRRP) forecast, for its service territory. For more information, please refer to Section 9.4.2 of Schedule 2-5-4 - Asset Management Process. This planning forecast aids in identifying transmission lines and distribution stations reaching or exceeding their capacity limits in the short, medium, and long term. Hydro Ottawa also provides information on limitations within the planning area that might not be readily apparent to the working group.

The IRRP process identifies cost-effective and sustainable solutions to ensure efficient and reliable energy distribution. The solutions include "wire" options such as: new transmission lines, autotransformers, step-down transformer stations, voltage control devices, upgrades to existing infrastructure, or control actions or protection schemes that influence how the system is operated to avoid or mitigate certain reliability concerns. Capacity needs that would be best suited for a more detailed assessment for Non-Wires Solutions (NWSs) are also identified. This includes local utility-scale generation or storage, DERs (including distribution-connected generation and demand response), CDM or electricity Demand-Side Management (eDSM), or distribution-level load transfers.

The main stages of the IESO regional planning process are:

- Needs Assessment, please refer to Section 4.1 - Needs Assessment
- Scoping Assessment, please refer to Section 4.2 - Scoping Assessment
- IRRP, please refer to Section 4.3 - Greater Ottawa Integrated Regional Resource Planning
- Regional Infrastructure Plan (RIP), please refer to Section 4.4 - Greater Ottawa Regional Infrastructure Plan

Results from the regional planning process are incorporated into Hydro Ottawa's investment plan to meet the capacity needs of the system and play a pivotal role in shaping Hydro Ottawa's investment plan. By incorporating these insights, Hydro Ottawa can strategically allocate resources to ensure the system's reliability, resilience, and ability to meet the growing energy demands of the Ottawa region.

Government decarbonization initiatives have added increased complexity to the regional planning process due to the impacts of decarbonization and the uncertainty of associated electrification rates at the community level. To address this a Decarbonization Sub-Working Group was created to support the IRRP. In support of this sub-working group, Black & Veatch was engaged to create a variety of load scenarios for 2025 to 2050 based on varying regional and local factors with refinement from the Decarbonization Sub-Working Group. Details of the working group are summarized in Section 4.3.1 - Decarbonization Sub-Working Group.

A key finding of the IESO regional planning process was the need for investment to support the region's electrification strategy. This includes accommodating increased electricity consumption and demand from new homes and businesses, as well as supporting the transition to electric vehicles (EVs) and other clean energy technologies. Hydro Ottawa's investment plan reflects these findings, ensuring the electricity grid can handle the increased demand and contribute to a sustainable energy future for the region.

4.1. NEEDS ASSESSMENT

A Needs Assessment is conducted at least every five years, or more frequently if one of the parties to the process raises a regional reliability or delivery performance issue, or if there are concerns with respect to the system's ability to handle a customer load request. The transmitter leads this analysis, with data provided by the IESO and the local distribution companies (LDCs). This assessment examines changes in demand within a specific area and conducts an initial screening to identify regional or sub-regional needs.

Due to increased load growth in the region, the third regional planning cycle was triggered in advance of the 5-year period. In 2022, an assessment was conducted by Hydro One Transmission to evaluate the needs of the Greater Ottawa region. The following asset renewal needs were identified by Hydro One over the planning horizon based on asset condition assessment:

- Lisgar TS: Replace transformer T1
- South March TS: Replace transformers T1/T2
- S7M Line Refurbishment

In terms of transformation capacity, many stations were found to be near or exceeding their limits. While load transfers can mitigate the need in the near term, station capacity was recommended to be reviewed as part of this regional planning cycle. The assessment's findings highlighted the necessity for enhanced regional collaboration, prompting the initiation of a Scoping Assessment.

4.2. SCOPING ASSESSMENT

During this phase, the IESO collaborates with the transmitter and LDCs to determine the most suitable planning strategy, as follows:

- If there is potential for integrating options such as conservation, generation, distribution, or emerging technologies, an IRRP will be recommended.

- If needs can be met solely through enhancements to transmission lines or infrastructure, a RIP led by the transmitter will be recommended.
- Alternatively, it may be recommended that the LDC and transmitter jointly plan for the necessary local infrastructure investments.

In the Scoping Assessment phase, the progress on recommendations from the previous IRRP, which was completed in March 2020 was reviewed. A summary of the recommendations and updates on progress made for completions are listed below:

Kanata-Stittsville

- Implement the North Kanata Retrofit Top-Up Program and the North Kanata Smart Thermostat Program, targeted commercial and residential energy efficiency programs.
- Improve distribution load transfer capability at the heavily loaded stations Marchwood MTS and Kanata MTS – Ongoing.

Southeast Ottawa

- Construction of a new 230kV connected supply station in southeast Ottawa. Construction of the new Piperville Station by Hydro Ottawa is ongoing and planned for energization in 2026. Please refer to Section 2 of Schedule 2-5-8 - System Service Investments for further detail.

Central Ottawa

- Replacement of transformers T2 and T3 at Slater TS due to end-of-life, with larger transformers, approximately 100 MVA, as was done for the recent replacement of T1 – work was completed by Hydro One in 2024.
- Replacement of transformers T1 and T2 at Lincoln Heights due to end-of-life – work completed by Hydro One in 2024.
- Replacement of transformers T1 and T2 at Albion TS due to end-of-life – planning

underway with an expected completion in 2031-2033. Hydro Ottawa has requested incremental capacity at the time of the replacement of these transformers.

Orleans

- The refurbishment and expansion of Bilberry Creek TS was cancelled due to increased forecasted demand in the Ottawa Area Sub-region. Instead, the working group considered decommissioning Bilberry Creek TS and transferring the loads to a new 230 kV connected supply station. Additionally, the existing Orleans TS will be upgraded to provide additional supply capacity. Hydro Ottawa is planning to energize the new Mer Bleue station in 2028. For further details, please refer to Section 2 of Schedule 2-5-8 - System Service Investments.

Regional 115 kV System

- The smaller Merivale autotransformer replacement need was identified, and the addition of a third 230-115 kV autotransformer at Merivale TS was evaluated. The Hydro One project includes replacing autotransformer T22, six 230 kV circuit breakers, four 115 kV circuit breakers, and installing a new autotransformer T23. This project is currently underway with a planned in-service date of 2029.

The Greater Ottawa Scoping Assessment Outcome Report[1] was completed and published in March 2023. The report recommended that an IRRP be undertaken to identify, evaluate and recommend solutions to address the needs identified for the Ottawa sub-region.

4.3. GREATER OTTAWA INTEGRATED REGIONAL RESOURCE PLANNING

When the Scoping Assessment Outcome Report concludes that an IRRP is necessary, the IESO, transmitter, and LDCs collaborate to develop the IRRP.

[1] Independent Electricity System Operator, *2023 Greater Ottawa Scoping Assessment Outcome Report*, (March 21, 2023).

The IRRP considers various resource options to address regional electricity needs, including:

- Conservation measures and demand management;
- Distributed generation;
- Large-scale generation;
- Transmission enhancements;
- Distribution upgrades; and
- Innovative solutions, including DERs, such as: renewable generation, energy storage, combined heat and power, and microgrids.

The IRRP evaluates these options based on their feasibility, cost, reliability, alignment with government policies (e.g., Conservation First Framework and Long-Term Energy Plan), environmental performance, and community preferences. The resulting plan will propose ways to meet the identified electricity needs, along with implementation and monitoring strategies.

Although IRRPs cover a 20-year planning horizon, they prioritize actions for the near term (0-5 years) and medium term (5-10 years), with long term (10-20 years) options being deferred for future consideration.

Community and stakeholder engagement remain crucial throughout the IRRP development phase. Ongoing dialogue facilitates an understanding of regional planning processes, allowing for local input and a successful implementation.

The completion of the Greater Ottawa Region IRRP is planned for Q1 2025. A Planning Status Letter has been provided by the transmitter to confirm the alignment of Hydro Ottawa's investment plans with the preliminary findings of the Regional Planning Process, refer to Attachment 2-5-2(A) - Planning Status Letter. As part of the IRRP process, a Decarbonization sub-working group was established to review plans and priorities of communities around electrification to understand the impact.

4.3.1. Decarbonization Sub-Working Group

The initial 20-year demand forecast provided in early 2023 for the IRRP lacked impact from electrification. The Decarbonization Sub-Working Group was asked to develop forecast scenarios that reflected local community energy plans and priorities around electrification. A High Growth Scenario, reflecting a full decarbonization of the region, was discussed through meetings with the sub-working groups. The IESO led six meetings between March 2023 to December 2023 with representatives from the City of Ottawa, Hydro Ottawa and Hydro One Distribution to develop the new scenario. Hydro One Transmission and Enbridge participated in the meetings as observers. In the Toronto and Ottawa IRRPs, the IESO included Enbridge as an observer on a pilot basis. The role of the observer is limited to providing feedback on areas where they are the subject matter experts. Electrification forecasting was difficult due to a lack of specific, localized targets. This disconnect between broad policy goals and practical implementation created uncertainty and hindered stakeholder engagement. A more robust framework with regional and local considerations was needed for effective electrification planning. To this end, Hydro Ottawa engaged Black and Veatch in April 2023 to evaluate the implications of the decarbonization initiatives on its system.

To determine the potential implications of decarbonization initiatives on Hydro Ottawa's distribution network from 2024 to 2050, Black and Veatch developed load scenarios. Each scenario incorporated different assumptions about decarbonization factors such as energy efficiency, population growth, EV adoption, and building heating.

Black and Veatch presented the details of the scenario assumptions to the Decarbonization sub-working group. Assumptions around population growth and heat pump efficiency in cold weather were modified based on feedback from the City of Ottawa and Enbridge Gas, respectively. A fifth scenario was added to address load sensitivity from customers switching to gas during colder weather conditions (less than -10 degrees Celsius).

Following these adjustments, three scenarios were adopted by the Sub-Working Group for use in regional planning: the Reference Scenario, the Policy-Driven Scenario (high sensitivity), and the Dual Fuel Scenario (low sensitivity). The Sub-Working Group decided to use the Reference Scenario as the primary scenario of investment planning.

Hydro Ottawa has integrated the IRRP forecast Reference Scenario, into its capacity planning process as a crucial sensitivity analysis. This is aimed at proactively informing the utility's investment plans and ensuring that these plans remain aligned with recommendations set out in the IRRP. By incorporating this sensitivity analysis, Hydro Ottawa can better anticipate and respond to potential future scenarios, thus safeguarding the reliability and effectiveness of its capacity investments. For a more detailed and comprehensive understanding of Hydro Ottawa's Planning Forecast and the integration of the IRRP Reference Scenario, refer to Section 9.4 of Schedule 2-5-4 - Asset Management Process.

4.3.2. IRRP Preliminary Results

This section describes the preliminary near- and medium-term asset renewal and capacity constraint needs identified through the IRRP cycle. The asset renewal needs focus on the replacement and capacity upgrades of several transformer stations, including South March TS, Lisgar TS, Russell TS, Albion TS, and Riverdale TS. The capacity constraints section highlights the need for additional transformation capacity in Kanata North, Moulton/Cyrville/Overbrook, Nepean 8kV, and Downtown Ottawa regions.

Asset Renewal Needs:

- **South March TS:** The station's two 230kV/44kV transformers, commissioned in 1971, need to be replaced due to their current asset condition. The IRRP working group is evaluating increasing the transformers' capacity by 50MVA to meet the long-term demand forecast. This Hydro One project has a planned in-service date of 2030-2032. Hydro Ottawa may need to contribute to the cost of increasing the station's capacity under the Connection and Cost Recovery Agreement (CCRA) program. For further details, refer to Section 7 of Schedule 2-5-9 - General Plant Investments.

- **Lisgar TS:** There are two T1/T2 115kV/13.8kV, 45/60/75MVA transformers at the station. Transformer T1 was in-serviced in 1974 and based on its asset condition it needs replacement. Based on the non-coincident forecast, the station loading has reached its capacity. The T1 transformer capacity will be increased at the time of replacement to 100MVA. This Hydro One project has a planned in-service date of 2025. Hydro Ottawa might need to contribute to the cost of increasing the station's capacity under the CCRA program in 2025.
- **Russell TS:** The two 45/60/75 MVA transformers T1 and T2 were installed in 1975 and 1971, respectively, and require replacement. A Hydro One project, coordinated with Hydro Ottawa, is currently underway to replace transformers T1/T2 with 60/80/100MVA units. The planned in-service date for the upgraded transformers is 2027. Upgrading capacity at this station supports the capacity needs in the East 13kV region. Refer to Section 9.1.4.5 of Schedule 2-5-4 - Asset Management Process and Section 7 of Schedule 2-5-9 - General Plant Investments for capacity needs and project details.
- **Albion TS:** The two 75 MVA transformers T1 and T2 were built in the 1970s. They have been identified for replacement with new closest standard size 60/80/100 MVA units. All existing Hydro One owned circuit breakers will be replaced with breakers of similar ratings. The planned in-service date of the project is in 2031. No capital contribution is expected from Hydro Ottawa for increased capacity since transformers are expected to be replaced to the closest standard size.
- **S7M Line refurbishment:** The 115 kV circuit, spread across several S7M line sections totaling 6.5 km, have been identified at or near their end of service life. It was suggested to replace conductors, wood poles, insulators, and other components. Some sections are considered for upgrades, which Hydro Ottawa, Hydro One, and IESO are working together to determine the preferred plan. No capital contribution is expected from Hydro Ottawa.

- **Riverdale TS:** Riverdale TS is a 115/13.8kV station connected to 115kV circuits A3RM, A5RK, and A6R. The 115kV breakers are identified to be replaced based on asset condition assessment. The planned in-service date of the project is in 2038. No capital contribution is expected from Hydro Ottawa.

Capacity Constraints:

- **Kanata North region:** The previous regional planning cycle identified this area as needing additional transformation capacity. Due to the IESO bulk system study being in progress at the time, temporary measures were implemented to mitigate this by load transfer and CDM programs. It was expected that the results from the IESO bulk system study could have impacted the area's supply, and therefore a plan was not developed before the results were available. The need was reviewed again during the current regional planning cycle, and the expected recommendation is a new transformer station and new 230 kV transmission circuit in the Kanata area by 2029. For capacity needs and project details, refer to Section 9.1.4.2.5 of Schedule 2-5-4 - Asset Management Process and Section 2 of Schedule 2-5-8 - System Service Investments. Hydro Ottawa is estimated to contribute to the cost of building the new transmission line to connect the new station under the CCRA program in the 2026-2030 period, refer to Section 7 of Schedule 2-5-9 - General Plant Investments and Schedule 9-2-1 - New Deferral and Variance Accounts.
- **Moulton/Cyrville/Overbrook region:** The 115kV supplied station is expected to have a large load increase in the near term. Given the location of Cyrville station near 230kV supplies, the IRRP working group is proposing to upgrade the station transformation capacity by 50MVA and change its supply to 230kV by 2028, refer to Section 3 of Schedule 2-5-8 - System Service Investments for project details. This will allow the station to meet its load forecast as well provide relief to other stations through distribution transfers. This conversion to 230kV supply will also help preserve capacity on the 115kV system which is nearing its limit. Hydro Ottawa might need to contribute to the cost of extending the transmission line to connect Cyrville under the CCRA program

in the 2026-2030 period, refer to Section 7 of Schedule 2-5-9 - General Plant Investments and Schedule 9-2-1 - New Deferral and Variance Accounts.

- **Downtown Ottawa Transformation Capacity:** Several stations in the downtown core are expected to or have reached their capacity based on the forecast. To address this several recommendations are expected from this cycle of regional planning:
    - **Bronson DS:** Upgrade 4kV station to 13kV and upgrade supply to a transmission connected station with higher rated transformers (150MVA). This will provide additional transformation capacity in the city center. For project details, refer to Section 2 of Schedule 2-5-8 - System Service Investments.
    - **King Edward TS:** Replace aging and limiting circuit breakers and cables at the station to increase the available station capacity by approximately 38 MVA.
    - **Carling TS:** Replace aging and limiting cables at the station to increase the available station capacity by approximately 40MVA.

Hydro Ottawa is estimated to contribute to the cost of removing station breaker and cable limitations at the existing Hydro One stations under the CCRA program in the 2026-2030 period, refer to Section 7 of Schedule 2-5-9 - General Plant Investments and Schedule 9-2-1 - New Deferral and Variance Accounts.

- **Nepean 8kV region:** The area directly west of Merivale TS, supplied by Manordale MTS and Center Point MTS, is predominantly supplied by 8kV distribution system. Hydro Ottawa has received some large scale customer load requests coupled with the transformation capacity being exceeded at nearly all the stations in the area has resulted in a need being identified for a new 230kV-28kV station adding 130MVA of additional capacity in the region. The new Hydro Ottawa owned station, Greenbank MTS, is planned for energization by 2028, refer to Section 2 of Schedule 2-5-8 - System Service Investments for project details.
- **Upgrades to 115kV circuits:** Several circuits have been identified as reaching capacity over the study period. The upcoming Regional Infrastructure Planning cycle is expected

to recommend upgrades to sections of F10MV, C7BM, M4G, and M5G.

- **Non-Wires Solutions:** NWSs are a valuable tool for managing growing electricity demands in Ottawa. Although they cannot replace traditional wire upgrades, they can support existing capacity and shape long-term investments. NWSs can reduce peak demand impacts, allowing for strategic phasing of wire upgrades. Due to significant growth forecasts, a tiered approach was adopted to evaluate NWSs, grouping similar needs together. While NWSs were not feasible for all issues, they showed promise for addressing voltage collapse and were thoroughly analyzed. The impact of planned large-scale battery storage projects was also considered. For further information on Hydro Ottawa NWSs to address capacity needs that align with the IRRP approach to using NWSs to manage growing electricity demands due to decarbonization goals, refer to Section 9.2 of Schedule 2-5-4 - Asset Management Process.

Solutions to address these needs are being finalized in the IRRP, and final recommendations will be available by the end Q1 2025. A Planning Status Letter dated March 14, 2025 has been provided by the transmitter to confirm the alignment of Hydro Ottawa's investment plans with the preliminary findings of the Regional Planning Process, refer to Attachment 2-5-2(A) - Planning Status Letter.

4.4. GREATER OTTAWA REGIONAL INFRASTRUCTURE PLAN

When a wires-only or transmission-based approach is determined to be the optimal solution for a planning need, a RIP is initiated. The transmitter leads this process.

A RIP can be initiated:

1. Following the Scoping Assessment: If it is determined that alternative resources cannot meet the needs.
2. During the IRRP process: If analysis indicates that a wires-only solution is part of the near-term solution.
3. Upon completion of the IRRP process: If it is determined that a wires-only solution is part of

the overall integrated solution for the region or sub-region.

The transmitter will identify the LDCs and other agencies that need to be involved in the planning studies for the RIP.

Preliminary results from the current IRRP suggest that a mix of wires-based and NWSs may be required to address capacity constraints within the region. Once confirmed, the RIP will be initiated.

4.5. RENEWABLE ENERGY GENERATION COORDINATION

Hydro Ottawa's Distribution System Plan (DSP) for 2026-2030 does not include any specific projects focused on Renewable Energy Generation (REG) under Hydro Ottawa's direct responsibility. While the plan considers integrating renewable energy sources into the grid, it does not currently include provisions for Hydro Ottawa to own, operate, or develop renewable energy generation facilities, such as solar farms, biomass, natural gas, landfill gas generators, or wind turbines. Therefore, Hydro Ottawa confirms that there are no REG investments in the region, and as such a letter from the IESO in support of renewable energy generation investments in the region has not been submitted as part of this Application.

Although Hydro Ottawa is not directly involved in REG projects, the utility actively participates in collaborative initiatives to support renewable energy integration. For example, Hydro Ottawa collaborates with the IESO and Hydro One to develop optimal solutions for transmission and bulk system needs within the Ottawa area as part of the IRRP. These solutions encompass conservation, demand management, distributed generation (including renewable generation), large-scale generation, transmission, and distribution. Work on the IRRP began in 2023 and is expected to be completed in the first quarter of 2025.

Additionally, Hydro Ottawa collaborates with the IESO and federal funding agencies (e.g. NRCan) to launch local programming for Hydro Ottawa customers, including programs like the

Ottawa DER Large Solar PV Funding Incentive, which offers financial incentives for the installation of large solar PV systems for facility load displacement. These collaborative efforts are described in detail in Section 2.4 of Schedule 1-4-1 - Customer Engagement Ongoing.

Lastly, Hydro Ottawa collaborates with customers by reviewing renewable generation requests to determine the most suitable connection for their projects. Over the past five years, the Hydro Ottawa service region has experienced substantial growth in connected renewable generation capacity, entirely attributed to grid-connected photovoltaic generators. From 2019 to 2023, almost 300 new renewable DERs were connected under the Net Metering and Load Displacement programs, as detailed in Section 9.3.1 of Schedule 2-5-4 - Asset Management Process.

Hydro Ottawa's active participation in collaborative initiatives and programs with key stakeholders ensures that the electricity grid can meet the demands of a growing population while supporting the transition to renewable energy sources.

5. TELECOMMUNICATION ENTITIES

Hydro Ottawa maintains a strong relationship with the telecommunications (telecom) companies serving Ottawa, as their infrastructure relies on Hydro Ottawa’s poles, ducts and cable chambers. The Building Broadband Faster Act, introduced in 2021, encourages better coordination and quicker permit turnaround times. The legislation’s intention is to provide better internet across Ontario by 2025. Hydro Ottawa consults with telecom companies within its service area on a regular basis through two main channels: the Attachment Process and City of Ottawa engagement, as outlined below in section 5.1 and 5.2, respectively. These consultations ensure timely and efficient coordination during planning and capital project execution. They also ensure telecom companies can rely on Hydro Ottawa's infrastructure to support their services, ultimately providing exceptional service to our customers and their clients. The sections below provide more information and details on those processes.

5.1. ATTACHMENT PROCESS

Hydro Ottawa requires all third parties, including telecom companies and local businesses, to sign an agreement prior to attaching onto its infrastructure. Once an agreement is in place, third parties must go through an attachment permitting process. Third party permits, specifically telecom permits, are submitted daily from various companies and require extensive review prior to approval.

For overhead attachments, the review process allows Hydro Ottawa to assess the structural integrity of the pole in question and plan for the proposed "make-ready work" for Hydro Ottawa to prepare the pole for the attacher. Review of underground attachment permits verifies the existing spacing available in ducts and cable chambers to ensure the telecom has adequate space. At this stage, the permit can be rejected, sent back to the telecom for revision or accepted based on the extent of the permit and make-ready work.

Make-ready work can vary from moving a Hydro Ottawa asset to make room for the telecom's attachment to replacing a pole for structural reasons. When extensive make-ready work is required, planning is undertaken to optimize work execution through a design project or further discussed with the telecom to incorporate their plans into upcoming projects.

Additionally, Hydro Ottawa provides telecom companies with notice of any upcoming work that may affect attachments to give them an opportunity to relocate or upgrade their infrastructure. As per the existing telecom agreements, telecoms are given a minimum 60 days notice prior to pole replacement, and this occurs for every pole replacement regardless of whether it's a large project or a single pole replacement. Depending on the nature of the work, for example projects involving poles not owned by Hydro Ottawa as discussed in section 3.3.2 of schedule 2-5-8, a joint-use coordination meeting will be held during the preliminary design process. A second example would be for upcoming OH Distribution Asset Renewal programs relating to Pole Renewal projects, as discussed in Section 3 of Schedule 2-5-7, where Hydro Ottawa will incorporate a third party consultation into the design phase to ensure telecom companies are aware and notified of upcoming changes to infrastructure. This consultation includes reaching out to the local planning contact for any affected telecoms, organizing planning and field meetings, and discussing the nature of the work including reviewing design drawings and proposed timelines. It should be noted that worst-case pole loading for telecom attachments are considered, that being 3 coaxial attachments per pole with maximum overlashing per attachment allowed through the Canada Standards Association (CSA), when sizing new poles. Additionally, adequate telecom spacing on new pole installations is incorporated into construction standards to ensure telecoms have adequate spacing and support, however consultations provide an opportunity for project specific coordination. Additionally, a joint use trench was approved through the City of Ottawa in 2022 to provide adequate underground spacing for all utilities in new residential areas and reduce time delays in coordinating clearances.

The attachment process is curated to ensure that telecom needs are supported by Hydro Ottawa through day-to-day processes, and that they are given an opportunity to incorporate their service planning into upcoming projects. The input received through the attachment process has an effect on DSP planning, as discussed in section 7, and is considered in Hydro Ottawa operations - for example, ensuring that telecom companies have adequate space on the poles and within ducts and maintenance chambers, and infrastructure is sized to properly support telecom infrastructure.

5.2. ENGAGEMENT THROUGH COORDINATION PLATFORMS

Hydro Ottawa partakes in several coordination platforms hosted by the City of Ottawa which provides an opportunity for utilities, including Telecommunication entities, in Ottawa to discuss upcoming projects, planning and initiatives. The main platforms that Hydro Ottawa participates in are the Utility Coordination Committee (UCC), Municipal Consent Circulations and the Central Registry Sub-Committee.[2]

As discussed in section 6.3, Hydro Ottawa meets on a monthly basis with utilities in Ottawa including Bell Canada, Rogers, and Telus through the City of Ottawa's UCC. These meetings address Municipal Consent applications, road cut permitting, locates, planning, capital projects, by-laws and forestry. In 2024, Hydro Ottawa provided an update monthly on outstanding telecom attachments, which led to frequent consultation meetings between Hydro Ottawa and the common attachers - Rogers and Bell Canada. Hydro Ottawa and Rogers met on February 13 2024, April 16 2024, August 22, 2024 and September 11 2024, and have bi-monthly meetings set up beginning in May 2025. Hydro Ottawa and Bell Canada met October 1 and 17 2024, December 6 2024, April 9 2025 and have monthly touch point meetings set beginning in May 2025.

The UCC goes hand in hand with municipal consent Circulations, which is a permitting program run by the City of Ottawa to ensure all utilities agree and coordinate prior to work commencing in the road right-of-way. Municipal consent applications are circulated to all UCC members to review and require approval before construction starts, allowing Hydro Ottawa to consult with telecom companies in Ottawa to ensure their work is incorporated into project execution and ensure conflicts are resolved. In 2024, Hydro Ottawa reviewed approximately 500 circulations - each circulation providing a confirmation of Hydro Ottawa underground infrastructure and pole locations, along with standards, clearances and notices relating to clearances from infrastructure. On rare occasions, the circulation can be rejected due to clearance issues but will be resolved through further discussion. The circulations are reviewed by the design team to notify of any upcoming projects and returned to the utility within 2 weeks. A new requirement in

[2] For more information regarding the City of Ottawa Municipal Consent and Utility Circulations including process and requirements, please refer to: https://ottawa.ca/en/planning-development-and-construction/construction-right-way/municipal-consent-and-utility-circulations#

2024 required utilities to provide any plans for the next 3 years within the municipal road right of way, allowing for further project consultation opportunities with telecoms.

Finally, Hydro Ottawa partakes in a data sharing program through the City of Ottawa Central Registry (CR) UCC Sub-Committee, which includes telecoms such as Bell Canada, Rogers, Telus, Fibrenoire, Zayo, Flex Networks and Videotron. Hydro Ottawa exports existing underground infrastructure locations three times a year, and in return receives an export of other utility infrastructure that is uploaded into Hydro Ottawa's Geographic Information System (GIS). The CR information is incorporated into design processes, MC applications and construction drawings, allowing for further consultation efforts should a conflict occur. The sub-committee meets on a quarterly basis to further discuss data sharing efforts.

Engagement with telecoms has an impact on planning upcoming projects, as discussed in section 7 below, as lack of coordination could cause delays or duplication of efforts to support telecom programs.

Hydro Ottawa relies on the two channels described above to gain extensive and ongoing consultation with telecommunication companies that ultimately feeds into ongoing work as well as the DSP. As noted, Hydro Ottawa considers all feedback received through the abovementioned venues when making capital plans.

6. OTHER UTILITY AND STAKEHOLDER COORDINATION

6.1. CITY OF OTTAWA OVERVIEW

Hydro Ottawa meets annually with the City of Ottawa's Planning Group to review new site plan circulations (see Section 6.2 - City of Ottawa Development Application Circulations) to receive updates on city standards and planning requirements. Hydro Ottawa also uses these meetings to inform the City of its standards and other requirements, and to impart to planning staff a better understanding of the local distribution system.

Hydro Ottawa engages with City of Ottawa right-of-way management personnel on a quarterly basis to discuss current and planned capital programs; municipal consent guidelines and circulation status; as well as road-cut permitting for new local, collector, and arterial roads. This has served to improve communication and information-sharing, while better coordinating required work that impacts for both parties. Hydro Ottawa also participates monthly in meetings of the City of Ottawa's Utility Coordinating Committee (UCC), where participants (including other utilities) can table issues of shared relevance. See Section 6.3 for further details.

Hydro Ottawa meets annually with the City of Ottawa's Building Department to discuss Ontario Building Code changes impacting new residential subdivision servicing, issues with overhead clearances between buildings and power lines, and opportunities to improve collaboration. These interactions have supported the smooth implementation of new requirements, for example, those relating to electric vehicle servicing for new homes.

Further engagement with the City of Ottawa takes place in the context of multi-stakeholder forums such as the IRRP Decarbonization Sub-Working Group, established through the IRRP process. The City of Ottawa was an active stakeholder throughout this process. Refer to Section 4.3.1 for further information.

6.2. CITY OF OTTAWA DEVELOPMENT APPLICATION CIRCULATIONS

The City of Ottawa requires all construction activities within their rights-of-way to be coordinated with stakeholders. This allows utilities to consent to the proposed work or upcoming developments as well as to flag any potential efficiencies or issues.

The municipal consent process requires each utility to submit an application to the City of Ottawa for review. Once the application is approved by the City of Ottawa, the proposed plan is circulated to each utility for 15 days for their review and approval. The types of applications typically seen during this process include:

- **Site Plan Control** - Proponent's development plans for a single site
- **Zoning By-Law Amendment** - Proponent seeking to change individual lot zoning to allow for a development
- **Lifting of Holding By-law** - Municipality removing lot restriction(s) that block development
- **Official Plan** - High-level development plans
- **Demolition Control** - Proponent's demolition plans for a single site
- **Plan of Condominium** - Development plan for condominium
- **Plan of Subdivision** - Development plan for subdivision
- **Community Design Plans** - Neighborhood/community development plan
- **Road/Street/Lane Closure** - Changes in road layout
- **Heritage Applications to be considered by Council** - Proponent seeking heritage status for a premise, so as to circumvent zoning/laws

Typical comments from Hydro Ottawa include: limits of approach notifications, safety notices, permitting required, standards that must be met, and any coordination that should be taken with Hydro Ottawa.

6.3. CITY OF OTTAWA UTILITY COORDINATING COMMITTEE

The City of Ottawa hosts a monthly UCC meeting. This meeting helps ensure safe and efficient construction management within the rights-of-way. It also provides an opportunity to discuss common issues, announcements and helpful information. The committee members are: City of Ottawa, Hydro Ottawa, Hydro One, Heavy Construction Association, Enbridge Gas Distribution, Birch Hill Telecom, Bell Canada, Rogers Cable Communications, Telus Communications, Zayo Group, the Provincial and Federal Government, Flex Networks, South Nation Conservation Authority, Rideau Valley Conservation Authority, Hiboo Networks, Ontario One Call, Canada Post, NAV Canada, and National Capital Commission.

The main topics of discussion are as follows:

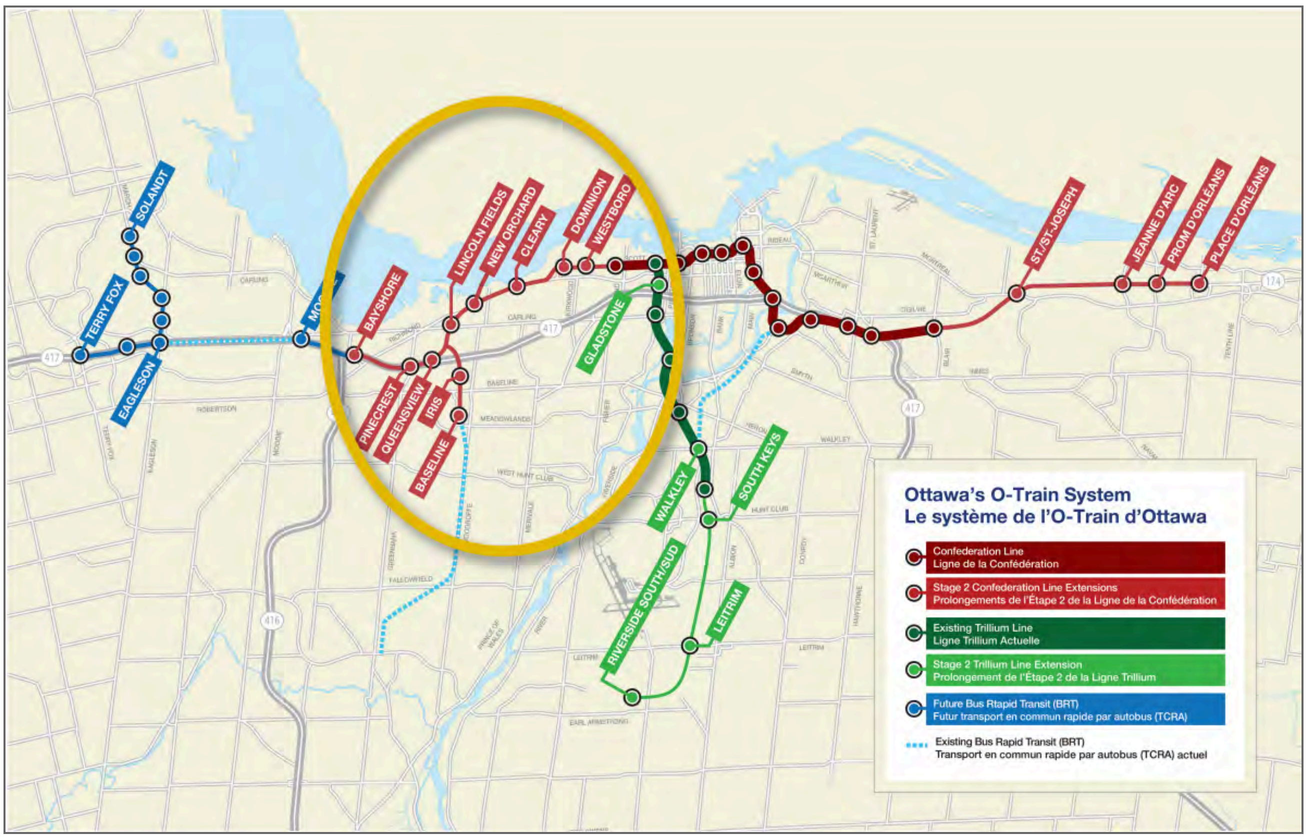
- Joint planning of construction activities
- Setting technical standards
- Steps to protect plant
- Providing a quick communication network
- Maintaining a central registry of underground utilities
- Resolving disputes between the parties
- Assisting the road authority with issues related to utility permit processes

This coordination does not directly impact the DSP, but rather is a part of day-to-day Hydro Ottawa coordination to ensure alignment with other local stakeholders and ensure safety, efficiency, and consistency.

6.4. OTTAWA LIGHT RAIL TRANSIT

The Ottawa LRT system expansion is an ongoing project aimed to improve transit connectivity and capacity in the City of Ottawa. Currently, the project is on Stage 2 which will extend the electrically-powered Confederation Line further to the west and east, and the diesel-powered Trillium Line further south, as shown in Figure 1. Stage 2 is expected to be completed by 2027, with Stage 3 being actively planned while funding options are explored.

Figure 1 - City of Ottawa Confederation Line and Trillium Line Extensions[3]



[3] City of Ottawa, Confederation Line West Light Rail Transit (LRT) Extension, https://ottawa.ca/en/parking-roads-and-travel/transportation-planning/environmental-assessment-completed-projects/confederation-line-west-light-rail-transit-lrt-extension

Hydro Ottawa is actively engaged in the project since the expansion requires upgrading and installing electrical infrastructure to service LRT stations and equipment, as well as relocating existing underground and overhead infrastructure within the planned LRT route to avoid conflict. This requires an electrical servicing strategy that is coordinated with the City of Ottawa and project contractors.

The development of the DSP has accounted for the impacts and planning considerations of LRT construction. For example, the Asset Management Process includes distribution load growth and station cable upgrades as well as the proposed forecasts for the plant relocation and upgrade program under System Access, which aligns with major City of Ottawa transportation projects. Please refer to Schedule 2-5-6 - System Access Investments for further details.

6.5. CITY OF OTTAWA’S RENEWABLE ENERGY STRATEGY – ENERGY EVOLUTION

The City of Ottawa initiated the development of a renewable energy strategy called “Energy Evolution” in 2015. The strategy aims to manage energy consumption, promote renewable energy use, and advance local economic development opportunities in Ottawa.

The City of Ottawa approved the Climate Change Master Plan in January 2020, which led to the full approval of the Energy Evolution strategy in October 2020 as one of the plan's priorities. The Climate Change Master Plan focuses on reducing community greenhouse gas (GHG) emissions by 100% by 2050 and corporate GHG emissions by 100% by 2040. It sets short-term targets of a 43% and 30% reduction, respectively, by 2025, and mid-term targets of a 68% and 50% reduction, respectively, by 2030. These targets align with the Intergovernmental Panel on Climate Change goal of limiting global warming increases to 1.5℃.

Achieving the long-term goals requires five sectors to meet this 100% target: land use and growth management, new and existing buildings, transportation, waste and renewable natural gas, and electricity. The master plan outlines projects and opportunities with two main focuses: GHG mitigation efforts and climate adaptation/resilience efforts.

Under the Energy Evolution strategy, the projected community wide GHG emission reductions required to achieve the long term goal is 6.5% in 2030 and 8.5% in 2050. Also impacting the sector are 2025 goals to increase EVs to 7% of all personal vehicle sales, increase EVs in commercial fleets to 18%, increase OC Transpo's passenger fleet to 48% zero emission, and transition 20% of residential and corporate buildings to heat pumps.

Due to the substantial increase in electrical load and required capacity, Hydro Ottawa has been actively involved in the Energy Evolution initiative since it began in 2017. The targets from the Energy Evolution initiative were considered in the Decarbonization study, which is summarized in Section 9.4.2.1 of Schedule 2-5-4 - Asset Management Process. This study explores the impact on the distribution system as electrification increases to meet 2050 goals.

6.6. CONTRACTORS AND LARGE DEVELOPERS

Hydro Ottawa recognizes contractors and large developers as crucial partners in delivering electricity services and treats them as valued customers. Hydro Ottawa's engagement strategy focuses on fostering strong relationships and ensuring efficient project execution.

For contractors, Hydro Ottawa emphasizes clear communication of technical specifications, predictable cost management through transparent estimates and tracking, and readily available crews (including after-hours support). The aim is to streamline processes like easement registration and change requests, reduce scheduling lag times, and provide easy online access to essential information like standards and documentation. To maintain open communication, Hydro Ottawa actively engages with electrical contractors through industry associations like the Ontario Electrical League (OEL) and the Electrical Contractors Association of Ottawa (ECA Ottawa), using these platforms to disseminate information about regulatory updates, safety developments, and procedural changes.

Similarly, Hydro Ottawa collaborates with builders and developers through the Greater Ottawa Home Builders' Association (GOHBA). Beyond these associations, Hydro Ottawa has established direct engagement mechanisms, including regular coordination meetings with contractors, architects, and developers, which have already led to improvements in project communication, development plans, and intake. Looking ahead, Hydro Ottawa plans to reinstate in-person coordination meetings and developer forums to further enhance communication, address shared concerns, and inform stakeholders about important updates related to personnel, policy, costing, and service level agreements.

This multi-faceted approach demonstrates Hydro Ottawa's commitment to collaboration and continuous improvement in its interactions with these key stakeholders.

6.7. INDUSTRY WORKING GROUPS CEATI

Hydro Ottawa collaborates with organizations like Centre for Energy Advancement through Technological Innovation (CEATI) to share information, advance common goals, and support a sustainable and reliable electricity system.

CEATI provides technology solutions to electrical utility participants. Utility participants can benefit from networking, sharing information, industry benchmarking and cost-sharing on asset technical projects.

Hydro Ottawa participates in several CEATI programs such as Protection & Control, Distribution Line Asset Management, Station Equipment Asset Management, Advanced Distribution Operations, Energy and Integration Strategy, Grounding and Lightning, and Power Quality. Knowledge sharing with other power distribution utilities to solve technical issues allows Hydro Ottawa to enhance its system and provide higher levels of reliability at lower cost.

7. PLANNING COORDINATION EFFECTS ON DSP

Effective planning coordination among customers, regional planning authorities, telecom entities, other utilities and stakeholders is crucial for successful planning of the distribution system. Collaboration and communication enable comprehensive planning, efficient infrastructure development, and the integration of DSP into the overall urban fabric. This coordination ensures that plans align with regional priorities and development, minimizes conflicts with existing infrastructure, and effectively addresses the needs of diverse stakeholders, including Hydro Ottawa customers. Due to the efforts discussed in section 5, telecom consultations have an impact on planning programs including overhead renewal, underground renewal, corrective renewal and distribution enhancements.

The pole renewal program listed in Section 3.1 of Schedule 2-5-7 requires coordination efforts with telecoms attached to all identified poles that will be replaced. Joint use meetings and transfer notifications for existing attachments to new poles will be coordinated as required, as well as cross referencing projects when reviewing permit applications to coordinate timing.

Underground cable and civil renewal work discussed in section 4.1 of Schedule 2-5-7 that identifies telecom attachments within Hydro Ottawa UG infrastructure will require coordination to adjust attachments and relocate as required. It should be noted that UG infrastructure projects by Hydro Ottawa will require an MC application to UCC members, providing another route of consultation with affected telecoms.

Corrective renewal of pole and UG civil and cable replacement mentioned within Section 6 of schedule 2-5-7 will require coordination with telecoms as required. Although emergency renewal projects are not planned, existing telecom needs will be considered while replacing assets to ensure their infrastructure is not affected. Emergency replacements and damage to plants, for example a pole hit by a car, are well coordinated with telecom emergency contacts to ensure effective cooperation and reduce service loss to telecom customers. Critical renewal replacements will be coordinated in advance where possible.

As referenced in Section 3 of Schedule 2-5-8 - System Service Investments, Critical Overhead Lines on Poles not owned by Hydro Ottawa and Strategic Grid Infrastructure enhancements require third party coordination with utilities that own poles in which Hydro Ottawa infrastructure is installed on, specifically with Bell Canada. These meetings typically occur when a pole replacement is in question. These meetings are held to discuss ownership and access to the poles, and potential ownership transfers between parties. These meetings also address ensuring adequate pole loading for new poles during design, and ensuring proper easements for work and access are obtained. Additionally, joint use meetings, applications and planning discussions as permitted through the third party agreement, (such as submitting Authorization for Billing) and Request for Joint Use Work forms, are required to prevent delays and ensure adequate infrastructure integrity. Bell Canada owns approximately 15% of utility poles within the Hydro Ottawa service territory with Hydro Ottawa infrastructure attached, therefore, proper consultation during critical replacement and grid infrastructure enhancements is extremely important.

March 14, 2025

Margaret Flores,
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Via email: margaretflores@hydroottawa.com

Dear Ms. Flores,

Subject: Regional Planning Status – Hydro Ottawa Service Area

This letter is in response to your request for a Planning Status letter. For the purposes of regional planning the province has been divided into 21 regions. A map showing details with respect to the 21 regions[1] and the list of Local Distribution Companies (LDCs) in each region are attached in Appendix A and B respectively. Hydro One Networks Inc. is the lead transmitter in 20 regions and Hydro Ottawa's service area belongs to the Greater Ottawa Region covering Ottawa, Kanata, Nepean, Goulbourn and Gloucester.

Hydro Ottawa load is supplied by Albion TS, Almonte TS, Bilberry Creek TS, Bridlewood MTS, Cambrian MTS, Carling TS, Centrepoint MTS, Cyrville MTS, Ellwood MTS, Nepean Epworth MTS, Fallowfield DS, Hawthorne TS, Hinchey TS, Kanata MTS, King Edward TS, Limebank MTS, Lincoln Heights TS, Lisgar TS, Manordale, MTS, Marchwood MTS, Moulton MTS, Merivale MTS, Nepean TS, Orleans TS, Overbrook TS, Richmond MTS, Riverdale TS, Russell TS, Slater TS, South Gloucester DS, South March TS, St Isidore TS, Terry Fox MTS, Upland MTS and Woodroffe TS in the Greater Ottawa Region.

This letter confirms that the second cycle of the Regional Planning process for the Greater Ottawa region was completed in December 2020. The current third regional planning cycle is currently underway, and the Needs Assessment (NA)[2] report was completed in December 2022 followed by the Scoping Assessment (SA)[3] in March 2023. The Integrated Regional Resource Planning (IRRP) phase is underway and scheduled for completion in March 2025. The final phase of the regional planning process, the Regional Infrastructure Plan (RIP) phase, will follow the completion of the IRRP in Q4 2025.

A summary of the regional planning status, including needs and plans currently identified (up to and including the 3rd cycle Needs Assessment and preliminary results from the ongoing Integrated Regional Resource Plan) in the Greater Ottawa region that affects Hydro Ottawa's service area is provided below. Also please note that, the effect of electrification, decarbonization, and the connection of large scale industrial and commercial customers growth in the region exceeds all historical projections. For example, the winter Gross electricity demand is expected to increase significantly and can double in the next

[1] Hydro One Regional Planning
[2] Greater Ottawa Needs Assessment
[3] Greater Ottawa Scoping Assessment

ten years. This will result in additional needs that will be identified during the next stages of the current and future regional planning cycle.

The previous regional planning cycle and the 3rd cycle Need Assessment identified the following needs:

Supply/transformation capacity need:

- Merivale TS: The need for additional 230/115kV auto-transformation capacity at Merivale TS was assessed. It is recommended to replace autotransformer T22, six (6) 230kV circuit breakers and four (4) 115kV circuit breakers, and the installation of a new autotransformer T23. This project is currently underway with planned in-service date of project is 2029.

- Piperville MTS: A new station was recommended to address the growing demand in the city's southeast and to address overloads at Leitrim MS. The project is ongoing with in service planned in February 2026 and with Hydro Ottawa building the transformer station and Hydro One providing connection to the transmission circuit.

- Mer Bleue MTS: An IESO-led study initiated in 2022 has reviewed different options to address the load growth in the east end of the city. From the findings of the study, the recommendation of the previous planning cycle completed in 2020 has changed and it was determined that, based on the expected demand new transformation capacity supplied from the 230kV network is required. It was also determined that Bilberry Creek TS, a 115kV supplied station, is no longer required and will be retired. The station will be replaced by a new Hydro Ottawa owned station to serve Hydro Ottawa's load. This new station is scheduled to be in-service in 2027. Included also as part of the recommendation is the conversion of Orleans TS to a 230kV DESN and the construction of a new 230kV circuit. The decommission of Bilberry and load transfer to the new Mer Bleue station to 230kV supply will also help preserve capacity on the 115kV system which is nearing its limit.

Asset renewal need:

- Russell TS: The two 45/60/75 MVA transformers T1 and T2 were installed in 1975 and 1971 respectively and they need to be replaced. Project for replacement of transformers T1/T2 is underway and is being led by Hydro One in coordination with Hydro Ottawa. The transformers will be upgraded with 60/80/100MVA units. The planned in-service date of project is 2027.

- Albion TS: The existing transformers T1 and T2 are rated at 75MVA each, were built in the 1970s, and have been identified for replacement with new closest standard size 60/80/100 MVA units. All existing Hydro One owned circuit breakers will be replaced with breakers of similar rating. The planned in-service date of project is in 2031.

- S7M Line refurbishment: The 115 kV circuit, spread across several S7M line sections totaling 6.5 km, have been identified at or near their end of service life. It was suggested to replace conductors, wood poles, insulators, and other components. Some sections are considered for upgrades, which Hydro Ottawa, Hydro One, and IESO are working together to determine the preferred plan. Once selected, the plan is expected to start in the near term over the next five years.

- South March TS: The station has two 230kV/44kV, 50/67/83MVA transformers that were in-serviced in 1971 and based on their asset condition need replacement. Technical Working Group is reviewing if the transformers should be replaced with similar 50/67/83MVA units or if the size should be upgraded to 75/100/125MVA units. Based on the forecast, the station capacity is expected to be reached by 2027 for both summer and winter. Hydro Ottawa, Hydro One Distribution and Hydro One Transmission will work together to determine the appropriate timing for the replacement and upgrade.

- Lisgar TS: There are two T1/T2 115kV/13.8kV, 45/60/75MVA transformers at the station. Transformer T1 was in-serviced in 1974 and based on its asset condition it needs replacement. Based on the non-coincident forecast, the station has reached its capacity under summer forecast and is expected to reach capacity in 2027 under the winter forecast. The TWG has reviewed whether the transformer should be replaced with a 45/60/75MVA unit or upgraded to 60/80/100MVA unit. To increase the station transformation capacity, it was determined to upgrade T1 and the LV circuit breakers and LV cables, and to review the need for T2 upgrade. Hydro Ottawa and Hydro One will work together to coordinate the upgrade at the station and the work is expected to start in the short term.

- Riverdale TS: this is a 115/13.8kV station connected to 115kV circuits A3RM, A5RK, and A6R. The 115kV breakers are identified to be replaced based on asset condition assessment. The planned in-service date of the project is in 2038.

The currently ongoing IESO led Integrated Regional Resource Plan has identified additional needs listed below. As indicated above, the anticipated demand growth is very high compared to the previous cycle. As part of the IRRP study, the working group is assessing non-wire options such as CDM measure and BESS to help meet this demand. The needs listed below are expected to require wire options in addition to non-wire options where feasible.

- Kanata-Stittsville Transformation Capacity. The area was identified as requiring additional transformation capacity in the previous cycle of regional planning which could be mitigated in the short term through load transfer. The recommendation also considered the then ongoing IESO bulk study, which could impact the area supply, before developing a plan for the area. The need was further reviewed during this ongoing cycle of regional planning, and the expected recommendation is a new transformer station and new 230kV transmission circuit in the Kanata area. Based on the forecast, transformation capacity has reached its summer supply limit and is also expected to reach its winter limit by 2026. Plan to upgrade the area is expected to start in the near term with Hydro Ottawa planning to energize the new station in late 2028.

- Downtown Ottawa Transformation Capacity. Several stations in the downtown core are expected to or have reached their capacity based on the forecast. To address this, several recommendations are expected from this cycle of regional planning:
    - Upgrade Bronson MS to a transmission connected station with higher rated transformers. This will provide additional transformation capacity in the city center. The project is expected to be in-service in 2031.
    - Upgrade King Edward TS: Replace aging and limiting circuit breakers and cables at the station to increase the available transformation capacity. Based on forecast, the station capacity is expected to be reached in 2037 in summer, and 2026 in winter.
    - Upgrade Carling TS: Replace limiting cables at the station to increase the available transformation capacity. Based on the forecast, the station capacity is expected to be reached in 2028 in summer, and 2029 in winter.

- West Ottawa transformation: The area directly west of Merivale TS, supplied by Manordale MTS and Center Point MTS, is predominantly supplied by 8kV distribution system. Hydro Ottawa has received some large-scale customer load requests coupled with the transformation capacity being exceeded at nearly all the stations in the area has resulted in a need being identified for new 230kV-28kV station in the short term. Options were reviewed during IRRP, and the expected recommendation is the following
  - Build a new 230kV station in the Greenbank Rd area. Connection of the station would be to circuit E34M and would require a new 230kV circuit from Merivale TS, a distance of approximately 4km. This new transmission line could also be used for further development in the city's west end.

- Cyrville MTS: The 115kV supplied station is expected to have large load increase. Given the station location near 230kV supplies, the TWG as part of the IRRP is proposing to upgrade the station transformation capacity and change its supply to 230kV. This will allow the station to meet its load forecast as well provide relief to other stations through distribution transfers. This conversion to 230kV supply will also help preserve capacity on the 115kV system which is nearing its limit. This plan will start in the near term with targeted energization in 2027.

- Moulton MTS: The existing Cyrville MTS 115kV transformers will be relocated to Moulton MTS to increase the station transformation capacity. This plan will start in the near term with targeted energization in 2027-2029.

- Upgrades to 115kV circuits. Several circuits have been identified as reaching their capacity over the study period. It is expected this cycle of RP will recommend upgrades sections of F10MV, C7BM, M4G, M5G. Upgrade would be required in the mid-term based on the winter forecast.

Capital contribution is expected by Hydro One Networks Inc. from Hydro Ottawa for some of the projects recommended through the regional planning in the Greater Ottawa Region.

Hydro One Networks Inc. would like to acknowledge and thank you for your work and effort in support of the Regional Planning process. We look forward to continuing to work with you in the future. If you have any further questions, please feel free to contact me.

Sincerely,

Ajay Garg,
Senior Manager, System Planning & Regional Planning Coordination

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Appendix A: Map of Ontario's Planning Regions

<u>Northern Ontario</u>

Southern Ontario

Greater Toronto Area (GTA)

Appendix B: List of LDCs for Each Region

[Hydro One as Upstream Transmitter]

Region	LDCs
1. Burlington to Nanticoke	• Burlington Hydro Inc. • GrandBridge Energy Inc. (Formerly Energy+ and Brantford Power) • Alectra Utilities Corporation (Formerly Horizon Utilities Inc.) • Hydro One Networks Inc. (Distribution) • Oakville Hydro Electricity Distribution Inc.
2. Greater Ottawa	• Hydro 2000 Inc. • Hydro Ottawa Limited • Hydro Hawkesbury Inc. • Ottawa River Power Corporation • Hydro One Networks Inc. (Distribution) • Renfrew Hydro Inc
3. GTA North	• Alectra Utilities Co. • Hydro One Networks Inc. (Distribution) • Newmarket-Tay Power Distribution Ltd. • Toronto Hydro Electric System Limited
4. GTA West	• Burlington Hydro Inc. • Hydro One Networks Inc. (Distribution) • Alectra Utilities Co. • Milton Hydro Distribution Inc. • Halton Hills Hydro Inc. • Oakville Hydro Electricity Distribution Inc.
5. Kitchener- Waterloo-Cambridge-Guelph (“KWCG”)	• Alectra Utilities Corporation. • Enova Power Corporation. • Grandbridge Energy Inc. • Centre Wellington Hydro Ltd. • Hydro One Networks Inc. (Distribution) • Halton Hills Hydro Inc. • Wellington North Power Inc.

6. Toronto	• Alectra Utilities • Elexicon Energy Inc. • Hydro One Networks Inc. (Distribution) • Toronto Hydro Electric System Limited
7. Northwest Ontario	• Atikokan Hydro Inc. • Fort Frances Power Corporation • Hydro One Networks Inc. (Distribution) • Synergy North • Sioux Lookout Hydro Inc.
8. Windsor-Essex	• E.L.K. Energy Inc. • Entegrus Powerlines Inc. (Chatham-Kent) • EnWin Utilities Ltd. • Essex Powerlines Corporation • Hydro One Networks Inc. (Distribution)
9. East Lake Superior [Hydro One Sault Ste. Marie L.P. is the Lead Transmitter for the region]	• Algoma Power Inc. • Hydro One Networks Inc. (Distribution) • PUC Distribution
10. GTA East	• Elexicon Energy Inc. • Oshawa PUC Networks Inc. • Hydro One Networks Inc. (Distribution)
11. London Area	• Entegrus Powerlines Inc. • ERTH Power Inc. • Hydro One Networks Inc. (Distribution) • London Hydro Inc. • Tillsonburg Hydro Inc.

12. Peterborough to Kingston	• Eastern Ontario Power Inc. • Elexicon Energy Inc. • Hydro One Networks Inc. (Distribution) • Kingston Hydro Corporation • Lakefront Utilities Inc.
13. South Georgian Bay/Muskoka	• Hydro One Networks Inc. (Distribution) • Alectra Utilities • InnPower • Orangeville Hydro • Elexicon Energy • Lakeland Power • EPCOR Electricity Dist. Ontario Inc. • Newmarket-Tay Power Distribution Ltd. • Wasaga Distribution Inc.
14. Sudbury/Algoma	• Greater Sudbury Hydro Inc. • North Bay Hydro • Hydro One Networks Inc. (Distribution)
15. Chatham-Kent/Lambton/Sarnia	• Bluewater Power Distribution Corporation • Entegrus Power Lines Inc. (Chatham-Kent) • Hydro One Networks Inc. (Distribution)
16. Greater Bruce/Huron	• Entegrus Powerlines Inc. • ERTH Power Corporation • Hydro One Networks Inc. (Distribution) • Festival Hydro Inc. • Wellington North Power Inc. • Westario Power Inc.

17. Niagara	• Canadian Niagara Power Inc. [Port Colborne] • Hydro One Networks Inc. (Distribution) • Grimsby Power Inc. • Niagara Peninsula Energy Inc. • Niagara-On-The-Lake Hydro Inc. • Alectra Utilities Co. • Welland Hydro-Electric System Corporation
18. North of Moosonee [Five Nations Energy Inc (FNEI) is the Lead Transmitter for the region]	• Distribution in this region is provided by FNEI
19. North/East of Sudbury	• Northern Ontario Wires Inc. • Hearst Power Distribution Company Limited • North Bay Hydro Distribution Ltd. • Hydro One Networks Inc. (Distribution) • Greater Sudbury Hydro Inc.
20. Renfrew	• Hydro One Networks Inc. (Distribution) • Ottawa River Power Corporation
21. St. Lawrence	• Cooperative Hydro Embrun Inc. • Hydro One Networks Inc. (Distribution) • Rideau St. Lawrence Distribution Inc.

PERFORMANCE MEASUREMENT FOR CONTINUOUS IMPROVEMENT

1. OVERVIEW

Hydro Ottawa's performance measurement framework, outlined within this document, is designed with a strong focus on customer-centric outcomes, guiding strategic planning, capital investments, and core operations. Aligned with the OEB's four key performance outcomes, detailed below, the framework ensures comprehensive performance tracking. Building on this foundation, the 2026-2030 Distribution System Plan (DSP) introduces an enhanced performance framework, emphasizing data-driven decision-making to ensure the delivery of reliable and sustainable electricity services.

2. INTRODUCTION

Hydro Ottawa has developed a comprehensive performance measurement framework that monitors outcomes and continuous improvement in service delivery. This framework, which prioritizes customer-centric outcomes, guides Hydro Ottawa's strategic planning, capital investments, and core operations, which aligns with the OEB *Renewed Regulatory Framework for Electricity Distributors: A Performance Based Approach,*[1] as well as the OEB's *2016 Handbook for Utility Rate Applications*.[2] Further details regarding Hydro Ottawa's Capital Investment Planning Process can be found in Section 5.3 of Schedule 2-5-4 - Asset Management Process.

Furthermore, Hydro Ottawa's plan incorporates all four key performance outcomes identified by the OEB:

- **Customer Focus:** services are provided in a manner that responds to identified customer preferences

[1] Ontario Energy Board, *Report of the Board - Renewed Regulatory Framework for Electricity Distributors: A Performance Based Approach* (October 18, 2012).
[2] Ontario Energy Board, *Handbook for Utility Rate Applications* (October 13, 2016).

- **Operational Effectiveness:** continuous improvement in productivity and cost performance is achieved; and utilities deliver on system reliability and quality objectives;
- **Public Policy Responsiveness:** utilities deliver on obligations mandated by government (e.g., in legislation and in regulatory requirements imposed further to Ministerial directives to the OEB);
- **Financial Performance:** financial viability is maintained; and savings from operational effectiveness are sustainable.

Hydro Ottawa maintains a steadfast commitment to these performance outcomes and diligently monitors its performance. This monitoring is facilitated through a multi-pronged approach consisting of the following:

- **Service Quality Requirements (SQR):** A comprehensive record of historical performance in respect to Service Quality Requirements, as defined in Chapter 7 of the Distribution System Code, as well Service Reliability Indicators are detailed in Excel Attachment 2-5-3 (A) - OEB Appendix 2-G - Service Quality and Reliability Indicators.
- **Electricity Utility Scorecard**: Submitted annually to the OEB to promote transparency and accountability in Ontario's electricity distribution sector, this scorecard tracks key indicators for all distributors, enables comparisons and highlights areas for improvement. The scorecard empowers customers with information about service quality and value, while also informing regulatory oversight and encouraging continuous improvement across the industry. Refer to Attachment 1-3-3(C) - Electricity Utility Scorecard for more details.
- **Custom Incentive Rate (CIR) Report:** This is an annual report submitted to the OEB under the OEB's Decision and Order on Hydro Ottawa's 2021-2025 Custom IR Application,[3] detailing:
  - Capital expenditure performance, including variance analysis and program progress across the four investment categories: system access, system service, system renewal, and general plant.

[3] Ontario Energy Board, *Decision and Order* EB-2019-0261 (November 19, 2020).

- Continuous improvement tracking via Key Performance Indicators (KPIs) specifically designed to enhance operational effectiveness in safety, system reliability, asset management, and cost control. These KPIs fulfill commitments made during the 2021-2025 CIR setting process (EB-2019-0261) and augment existing OEB reporting metrics.
- Performance Outcomes Accountability Mechanism (POAM) reporting, which tracks progress against targets established in Hydro Ottawa's 2021-2025 Approved Settlement Agreement.[4]

Hydro Ottawa's 2026-2030 DSP introduces a performance framework, detailed in Section 6, that prioritizes data-driven decision-making to ensure the delivery of reliable and sustainable electricity services. This framework represents an evolution from previous iterations, leveraging historical performance data and KPIs to inform decisions, drive continuous improvement, and guide investment priorities. This evolution is driven by Hydro Ottawa's transition to a risk-based asset management approach and advancements in data analytics capabilities, enabling a more accurate approach to performance monitoring at the Material Investment Plan (MIP) level.

3. HISTORIC (2021-2025) DSP PERFORMANCE

Hydro Ottawa's 2021-2025 DSP established KPIs to assess and enhance performance across four critical areas: Customer Oriented Performance, Cost Efficiency & Effectiveness, Asset Performance, and System Operations Performance. The KPIs aligned with Hydro Ottawa's Asset Management Objectives, which directly support the organization's Corporate Strategic Objectives.

Utilizing these metrics, Hydro Ottawa monitored the efficacy of its planning processes, identified operational efficiencies and areas for improvement, and evaluated overall performance. This section presents the historical KPI data and explains the results.

[4] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Settlement Agreement*, EB-2019-0261 (September 18, 2020).

Table 1 below provides a categorized overview of the KPIs, aligning them with the corresponding Asset Management Objective and Sub-Category. Furthermore, the table directs the reader to the relevant sections containing detailed descriptions and historical performance data for each KPI.

Table 1 - 2021-2025 DSP KPIs by Category and Asset Management Objective

Category	Asset Management Objective	Sub-Category	KPIs
3.1. Customer Oriented Performance	Levels of Service	3.1.1. Customer Engagement	○ Customer Satisfaction ○ Staff Knowledge ○ Staff Courtesy ○ First Call Resolution ○ Residential & Small Commercial Satisfaction ○ Commercial Satisfaction ○ Staff Helpfulness ○ Value for Money ○ Customer Loyalty
		3.1.2. System Reliability	○ System Average Interruption Frequency Index (SAIFI) ○ System Average Interruption Duration Index (SAIDI) ○ Customer Average Interruption Duration Index (CAIDI) ○ Feeders Experiencing Multiple Sustained Interruptions (FEMI)
		3.1.3. System Power Quality	○ System Average Root Mean Square Variation Frequency Index (SARFI)
3.2. Cost Efficiency & Effectiveness	Compliance	3.2.1 Distribution System Plan Implementation Progress	○ Cost Efficiency
	Resource Efficiency	3.2.2 Labour Utilization	○ Productive Time ○ Labour Allocation
3.3. Asset Performance	Asset Value	3.3.1 Equipment Failure Contribution to SAIFI	○ System Average Interruption Frequency Index – Defective Equipment ($SAIFI_{DE}$)
	Health, Safety & Environment	3.3.2 Public Safety Concerns	○ Public Safety Concerns (PSC)
		3.3.3 Oil Spilled	○ Litres Annual Oil Spilled ○ Cost of Annual Oil Remediation
3.4. System Operations Performance	Levels of Service	3.4.1 Stations Capacity	○ Stations Exceeding Planning Capacity ○ Stations Approaching Rated Capacity
		3.4.2 Feeder Capacity	○ Feeders Exceeding Planning Capacity ○ Feeders Approaching Rated Capacity
		3.4.3 System Losses	○ Losses

Service Quality Requirements

As per Chapter 7 of the OEB's Distribution System Code and Section 2.1.4 of the OEB's Electricity Reporting and Record Keeping Requirements (RRRs), Hydro Ottawa maintains and reports on Service Quality Requirements (SQRs). The SQRs for the last five historical years are included in Excel Attachment 2-5-3(A) - OEB Appendix 2-G - Service Quality and Reliability Indicators.

Hydro Ottawa met all OEB Targets in its SQRs for the last five years, with the exception of "Rescheduling a Missed Appointment" in 2023. Hydro Ottawa experienced an 84-day labour strike from June through September of 2023. During this period, scheduled appointments were cancelled, and customers were notified via email of the cancellations. Hydro Ottawa rescheduled those appointments when regular business operations resumed after the strike, and thus they were not rescheduled within one business day of the cancellation as per Section 7.5.1 of the Distribution System Code.

Other Appointment-related SQRs were also lower in 2023 than Hydro Ottawa's typical performance due to the strike - namely "Appointments Met" and "Appointment Scheduling". However, these as well as all other SQR targets were met in 2023. Hydro Ottawa expects its SQRs related to Appointments to return to normal levels in 2024.

Hydro Ottawa's service territory is a mix of urban and rural, with more than 50% of Hydro Ottawa's service territory considered rural. The administrative complexity of capturing urban and rural response rates, relative to Hydro Ottawa's emergency response rate performance overall, is not cost effective or insightful for Hydro Ottawa. Rather, Hydro Ottawa strives to adhere to the urban emergency response rate (60 minutes opposed to 120 minutes for rural) for both rural and urban customers. Hydro Ottawa notes that in 2023, its Urban Response time shows a downward trend. This is largely attributed to the Freezing Rain and a subsequent Loss of Supply event that took place in April 2023, as described in Section 4.4 below.

Hydro Ottawa confirms that the SQRs as filed in Appendix 2-G are consistent with those SQRs that appear on the Electricity Utility Scorecard.

The following sections detail Hydro Ottawa's performance as laid out in Table 1 above.

3.1. CUSTOMER ORIENTED PERFORMANCE

Hydro Ottawa's KPIs surrounding Customer Oriented Performance align with the asset management objective for Levels of Service, which in the 2021-2025 DSP was defined as "*to maintain and enhance leading performance of the distribution system through improving electrical service and alignment with customers' expectations.*" Specifically, Hydro Ottawa continuously seeks feedback from customers on their satisfaction with the services provided by the utility. The customer satisfaction levels are greatly impacted by the distribution system's service reliability which is integral to all work undertaken as part of system planning. Hydro Ottawa continually assesses system reliability, and where gaps are found, implements appropriate actions to address the issues.

Hydro Ottawa regularly engages with its customers to inform the utility's planning, strategy and decision making. Full details on Hydro Ottawa's ongoing customer engagement efforts can be found in Schedule 1-4-1 - Customer Engagement Ongoing, while details related to the customer engagement undertaken specific to this Application are available in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

3.1.1. Customer Engagement

Hydro Ottawa conducts customer engagement surveys to inform KPIs and drive service improvements. The feedback collected through these surveys provides valuable insights that are used to identify areas for service improvement and enhancement. Two surveys contribute to this process:

- **Annual Electric Utility Customer Satisfaction Survey:**[5] Details regarding this annual survey are available in Section 2.1.1.1 of Schedule 1-4-1 - Customer Engagement Ongoing.

[5] Previously referred to as the "Customer Satisfaction Survey (SIMUL Survey)" in the 2021-2025 DSP.

- **Contact Centre Satisfaction Survey:**[6] Details regarding this survey are available in Section 2.1.2.1 of Schedule 1-4-1 - Customer Engagement Ongoing.

The KPI results over the past five years are presented in Table 2 and Table 3.

Table 2 - Annual Electric Utility Customer Satisfaction Survey

KPI	Target	2019	2020	2021	2022	2023
Customer Satisfaction: Residential & Small Commercial	≥90%	95%	96%	94%	93%	91%
Customer Satisfaction: Large Commercial	≥90%	96%	N/A	N/A	94%	N/A
Staff Helpfulness	≥80%	78%	59%	69%	74%	78%
Value for Money	Result	77%	80%	74%	73%	73%
	Target[7]	77%	82%	74%	73%	74%
Customer Loyalty	Result	50%	51%	43%	47%	48%
	Target[7]	45%	51%	46%	38%	50%

Descriptions of these measures are as follows:

- Customer Satisfaction: measures overall customer satisfaction at the start of the survey;
- Staff Helpfulness: based on a small sample of customers who said they contacted Hydro Ottawa, describes whether a customers' recent concern was addressed in a manner that was useful, providing a solution to the customers' problem. This metric is based on a limited sample of customer contacts and, as such, may not be representative of overall customer experiences.
- Value for Money: Measures perceptions about service quality and value, and is linked to the utility's overall image;
- Customer Loyalty: Measures the degree to which customers are satisfied, would continue to do business with Hydro Ottawa if given a choice, and would recommend Hydro Ottawa to others

[6] Previously referred to as the "TouchLogic Survey" in the 2021-2025 DSP.
[7] The Hydro Ottawa target is defined to be 2% better than Ontario Average.

Table 3 - Contact Centre Satisfaction

KPI	Target	2019	2020	2021	2022	2023
Call Center Customer Satisfaction	≥85%	87%	87%	86%	84%	85%
Staff Knowledge	≥90%	88%	88%	88%	86%	87%
Staff Courtesy	≥90%	87%	88%	87%	86%	87%
First Call Resolution	≥85%	89%	90%	89%	86%	86%

Descriptions of these measures are as follows:

- Customer Satisfaction – the customer's overall level of satisfaction with the call;
- Staff Knowledge – the customer's assessment of the knowledge of the contact centre staff;
- Staff Courtesy – the customer's assessment of the courtesy of the contact centre staff; and
- First Call Resolution – the ability of the staff to deal with the customer's issue.

Hydro Ottawa notes that the Customer Engagement KPIs are used in combination with other ongoing customer engagement activities as described in Schedule 1-4-1 - Customer Engagement Ongoing to assess customers expectations and experiences.

3.1.2. System Reliability

Hydro Ottawa tracks system reliability performance using four indicators: System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI), Customer Average Interruption Duration Index (CAIDI) and Feeders Experiencing Multiple Sustained Interruptions (FEMI). Historical reliability performance is comprehensively detailed in Section 4 below. Hydro Ottawa confirms that the data presented in Appendix 2-G regarding SAIDI and SAIFI is consistent with the OEB's Electricity Utility Scorecard.[8] This data is included in this Application as Excel Attachment 2-5-3(A) - OEB Appendix 2-G - Service Quality and Reliability Indicators.

[8] Noting that the OEB Scorecard presents SAIDI and SAIFI excluding LOS and MEDs.

3.1.2.1. System Average Interruption Frequency (SAIFI)

This information is comprehensively detailed in Section 4.1.

3.1.2.2. System Average Interruption Duration Index (SAIDI)

This information is comprehensively detailed in Section 4.2.

3.1.2.3. Customer Average Interruption Duration Index (CAIDI)

This index, representing the average time required to restore power per sustained interruption, is defined as follows:

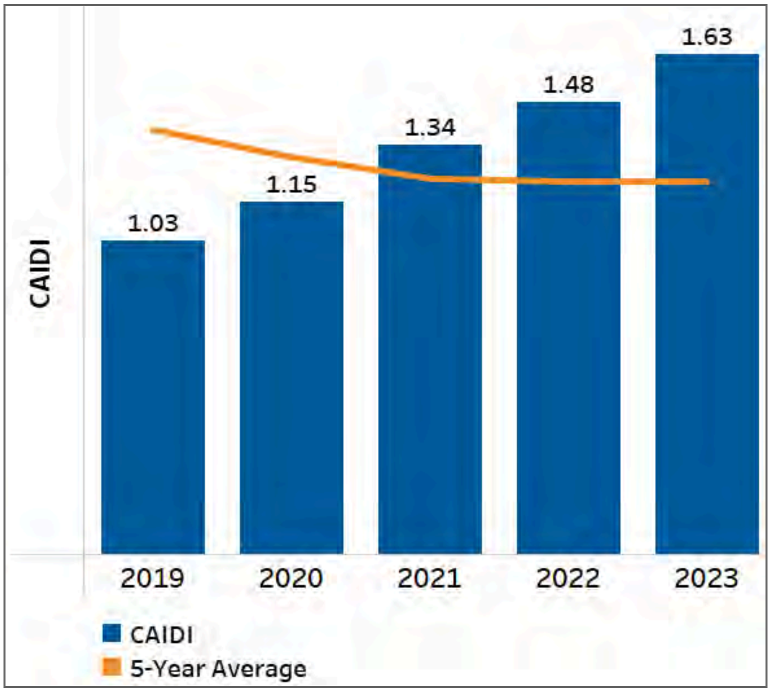
$$CAIDI = \frac{SAIDI}{SAIFI} = \frac{Total\ hours\ of\ customer\ interruptions}{Total\ number\ of\ customer\ interruptions}$$

CAIDI is reported excluding Loss of Supply (LOS) and Major Event Days (MEDs). Please see Table 4 and Figure 1 for the historical results.

Table 4 - CAIDI Reliability Performance

Metric		2019	2020	2021	2022	2023
CAIDI	Excluding LoS & MED	1.03	1.15	1.34	1.48	1.63
	5- Year Historical Average	1.39	1.30	1.23	1.22	1.22

Figure 1 - CAIDI Reliability Performance



Hydro Ottawa monitors the annual trend of CAIDI performance to identify and evaluate potential concerns with restoration efforts. The CAIDI metric exceeded the 5-year historical average for 2022 and 2023 due to the increasing trend of total hours of customer interruptions (SAIDI) and reducing trend of total number of customer interruptions (SAIFI). For analysis of SAIDI and SAIFI refer to Sections 4.1 System Average Interruption Frequency Index (SAIFI) and 4.2 System Average Interruption Duration Index (SAIDI).

3.1.2.4. Feeders Experiencing Multiple Sustained Interruptions (FEMIn)

This index quantifies the number of feeders experiencing sustained interruptions (exceeding one minute in duration) greater than or equal to a value n. Current reporting utilizes n=10, signifying the count of feeders experiencing ten or more sustained interruptions. Hydro Ottawa's performance target is to maintain a $FEMI_{10}$ value less than or equal to 10.

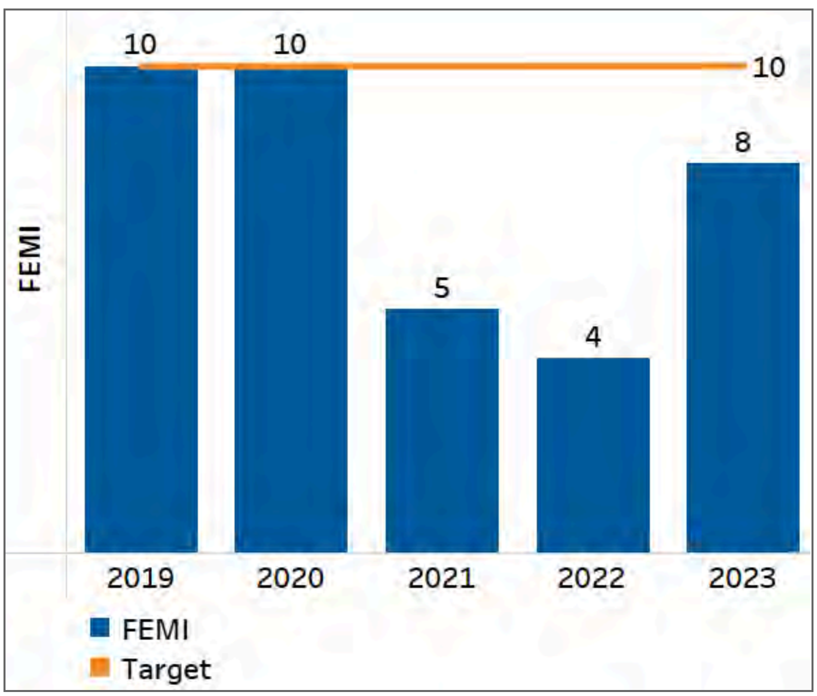
FEMI serves as a customer-centric metric, providing insights into regional variations in service quality. To ensure accuracy and relevance, $FEMI_{10}$ reporting excludes Scheduled Outages, LOS, and MEDs. This exclusion allows for a more focused analysis of system performance and its impact on customers.

Table 5 and Figure 2 show the historical system performance for FEMI.

Table 5 - FEMI Reliability Performance

Metric	Target	2019	2020	2021	2022	2023
$FEMI_{10}$	10	10	10	5	4	8

Figure 2 - FEMI Reliability Performance



Hydro Ottawa achieved its targets for FEMI between the 2019-2023 period. Hydro Ottawa tracks and evaluates feeders that affect the performance of the FEMI metric monthly to identify projects to improve the reliability of these parts of the distribution system. Hydro Ottawa will continue to evaluate the performance of feeders that appear in the FEMI metric to ensure customer reliability is maintained.

3.1.3. System Power Quality

Hydro Ottawa monitors the quality of power supplied to its customers to ensure adherence to service levels outlined in CSA document CAN3-C235-83 for steady-state conditions. With increasing sensitivity of customer equipment to voltage fluctuations, monitoring power quality is a critical aspect of service delivery. To assess power quality, Hydro Ottawa utilizes the System Average Root Mean Square (RMS) Variation Frequency Index (SARFI). This industry-standard metric measures the average number of voltage sags or swells on the system, excluding events originating from the transmission system or third parties.

Hydro Ottawa endeavors to maintain system voltage within ±6% of nominal levels, ensuring compliance with the Information Technology Industry Council (ITIC) curve for acceptable voltage limits. Hydro Ottawa's SARFI performance outcomes for the 2019-2023 period are presented in Table 6, while the 2023 SARFI performance is shown in Figure 3.

Figure 3 - 2023 Power Quality Events ITIC Curve

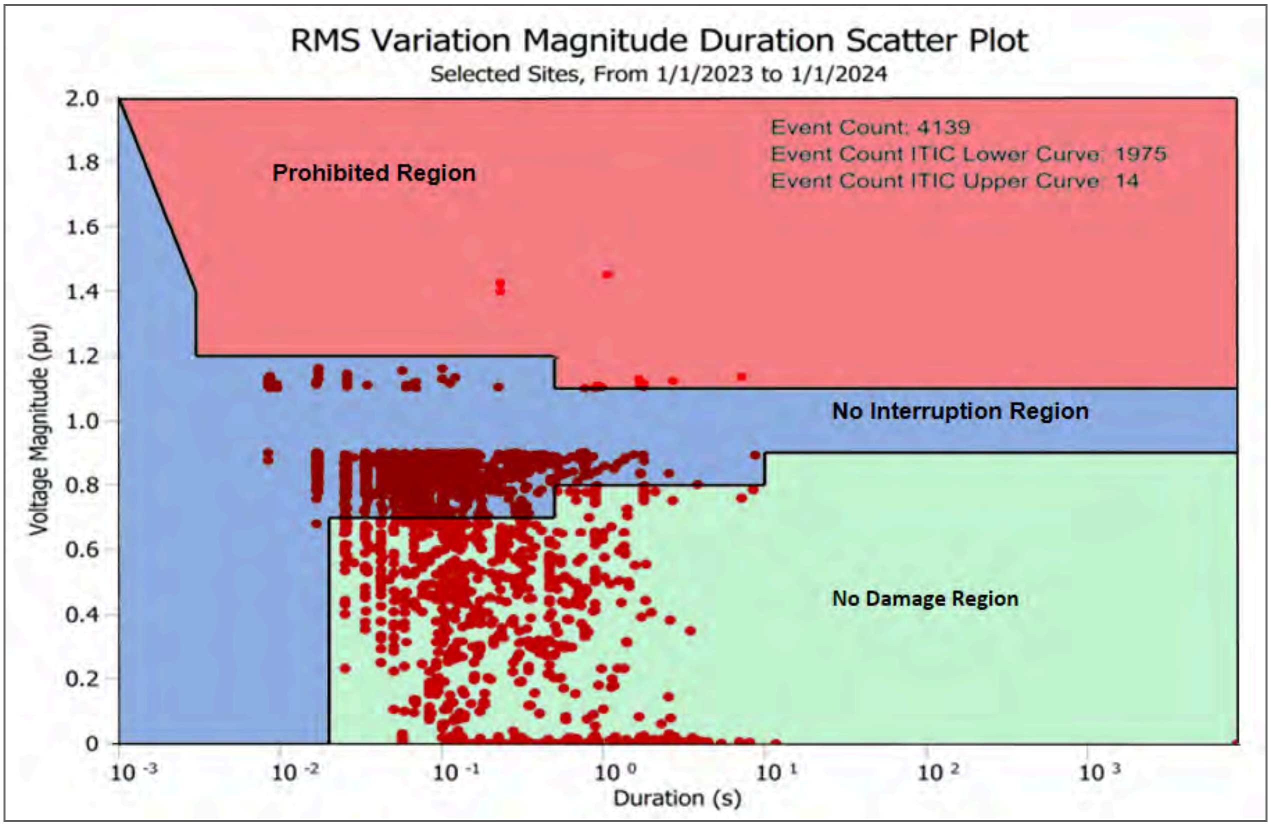


Table 6 - SARFI Performance

Metric	2019	2020	2021	2022	2023
SARFI	10	21	11	20	14

Hydro Ottawa saw SARFI values higher than the 5-year average in 2020 and 2022 due to supply voltage swings upstream (from the transmitter) resulting in a voltage swell event for a short duration until the station transformer tap changer could operate. As illustrated in Figure 4, Hydro Ottawa recorded 4,139 events in 2023, of which 14 fell within the prohibited region of the ITIC curve, with six events caused by Hydro One Networks Inc. (Hydro One) with their tap changer operation/voltage regulation and the remaining attributed to transient fault events on Hydro Ottawa's system. Each year, Hydro Ottawa diligently tracks and monitors SARFI events to identify and address any areas of concern, ensuring that power quality remains within acceptable limits for all customers.

3.2. COST EFFICIENCY & EFFECTIVENESS

Hydro Ottawa conducts annual assessments of its cost efficiency and labour utilization KPIs. This evaluation provides critical insights into the progress, efficiency, and effectiveness of the company's planning processes, as well as the efficiency of plan execution, and supports a continuous improvement framework, data-driven decision-making and operational optimization.

3.2.1. Distribution System Plan Implementation Progress[9]

The Distribution System Plan Implementation Progress (DSP Implementation Progress) KPI measures and reports on the progress of capital projects identified within Hydro Ottawa's DSP. This KPI ensures the company delivers maximum value to its customers by demonstrating the effective execution of essential capital projects necessary for the continued reliable operation of the electricity distribution system. This KPI is publicly reported on the Hydro Ottawa Electric Utility Scorecard under the Asset Management Performance Category and is titled "Distribution System Plan Implementation Progress." Refer to Attachment 1-3-3(C) - Electricity Utility Scorecard Analysis for details.

DSP Implementation Progress tracking focuses on planned capital projects categorized as either system renewal or system service investments. This KPI excludes system access projects, general plant expenditures, and all emergency work. It is calculated as the ratio of the allocated budget for planned capital activities to the actual expenditures incurred annually. The specific formula employed in this calculation is provided below.

$$DSP\ Implementation\ Progress\ (\%) = \frac{Actual\ SS\ \&\ SR\ Expenditures}{Budgeted\ SS\ \&\ SR\ Expenditures} \times 100$$

[9] Previously referred to as “Cost Efficiency" in the 2021-2025 DSP.

The budget and execution of planned capital projects is rigorously managed through Hydro Ottawa's financial system. Any deviations from the projected budget necessitate a formal change request, subject to approval on a case-by-case basis. The target for the DSP Implementation Progress KPI is to achieve 100% completion of the annual planned work within the approved budget. The KPI trend is presented in Table 7.

Table 7 - Distribution System Plan Implementation Progress

KPI	Target	2019	2020	2021	2022	2023
DSP Implementation Progress	100 %	84%	89%	92%	90%	75%

Between 2019 and 2023, inclusive, Hydro Ottawa faced challenges in achieving its target. These challenges were primarily attributed to external factors outside of Hydro Ottawa's direct control, as detailed below.

In 2019, the DSP Implementation Progress was 84%, falling short of the target due to the financial impact of three significant storms in 2018, which necessitated increased spending on emergency repairs and station projects. These reactive investment needs led to a reduction in planned expenditures for 2019 and 2020.

The 2020 DSP Implementation Progress reached 89%. However, the COVID-19 pandemic caused disruptions, requiring deferral of planned work to 2021 in order to accommodate emergency tasks, outage restrictions and constrained labour availability.

In 2021, Hydro Ottawa achieved a 92% DSP Implementation Progress despite the ongoing challenges posed by the COVID-19 pandemic. However, the target of 100% completion remained unmet due to project deferrals necessitated by persistent labor and material shortages, as well as outage restrictions.

In 2022, the DSP Implementation Progress decreased to 90%. This was attributed to project deferrals necessitated by emergency restoration work following severe storms one of which being the Derecho, compounded by ongoing labour and material availability challenges.

The year 2023 saw a significant drop in the DSP Implementation Progress to 75%. This was primarily attributed to an 84-day labour strike, which posed a major obstacle, causing delays across all planned programs. This disruption necessitated re-prioritization efforts and deferral of projects to 2024.

3.2.2. Labour Utilization

Hydro Ottawa conducts annual assessments of its labour utilization KPIs to monitor and report on the progress, efficiency, and effectiveness of plan execution, while also identifying areas for continuous improvement. This practice enables Hydro Ottawa to demonstrate efficient resource allocation and responsible stewardship.

To evaluate labour utilization performance, Hydro Ottawa tracks productive time and labour allocation KPIs. This data-driven approach facilitates ongoing optimization of workforce deployment and operational efficiency.

3.2.2.1. Productive Time

Productive time is defined as the ratio of total regular hours charged to a work order (billable) to the total regular hours available per year. The formula for calculating productive time is as follows:

$$Productive\ Time = \frac{Percent\ of\ Billable\ Hours}{Total\ Regular\ Hours}$$

It is important to note that this KPI is influenced by hours allocated for training, vacation, and sick time. Additionally, it does not account for work completed using overtime. Table 8 presents the trend in productive time over the past five years. This historical data provides valuable context for evaluating current performance and identifying opportunities for improvement.

Table 8 - Productive Time

KPI	2019	2020	2021	2022	2023
ProductiveTime	72%	69%	73%	69%	73%
Target	≥74%	≥74%	≥72%	≥72%	≥73%

Hydro Ottawa's productivity time performance between 2019 and 2023 has fluctuated relative to its established targets.

In 2019, a 72% productivity time was achieved, slightly below the 74% target but consistent with the previous year's performance. This minor shortfall was partly attributed to over 3,000 hours dedicated to an administrative work order associated with the company's relocation to new offices, Dibblee and Hunt Club.

The year 2020 saw a productivity time of 69%, not meeting the 74% target and the previous year's performance. This was primarily due to COVID-19 related downtime, implemented to facilitate social distancing measures in the second quarter.

In 2021, a 73% productivity time was achieved, meeting the target.

The year 2022 saw a productivity time of 69%, falling short of the 72% target. Analysis indicates that the observed deviation in the 2022 productivity rate is primarily attributable to a significant increase in non-productive time allocation following the relaxation of COVID-19 related restrictions. Specifically, training activities, deemed essential for staff recertifications and other required skill development, consumed 4,700 hours. Additionally, meeting attendance, including the first all-employee forum since 2019, required 700 hours. These increased allocations of time to non-productive activities consequently decreased the available time for productive work, resulting in the reported shortfall in the productivity rate.

Hydro Ottawa achieved its productivity time target in 2023 with a result of 73%. Notably, the result is calculated based on the number of hours worked, thus the labour strike did not impact the productivity rate for the year.

3.2.2.2. Labour Allocation

Labour allocation is defined as the ratio of labour hours dedicated to maintenance and administrative work versus the total productive time available, as defined in Section 3.2.2.1 above. This KPI aims to quantify the proportion of time spent on operations, maintenance, and administration (OM&A) activities, as outlined in annual work plans, compared to time allocated for capital activities. The formula used in this calculation is provided below:

$$Labour\ Allocation = \frac{Percent\ of\ Labour\ Time\ on\ Maintenance\ and\ Administrative\ Activities}{Total\ Productive\ Time}$$

Historically, this metric represented the amount of labour spent on capital activities as a ratio of total regular hours. However, starting in 2020, Hydro Ottawa has modified this metric in order to support broader performance management objectives. Accordingly, the target under the modified metric is to stabilize the amount of labour allocated to maintenance and administrative work. Table 9 presents the trend in this KPI over the previous five years, offering insights into the dynamic relationship between OM&A demands and capital project execution.

Table 9 - Labour Allocation

KPI	2019	2020	2021	2022	2023
Labour Allocation	N/A	37%	29%	35%	35%
Target	N/A	≤ 34%	≤ 33%	≤ 32%	≤ 32%

Hydro Ottawa's performance results for this KPI between 2019 and 2023 are described below.

In 2019, this was the year that this metric was established, resulting in no comparative result for that year.

The year 2020 saw Labour Allocation result of 37%, exceeding the target of 34%. This was attributed to the impact of the COVID-19 pandemic.

In 2021, Hydro Ottawa achieved its target. This success was attributed to a greater allocation of time towards capital projects and improved operational efficiency compared to the previous year, which was significantly impacted by the COVID-19 pandemic.

However, in 2022, the yearly Labour Allocation increased to 35%, exceeding the 32% target. This was primarily due to an increase in non-capital work, both during and after the Derecho storm, which necessitated extensive repair and restoration efforts.

Lastly, in 2023, the yearly Labour Allocation was 35%, again exceeding the 32% target. This was attributed to capital project deferrals caused by the labour disruption which led to an increase in maintenance activities.

3.3. ASSET PERFORMANCE

Hydro Ottawa employs a comprehensive approach to asset performance monitoring, utilizing three key metrics: defective equipment contribution to SAIFI, public safety concern notifications, and oil spill incidents. These metrics collectively enable Hydro Ottawa to effectively achieve its asset management objectives and proactively mitigate risks within the electricity distribution system. This section provides a detailed examination of each metric, explaining their significance in ensuring system reliability, safety, and environmental responsibility.

3.3.1. Equipment Failure[10] Contribution to SAIFI

Hydro Ottawa adopted "Equipment Failure" as the primary cause code, replacing "Defective Equipment", for reliability reporting. This change aligns with the OEB updates to the RRRs. The OEB amended the RRRs in November 2022 to improve interruption reporting detail and usefulness by updating primary and secondary cause codes.[11] Hydro Ottawa implemented the updated primary cause codes on January 1, 2023, and subsequently implemented the updated secondary cause codes on January 1, 2024.

This KPI specifically tracks the contribution of equipment failure outages by asset class to the overall SAIFI (including MEDs) per 100 customers (SAIFI x 100). Hydro Ottawa's target is to achieve year-over-year reductions in customer interruptions caused by equipment failure, employing a rolling average of the previous five years to establish the annual target.

SAIFI, detailed in Section 4.1, serves as a critical metric for Hydro Ottawa in its pursuit of enhancing service levels, optimizing asset value, and improving resource efficiency. By analyzing the contribution of equipment failure outages by asset class to the overall SAIFI, Hydro Ottawa is able to identify assets contributing to multiple outages, allowing for targeted interventions and a more focused approach to addressing issues directly impacting customers.

Each asset class plays a role in the overall SAIFI reliability metric. Table 10 provides a detailed breakdown of each asset class's contribution to the SAIFI x 100 value, facilitating a comprehensive understanding of system performance and areas for potential improvement. The target has been derived from the 2014-2018 average.

[10] Previously referred to as “Defective Equipment " in the 2021-2025 DSP.
[11] Ontario Energy Board, *Notice of Amendments to RRR 2.1.4.2 System Reliability*, EB-2021-0307 (November 21, 2022).

Table 10 - Equipment Failure SAIFI per 100 Customers

Asset – SAIFI x 100	Target	2019	2020	2021	2022	2023
Overhead Assets	10.12	5.20	11.64	9.11	15.73	7.49
Station Assets	1.67	0.35	1.93	0.32	1.25	0.27
Underground Assets	11.16	13.27	11.95	9.26	11.26	4.17

Customer interruptions caused by Overhead and Underground Assets have generally decreased since 2020. The exception was 2022, due to extreme weather events, particularly the Derecho. Through 2019-2023, overhead interruptions were mainly due to the failure of overhead switchgear, transformers and conductors. Underground interruptions were primarily caused by cable and transformer issues, especially leaks. Defective station transformers and switchgear have been the primary contributors to the station equipment trend. The impact of equipment failure to SAIFI underpins the renewal investment needs proposed in Schedule 2-5-7 - System Renewal Investments and the increased maintenance spending outlined in Section 3.1 - Testing, Inspection and Maintenance and Section 3.4 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

3.3.2. Public Safety Concerns

Hydro Ottawa prioritizes public safety through diligent monitoring and response to Public Safety Concerns identified by the Electrical Safety Authority (ESA). These concerns fall into two categories:

- **Hydro Ottawa's Responsibility:** These are issues directly related to distribution equipment, for which Hydro Ottawa takes full responsibility and ensures prompt resolution.
- **Customer-Related Issues:** These concerns stem from customer actions or inactions that impact the safety of the distribution system, such as exposed wiring or construction near power lines. Hydro Ottawa proactively collaborates with customers to address these issues.

Table 11 presents the annual count of public safety concerns recorded by Hydro Ottawa. Hydro Ottawa diligently responds to and undertakes, where required, corrective actions for all reported public safety concerns, ensuring a continuous improvement cycle focused on enhancing public safety.

Table 11 - Public Safety Concerns

KPI	2019	2020	2021	2022	2023
Public Safety Concerns	2	1	7	9	21

In 2023, a total of 21 Public Safety Concerns were identified, of which six were the sole responsibility of Hydro Ottawa. Analysis of historical data indicates no specific trends in the Public Safety Concerns issued to Hydro Ottawa by the ESA.

While this metric is not a fully reliable indicator for achieving health, safety, and environmental objectives on its own, Hydro Ottawa remains committed to monitoring Public Safety Concerns for emerging trends and taking appropriate corrective actions.

3.3.3. Oil Spilled

The annual oil spilled metric is an essential indicator used by Hydro Ottawa to advance its health, safety, and environmental objectives. This metric enables the company to track both the volume of oil spilled into the environment and the associated annual costs of remediation. By monitoring this data, Hydro Ottawa can identify trends and continuously improve its environmental performance.

Table 12 presents the annual volume of oil spilled into the environment, along with the corresponding remediation costs. Hydro Ottawa's objective is to achieve zero oil spills and eliminate associated cleanup costs.

Table 12 - Annual Oil Spilled

KPI	Target	2019	2020	2021	2022	2023
Oil Spilled (L)	0	1,131 L	954 L	804 L	781 L	1,230 L
Oil Remediation ($000)	0	$ 1,234	$ 1,454	$ 1,897	$ 1,565	$ 1,099

Hydro Ottawa monitors oil spills from both an enterprise risk and company-wide performance perspective. While the ultimate goal is zero spills, the inherent challenges of operating tens of thousands of pieces of oil-filled equipment, essential for electricity delivery, necessitate a pragmatic approach. These assets are exposed to extreme environmental conditions, including winter salt, storms, and other weather events, which can lead to leaks despite robust asset management programs. Hydro Ottawa addresses any leaks immediately upon detection.

During 2023, Hydro Ottawa experienced two significant oil spills, each resulting from contractor activity during excavation. In both cases, contractors struck underground infrastructure, leading to a total spill volume of 390 liters. These two incidents represent the primary cause of the 2023 KPI results deviating drastically from recent historical performance. Aside from these incidents, Hydro Ottawa has observed a general trend/issue with leaking transformers related to a specific manufacturer and certain localized regions. The identified transformers are being phased out through the Cable Replacement program and the Emergency Renewal program as outlined in Section 4 and Section 6 of Schedule 2-5-7 - System Renewal Investments.

To further mitigate the environmental impact of oil spills, Hydro Ottawa implements several proactive measures. These include routine inspections of oil-filled equipment, strategic asset replacement initiatives, and periodic communication with local construction associations emphasizing the critical importance of utilizing locate services before commencing any excavation work. This comprehensive and transparent strategy underscores Hydro Ottawa's commitment to environmental responsibility and sustainable operations.

3.4. SYSTEM OPERATIONS PERFORMANCE

Hydro Ottawa's KPIs surrounding System Operations Performance align with the 2021-2025 DSP Asset Management Objectives for Levels of Service and Asset Value. Specifically, Hydro Ottawa monitors the operational performance of the system by tracking annual levels of station capacity, feeder capacity and system losses. This information is used to identify potential equipment upgrades ensuring that adequate capacity is available during normal system conditions and for reliable operation during system contingency in order to meet the levels of service expected by Hydro Ottawa's customers. In addition, these KPIs allowed the identification of stations and feeders operating above or approaching its design ratings in order to implement the appropriate actions required to maximize the value of the distribution system assets throughout its lifecycle.

3.4.1. Stations Capacity

Hydro Ottawa utilizes Station Capacity KPIs to gain insights into large, medium, and long-term capacity needs, as well as to identify smaller capacity deficits that may be addressed through load transfers. These KPIs include:

- **Station Exceeding Planning Capacity**
- **Station Approaching Rated Capacity**

These KPIs quantify capacity risks by comparing demand to a station's planning and equipment ratings and by determining the potential for stranded load during an N-1 contingency. This comprehensive evaluation framework enables proactive capacity planning and risk mitigation.

3.4.1.1. Stations Exceeding Planning Capacity

This KPI is defined as the percentage of stations with a summer peak operating load exceeding 100% of their planned capacity rating. The calculation for this KPI is provided below.

$$Stations\ Exceeding\ Capacity\ (\%) = \frac{\#\ of\ Stations\ Exceeding\ Planning\ Capacity}{\#\ of\ Total\ Stations} \times 100\%$$

Table 13 - Stations Exceeding Planning Capacity

KPI	Target	2019	2020	2021	2022	2023
SEPC %	≤ 5%	8.8%	13.2%	7.7%	4.3%	8.7%
Count		8	12	7	4	8

Since 2019, the number of stations identified as exceeding their planning capacity has remained relatively stable, as per Table 13, fluctuating with variation in the yearly peak' intensity. With respect to this KPI, there are three key capacity constrained regions: South 28kV, West 28kV and Central 4kV. The energization of Cambrian MTS in the south relieved some south-end capacity concerns in 2022, and the proposed Piperville MTS will alleviate the load further. West-end capacity issues represent the largest concern and the proposed "New Kanata" station is aimed at relieving the constrained West 28kV system. Central 4kV stations continue to approach their planned limits due to transit-oriented development and downtown electrification and intensification. The proposed 4kV-to-13kV voltage conversion/station upgrades will resolve the inherent limitations of the 4kV and increase capacity. More information on Hydro Ottawa's capacity upgrade plans can be found in Section 2 of Schedule 2-5-8 - System Service Investments. Overall, Hydro Ottawa's future plans seek to bring the SEPC KPI within or under target over the next rate application term.

3.4.1.2. Stations Approaching Rated Capacity

This KPI is defined as the percentage of stations operating at or above 100% of their rated capacity. The calculation for this KPI is provided below. Rated capacity is defined as the sum of the maximum ratings of all transformers within a given station. Exceeding this operational threshold can result in accelerated transformer degradation and loss of life, impacting system reliability and longevity.

$$Stations\ Approaching\ Capacity\ (\%) = \frac{\#\ of\ Stations\ Approaching\ Rated\ Capacity}{\#\ of\ Total\ Stations}$$

Table 14 - Stations Approaching Rated Capacity

KPI	Target	2019	2020	2021	2022	2023
SARC %	0%	0%	0%	1.1%	0%	0%
Count		0	0	1	0	0

Since 2019, Hydro Ottawa has succeeded in meeting the KPI target of keeping all stations under their rated capacity during the annual system peak, as per Table 14. There is one exception in 2021, where a station was approaching its rated capacity due to capacity constraints in the South 28kV system. It was ensured that the station was operated in a safe manner and the time period when it operated close to rated capacity did not cause any damage to the equipment. The energization of Cambrian MTS in 2022, alleviated this unique situation by bringing additional capacity support to that area.

3.4.2. Feeder Capacity

Hydro Ottawa employs a comprehensive feeder capacity planning approach that considers both coincident peak loading and single (N-1) contingency scenarios. This methodology necessitates the evaluation of two key capacity ratings:

- **Feeders Exceeding Planning Capacity:** This metric identifies feeders where the operational load surpasses the planned capacity, highlighting potential areas of concern.
- **Feeders Approaching Rated Capacity:** This metric identifies feeders nearing their maximum capacity, enabling proactive mitigation to prevent overload conditions.

3.4.2.1. Feeders Exceeding Planning Capacity

This KPI is defined as the percentage of feeders with a summer peak operating load exceeding 100% of their planned capacity rating, calculated using the equation below.

$$Feeders\ Exceeding\ Capacity\ (\%) = \frac{\#\ of\ Feeders\ Exceeding\ Planning\ Capacity}{\#\ of\ Total\ Feeders} \times 100\%$$

Table 15 - Feeders Exceeding Planning Capacity

KPI	Target	2019	2020	2021	2022	2023
FEPC %	≤ 10%	1.6%	1.9%	1.0%	0.9%	2.2%
Count		13	17	8	10	19

As per Table 15, Hydro Ottawa has succeeded in keeping feeders below the 10% target for feeders exceeding their planning capacity. Hydro Ottawa's proactive approach of load balancing and redundancy/backups ensures that adequate capacity is maintained in contingency scenarios, providing secure and reliable power delivery to customers. Feeders that are operating over their planning rating are symptomatic of excess demand at the station, rather than a feeder-level capacity concern, and hence this KPI will continue to improve with the implementation of station capacity plans. Secondly, feeders operating above planning capacity are mostly in the Nepean 8kV system which is currently insufficient to manage the load growth due to electrification in the region. The proposed Greenbank MTS in the South 28kV system will help cater to large loads as well as introduce the 28kV system in the Nepean region. Please see further details in Schedule 2-5-8 - System Service Investments.

3.4.2.2. Feeders Approaching Rated Capacity

This KPI is defined as the percentage of feeders operating at or above 90% of their rated capacity. The calculation for this KPI is provided below. Rated capacity is defined as the 8-hour loading limit of the egress cable. Sustained operation above this threshold for periods exceeding 8 hours can result in overheating and accelerated degradation of the cable, ultimately impacting system reliability and longevity.

$$Feeders\ Approaching\ Capacity\ (\%) = \frac{\#\ of\ Feeders \geq 90\%\ of\ Rated\ Capacity}{\#\ of\ Total\ Feeders} \times 100\%$$

Table 16 - Feeders Approaching Rated Capacity

KPI	Target	2019	2020	2021	2022	2023
FARC %	0%	0.1%	0.4%	0.1%	0%	0%
Count		1	3	1	0	0

As per Table 16, as of 2022, Hydro Ottawa has met the KPI goal for feeders approaching rated capacity. As discussed in Section 3.4.2.1 above, the proactive approach for load balancing and redundancy has ensured based on feeder-level design that feeders do not see excessive amperage. Aforementioned capacity concerns in the South 28kV system led to excessive loading in some feeders, however, the energization of Cambrian MTS and other capacity upgrade work has alleviated that concern since 2022.

3.4.3. System Losses

Hydro Ottawa continuously monitors and records annual system losses to ensure they remain within acceptable levels. An upward trend in losses would trigger the identification of investment needs aimed at reducing losses and maintaining the established levels of service.

Distribution system losses, as defined by the OEB Distribution System Code, are "*energy losses that result from the interaction of intrinsic characteristics of the distribution network such as electrical resistance with network voltages and current flows.*" Table 17 presents the historical performance of system losses as referenced in Table 1 - Losses as a Percentage of Higher Value Purchases for the Previous Five Years in Schedule 8-2-3 - Loss Adjustment Factors.

Table 17 - System Losses

KPI	Target	2019	2020	2021	2022	2023
Losses %	≤ 3.02%	3.02%	3.14%	2.89%	3.05%	3.10%

Hydro Ottawa committed to preparing a plan to reduce distribution system losses as part of Hydro Ottawa's 2021-2025 Approved Settlement Agreement for the Custom Incentive Rate-Setting Application, and maintain the five-year average total system losses below the target of 3.02%.[12]

Please refer to Attachment 8-2-3(B) - Hydro Ottawa System Loss Plan (the Plan), which outlines six mitigating actions to further reduce system losses. These actions included power factor correction, load balancing, reconductoring, voltage conversion, review of unmetered load services, and project optimization. While Hydro Ottawa did not achieve the target of an average system loss below 3.02% over the 5-year period, a low 5-year average total system loss was maintained along with a commitment to continue implementing the Plan. As a part of Hydro Ottawa's regular reliability improvement initiatives and distribution enhancement projects, load balancing and reconductoring is assessed and implemented. There are planned voltage conversions in place and Hydro Ottawa endeavours to continue investing in loss improvement through the execution of the capital programs planned in the 2026-2030 period.

4. HISTORICAL RELIABILITY PERFORMANCE

Hydro Ottawa diligently monitors and reports on its service reliability performance in accordance with OEB reporting requirements for electricity distributors. This section provides a detailed analysis of Hydro Ottawa's reliability performance trends, including an evaluation of SAIDI and SAIFI. A comprehensive assessment of Hydro Ottawa's performance against the OEB's Service Reliability Indicators is presented in Section 4.1 (SAIFI) and Section 4.2 (SAIDI) of this document.

Hydro Ottawa has completed Appendix 2-G, documenting historical performance of Service Quality Requirements, as outlined in Section 7 of the Distribution System Code, and Service Reliability Indicators. Appendix 2-G can be found as Excel Attachment 2-5-3(A) - OEB Appendix 2-G - Service Quality and Reliability Indicators.

[12] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Settlement Agreement*, EB-2019-0261 (September 18, 2020).

The following sections provide a detailed look at historical system reliability, including a close examination of primary cause trends and an in-depth exploration of the factors underlying these trends. The reliability metrics established by Hydro Ottawa in the 2021-2025 DSP are:

- System Average Interruption Frequency Index (SAIFI)
  - SAIFI for all interruptions
  - SAIFI excluding loss of supply interruptions
  - SAIFI excluding Major Events and loss of supply interruptions
- System Average Interruption Duration Index (SAIDI)
  - SAIDI for all interruptions
  - SAIDI excluding loss of supply interruptions
  - SAIDI excluding Major Events and loss of supply interruptions
- Worst Feeder Analysis
- Major Event Days Summary
- Loss of Supply Summary
- Analysis of cause of interruption
  - Number of interruptions that occurred as a result of the cause of interruption
  - Number of customer interruptions that occurred as a result of the cause of interruption
  - Number of customer-hours of interruptions that occurred as a result of the cause of interruption

4.1. SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

SAIFI represents the average frequency of sustained interruptions per customer and is defined as follows:

$$SAIFI = \frac{Total\ number\ of\ customer\ interruptions}{Total\ number\ of\ customers\ served}$$

SAIFI, is reported in three ways:

- **All Interruptions:** This includes all interruptions, regardless of cause.

- **Interruptions Excluding Loss of Supply (LoS):** This excludes interruptions caused by LoS events outside of Hydro Ottawa's distribution system, such as loss of supply from Hydro One.
- **Interruptions Excluding LoS and Major Event Days (MEDs):** This further refines the metric by excluding interruptions caused by LoS and MEDs, such as severe storms, which are outside of Hydro Ottawa's control.

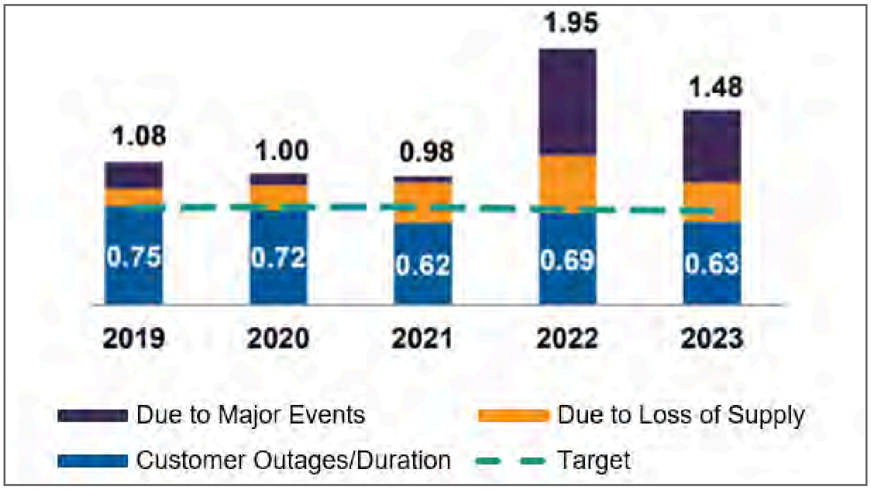
Excluding interruptions caused by MEDs and LoS allows for a more focused evaluation of system performance and isolates factors within Hydro Ottawa's control. Hydro Ottawa's target for SAIFI is to maintain a value at or below the five-year rolling average, excluding MEDs and LoS events. This objective aligns with the OEB distributor-specific target for reliability performance. Table 18 and Figure 4 below show SAIFI performance in tabular form and in graphical form for different methods to depict Hydro Ottawa performance.

Table 18 - SAIFI Reliability Performance

KPI		2019	2020	2021	2022	2023
SAIFI	All Interruptions	1.08	1.00	0.98	1.95	1.48
	Excluding LoS	0.95	0.81	0.67	1.51	1.18
	Excluding LoS & MEDs	0.75	0.72	0.62	0.69	0.63
	SAIFI Target[13]	0.74	0.74	0.74	0.72	0.71

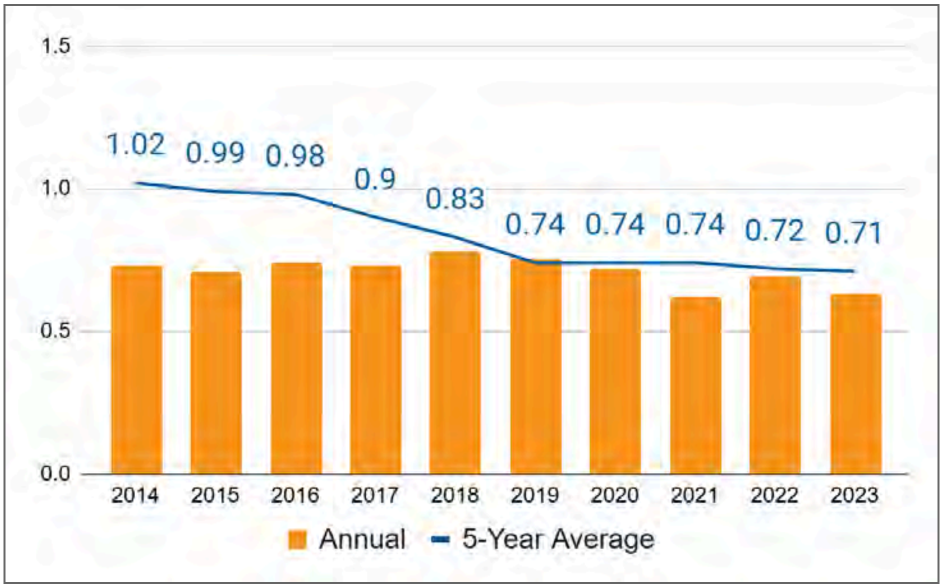
[13] This value represents the rolling five-year historical average excluding LoS and MED.

Figure 4 - SAIFI Reliability Performance



Hydro Ottawa has demonstrated strong reliability performance over the past five years, consistently meeting its goal of keeping the SAIFI excluding LoS and MED, below or equal to the five-year historical average. This trend is particularly evident when excluding major weather events, with 2021 and 2023 showing especially strong performance. The only exception was a slight exceedance of the target by 0.01 in 2019, due to the higher number of outages which were unplanned, mainly due to lightning, foreign interference and unknown, and human element issues. In general, Hydro Ottawa's SAIFI performance has improved due to the renewal of deteriorating key assets, corrective maintenance, feeder reconfigurations to reduce customer impact, and continued improvements to protection coordination. The reduction in annual targets, which are determined based on a rolling 5-year average SAIFI performance excluding Loss of Supply and Major Event Days, demonstrates that targeted efforts mentioned above have supported the overall improvement to system reliability. Figure 5 below shows this downward trend from 2014 through 2023.

Figure 5 - SAIFI excluding Loss of Supply and Major Event Days



However, severe weather events like the 2022 Derecho and the 2023 freezing rain and thunder/hail storms caused significant disruptions, leading to a sharp increase in SAIFI. These events, categorized as MED, highlight the challenge of maintaining reliability in the face of unpredictable weather patterns. Sections 4.4 - Major Event Days and 4.5.3 - Loss of Supply below provide detailed analyses of historical MED and LoS events, respectively.

To maintain the SAIFI trend (excluding LoS and MED), Hydro Ottawa has proposed plans for enhanced investment in degraded assets at risk of failure, feeder ties to enhance redundancy by addressing radial supply configurations, installing sectionalizing devices, feeder reconfigurations and strategic undergrounding of vulnerable overhead sections. For further details on these investments, please refer to Section 3 of Schedule 2-5-8 - System Service Investments.

4.2. SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

SAIDI represents the average interruption duration per customer and is defined as follows:

$$SAIDI = \frac{Total\ hours\ of\ customer\ interruptions}{Total\ number\ of\ customers\ served}$$

SAIDI, is reported in three ways:

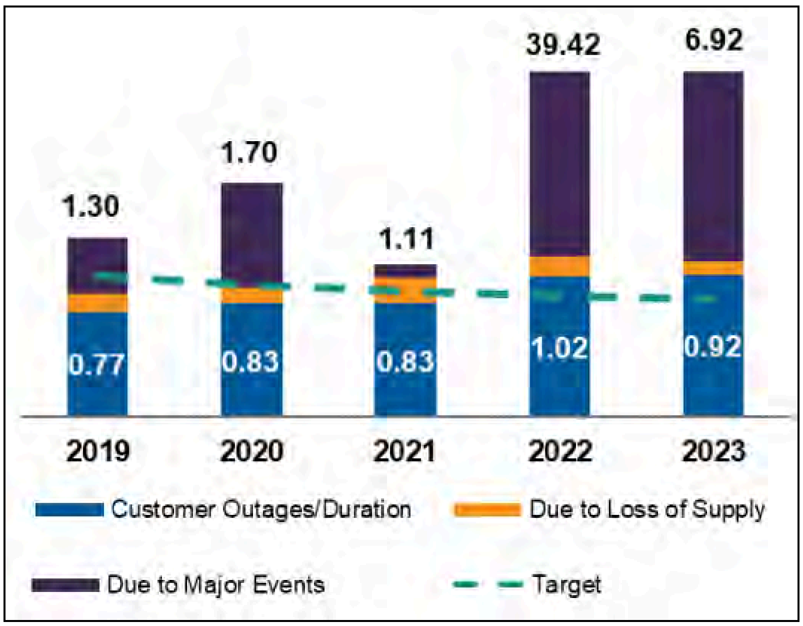
- **All Interruptions:** This includes all hours of customer interruptions, regardless of cause.
- **Interruptions Excluding Loss of Supply (LoS):** This excludes hours of customer interruptions caused by LoS events outside of Hydro Ottawa's distribution system, such as loss of supply from Hydro One.
- **Interruptions Excluding LoS and Major Event Days (MEDs):** This further refines the metric by excluding LoS and hours of customer interruptions caused by MEDs, such as severe storms, which are outside of Hydro Ottawa's control.

Excluding interruptions caused by MEDs and LoS helps to evaluate system and process performance without extenuating circumstances not fully within Hydro Ottawa's control. Hydro Ottawa's target for SAIDI is to maintain a value at or below the five-year rolling average, excluding MEDs and LoS events. This objective aligns with the OEB distributor-specific target for reliability performance. Table 19 and Figure 6 below show SAIDI performance in tabular form and in graphical form for different methods to depict Hydro Ottawa performance.

Table 19 - SAIDI Reliability Performance

KPI		2019	2020	2021	2022	2023
SAIDI	All Interruptions	1.30	1.70	1.11	39.42	6.92
	Excluding LoS	1.17	1.60	0.93	39.28	6.82
	Excluding LoS & MEDs	0.77	0.83	0.83	1.02	1.03
	SAIDI Target[14]	1.02	0.96	0.91	0.88	0.86

Figure 6 - SAIDI Reliability Performance

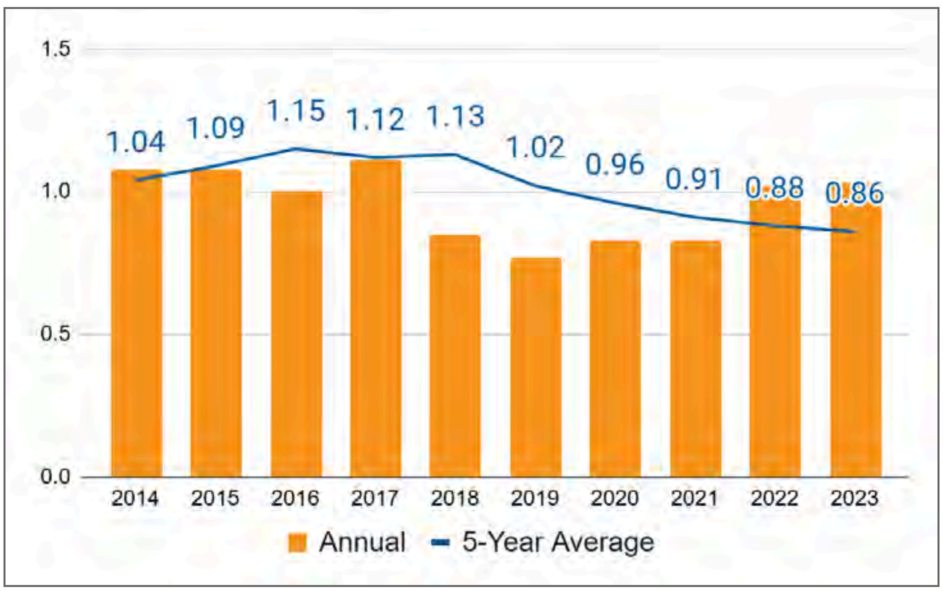


Similar to SAIFI, SAIDI, which measures the average outage duration for each customer, has also been impacted by major weather events. Excluding LoS and MEDs, SAIDI performance remained stable from 2019 to 2021. However, in 2022 and 2023, SAIDI exceeded the five-year average target by 0.14 and 0.17, with a small percentage (3%) of outages being responsible for a relatively large proportion (48%) of SAIDI. This was due to several factors, including delays in making areas safe, increased adverse weather events, need for additional fault locating equipment and resources, tree

[14] This value represents the rolling five-year historical average excluding LoS and MED.

contact, and foreign interference. These findings highlight the importance of mitigating these factors through measures such as investment in resilient infrastructure and enhanced emergency response capabilities to reduce outage duration and severity, and improve grid reliability and resilience. More details are presented below in Section 5 - Continuous Improvement. In general, the targeted infrastructure renewal projects have improved overall system reliability, which is shown by the reduction in annual targets. These targets are determined by using a rolling 5-year average SAIDI performance, excluding Loss of Supply and Major Event Days. Figure 7 shows this downward trend from 2014 to 2023.

Figure 7 - SAIDI excluding Loss of Supply and Major Event Days



Severe weather events like the 2022 Derecho and the 2023 freezing rain and thunder/hail storms caused significant disruptions, leading to a sharp increase in SAIDI. These events, categorized as MED, highlight the challenge of maintaining reliability in the face of unpredictable weather patterns. For a detailed analysis of historical LoS and MED events, please refer to Sections 3.2 - Cost Efficiency & Effectiveness and 3.1 - Customer Oriented Performance, respectively.

To enhance the system's resilience against future storms and support quicker restoration times, Hydro Ottawa is investing in targeted projects through the Distribution System Resiliency, Distribution System Reliability and Distribution System Observability programs, as a key part of its System Service investments, please refer to Schedule 2-5-8 - System Service Investments. These projects aim to mitigate the impact of major weather events on the distribution system, improving grid resilience and advancing grid technology to support faster fault identification and isolation.

To improve the SAIDI trend (excluding LoS and MED), Hydro Ottawa has proposed plans for feeder ties to enhance redundancy by addressing radial supply configurations, installing sectionalizing devices, strategic undergrounding of vulnerable OH sections, relocating lines from areas that are difficult to access, installing remote operable switches and smart fault circuit indicators. For further details on these investments, please refer to Section 3 of Schedule 2-5-8 - System Service Investments.

4.3. WORST FEEDER ANALYSIS

Hydro Ottawa uses a Feeder Performance Index (FPI) to assess the condition of its electricity distribution feeders. This index, detailed in Table 20, considers outage frequency, customer impact, and outage duration over a 12-month period.

Table 20 - Feeder Condition Description

FPI	Performance
85-100	Very Good
70-85	Good
50-70	Fair
30-50	Poor
0-30	Very Poor

Feeders with an FPI score below 30 ("Very Poor" performance) are placed on a worst-performing feeder list. The number of feeders on the worst-performing feeder list has remained relatively stable since tracking began in 2019, with a peak in 2020. Table 21 provides the number of worst-performing feeders over the past five years.

Table 21 - Worst Feeder Analysis

KPI	2019	2020	2021	2022	2023
Worst Feeder Analysis	5	8	6	7	6

Hydro Ottawa continuously monitors feeder performance to guide targeted improvements and minimize customer impact. Hydro Ottawa further addresses the poorly performing feeders through targeted investments in worst feeder betterment projects, please refer to Section 3.6.3.4 of Schedule 2-5-8 - System Service Investments, for details such as:

- Reconfiguring feeders
- Upgrading distribution protection
- Installing sectionalizing devices (reclosers, remotely operable switches)
- Adding animal guards

4.4. MAJOR EVENT DAYS

In accordance with the OEB's RRRs, Hydro Ottawa utilizes the IEEE Standard 1366 approach to identify MEDs.[15] The threshold for classifying an MED is determined annually based on the previous five years' daily SAIDI values.

Over the past five years, Hydro Ottawa has experienced 12 MEDs, as illustrated in Figure 8 below. A notable increase in MED severity was observed in 2022 compared to the preceding three years.

[15] IEEE Std 1366-2022 - IEEE Guide for Electric Power Distribution Reliability Indices.

Figure 8 - Major Event Day Threshold

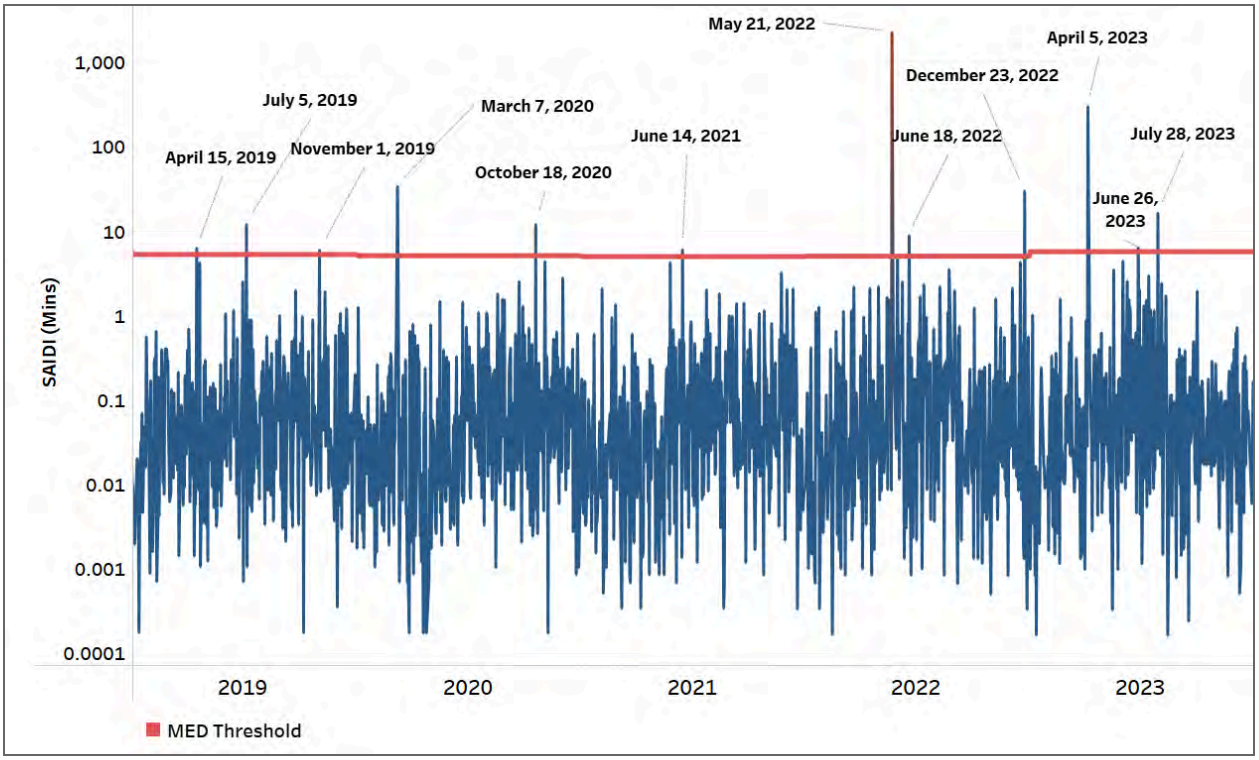


Table 22 below reveals the significant impact of MEDs on reliability over the past five years, with a particular focus on the devastating May 21, 2022 Derecho depicted in the images in Figure 9. This storm stands out as the most impactful event in Hydro Ottawa history, causing a staggering 13,367,385 customer-hours of interrupted service and a SAIDI value of 37.58 hours per customer. This far surpasses the impact of other major events, not only in the past five years but also in the history of the community.

Table 22 – 2019-2023 Major Event Day Overview

Event Date	Interruption Count	Customer		SAIDI (Mins)	Event Description
		Hours	Impacts		
2019-04-15	11	34,425	44,511	6.14	Lightning, Flooding, and Loss of Supply
2019-07-05	13	68,268	70,069	12.14	Hydro One Station derating and an interruption due to planned work
2019-11-01	22	33,805	14,228	5.98	Heavy Wind resulting in Falling Trees and Downed Power Lines
2020-03-07	1	193,888	11,686	34.05	Equipment failure resulting in a fire
2020-10-18	2	69,519	9186	12.14	Loss of Supply and Defective Equipment
2021-06-14	2	35,363	17,441	6.06	Caused by Lightning and Loss of Supply
2022-05-21	City wide	13,367,385	192,474	2,254.65	Derecho storm outages (May 21, 23, 28, 30, and 31), all of which are MEDs
2022-06-18	1	51,196	27,405	8.62	Cable Fault impacting six Hydro Ottawa substations
2022-12-23	35	179,856	67,710	29.98	Loss of Supply and Wet Snow
2023-04-05	112	1,960,834	163,448	324.96	Freezing Rain and a subsequent Loss of Supply
2023-06-26	15	38,691	15,413	6.39	Thunderstorm, Lightning and Loss of Supply
2023-07-28	28	99,360	37,821	16.40	Hailstorms resulting in Falling Trees and Downed Power Lines

Figure 9 - Damage caused by the Derecho Storm in May 2022

Given the numerous and complex drivers influencing the effects of MEDs on the distribution grid, including changing weather patterns, distribution of vulnerable assets, and regional topography, a key indicator of vulnerability is the historical record of MED impacts on regions and infrastructure. Table 23 details the distribution of MED outages between main trunk (main lines designed to handle higher loads and distribute electricity from stations to multiple lateral lines) and lateral sections (lines that branch off the main trunk to serve smaller areas and could extend radially) in the different regions of Hydro Ottawa's service territory since 2019.

Table 23 - Regional Breakdown of MED Outages between Main Trunk and Lateral since 2019

Region	Main Trunk Outage	Lateral Outage
Central	10%	11%
East	21%	15%
South	13%	16%
West	8%	6%
All Regions	**52%**	**48%**

Analysis of MED outages since 2019 indicates that approximately 52% occurred on main trunks, while the remaining 48% occurred on lateral sections. The East region experienced the highest number of main trunk outages (21%), and the South region experienced the highest number of lateral outages (16%). Analyzing the infrastructure and regions most disrupted by these outages helps guide resilience program investment, please refer to Section 3 of Schedule 2-5-8 - System Service Investments. The findings from this analysis, along with inputs from Attachment 2-5-4(E) - Resilience Investment Business Case Report and Section 6.4 of Schedule 2-5-4 - Asset Management Process, inform resilience investments to strategically improve system resilience to severe weather events.

4.5. PERFORMANCE BY CAUSE CODE

Hydro Ottawa assiduously records all power interruptions in accordance with the OEB's definitions for primary causes outlined in the OEB's RRRs. Hydro Ottawa conducts detailed root cause analysis on these interruptions, allowing for risk assessment and investment prioritization. The cause codes defined by the OEB are stated in Table 24 below.

Table 24 - OEB Definition of Cause Codes

Root Cause	Definition
0 - Unknown	Interruptions with no apparent cause
1 - Scheduled Outage	Interruption due to disconnection at a selected time for the purpose of construction or maintenance.
2 - Loss of Supply	Interruption due to problems associated with the distribution system owned and/or operated by another distributor, and/or in the transmission system.
3 - Tree Contacts	Interruption caused by faults resulting from tree contact with energized circuits except for the interruptions under the conditions described under cause code 6.
4 - Lightning	The lightning category includes all interruptions caused by lightning.
5 - Equipment Failure	Interruption resulting from the failure of distributor owned equipment due to deterioration, insufficient maintenance or defective equipment/material.
6 - Adverse Weather	Interruption resulting from severe rain, ice storms, heavy snow, severe windstorm (~90 kilometres an hour or greater), extreme temperatures, freezing rain, frost, hail or other extreme weather conditions (exclusive of cause code 4).
7 - Adverse Environment	Interruption due to distributor equipment being subject to abnormal environments, such as salt spray, industrial contamination, humidity, corrosion, vibration, fire or flooding.
8 - Human Element	Interruption due to the interface of distributor staff with the distribution system. Only interruptions caused by distributor staff should be reported under this cause code, including improper protection settings, improper system operation and improper construction & installation.
9- Foreign interference	Interruption caused by external factors, such as those caused by customer equipment, DERs not owned by distributors, animals, vehicles, dig-ins, vandalism, sabotage, foreign objects and cyber security events.

Table 25 below shows the SAIDI, SAIFI contribution by cause code over the 2019-2023 period with specific contributions broken out for number of interruptions, number of customer interruptions, and the number of customer interruption hours.

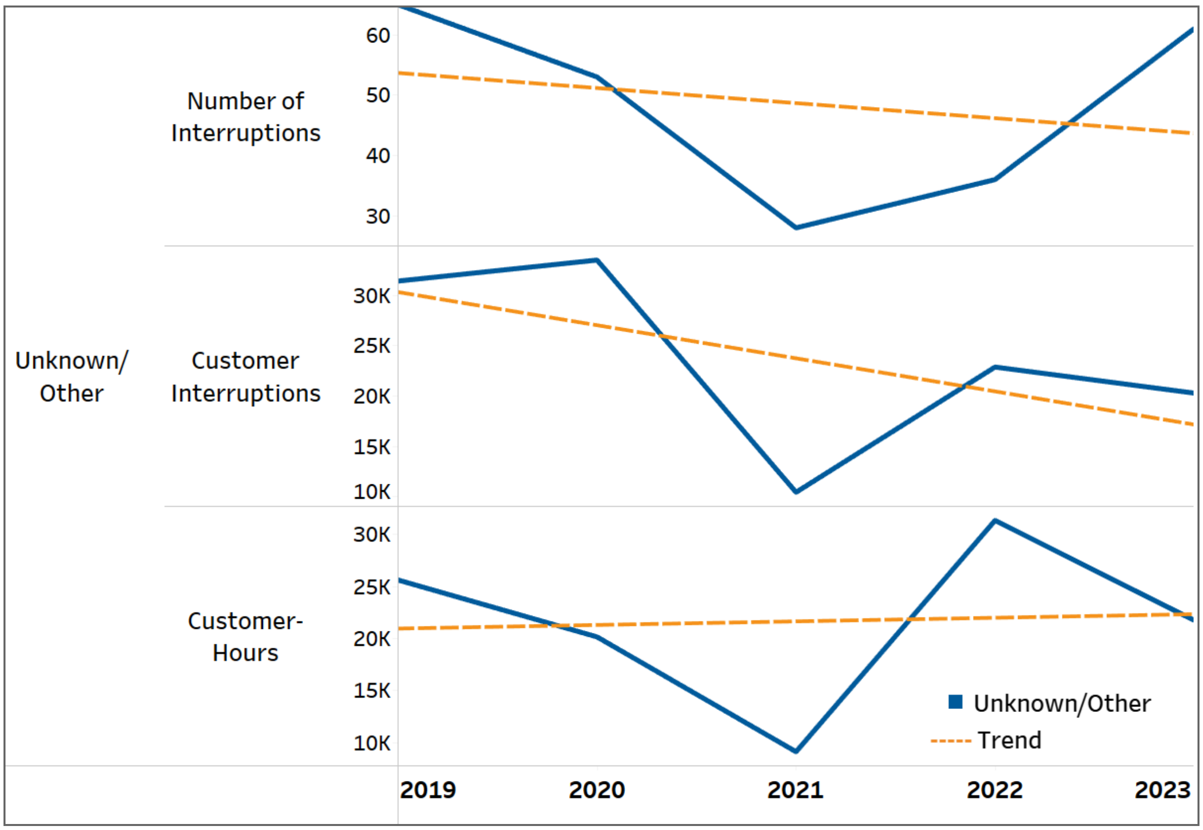
1 **Table 25 - Five-Year SAIFI and SAIDI Contribution by Outage Type (Excluding MED's)**

Code - Cause	SAIFI & SAIDI Contribution	2019	2020	2021	2022	2023
0 - Unknown	Number of Interruptions	65	53	28	36	61
	Customer Interruptions	31,447	33,536	10,420	22,886	20,294
	Customer-Hours	25,623	20,163	9,138	31,339	21,762
1 - Scheduled Outages	Number of Interruptions	645	753	740	614	550
	Customer Interruptions	13,621	22,520	17,044	20,529	29,634
	Customer-Hours	34,807	49,203	59,257	45,350	55,557
2 - Loss of Supply	Number of Interruptions	24	26	34	38	19
	Customer Interruptions	44,089	64,759	107,282	155,674	107,874
	Customer-Hours	42,548	37,565	64,603	52,284	35,794
3 - Tree Contact	Number of Interruptions	60	104	82	101	95
	Customer Interruptions	32,418	18,548	21,460	43,967	32,733
	Customer-Hours	35,526	30,671	30,337	74,967	47,158
4 - Lightning	Number of Interruptions	21	27	16	9	22
	Customer Interruptions	24,659	12,188	11,031	7,008	18,931
	Customer-Hours	8,284	6,797	13,883	3,812	15,713
5 - Equipment Failure	Number of Interruptions	262	265	247	209	158
	Customer Interruptions	64,747	94,236	65,871	100,769	43,302
	Customer-Hours	79,803	104,622	97,052	144,848	84,798
6 - Adverse Weather	Number of Interruptions	13	6	11	10	41
	Customer Interruptions	3,671	1,393	10,706	4,285	13,228
	Customer-Hours	4,237	4,750	7,511	5,852	34,915
7 - Adverse Environment	Number of Interruptions	9	4	9	3	2
	Customer Interruptions	1,327	197	8,740	221	1,243
	Customer-Hours	2,190	475	9,754	530	2,436
8 - Human Element	Number of Interruptions	23	9	17	14	11
	Customer Interruptions	33,391	8,267	19,019	11,109	28,727
	Customer-Hours	16,452	1,508	13,139	3,720	33,600
9 - Foreign Interference	Number of Interruptions	208	177	151	109	169
	Customer Interruptions	47,360	55,962	53,375	36,416	41,057
	Customer-Hours	51,891	65,971	48,916	54,714	77,856

4.5.1. Unknown/Other

Figure 10 provides a visual representation of the trend in outages caused by unknown/other (excluding MEDs) over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year.

Figure 10 - Unknown/Other Historical Trends

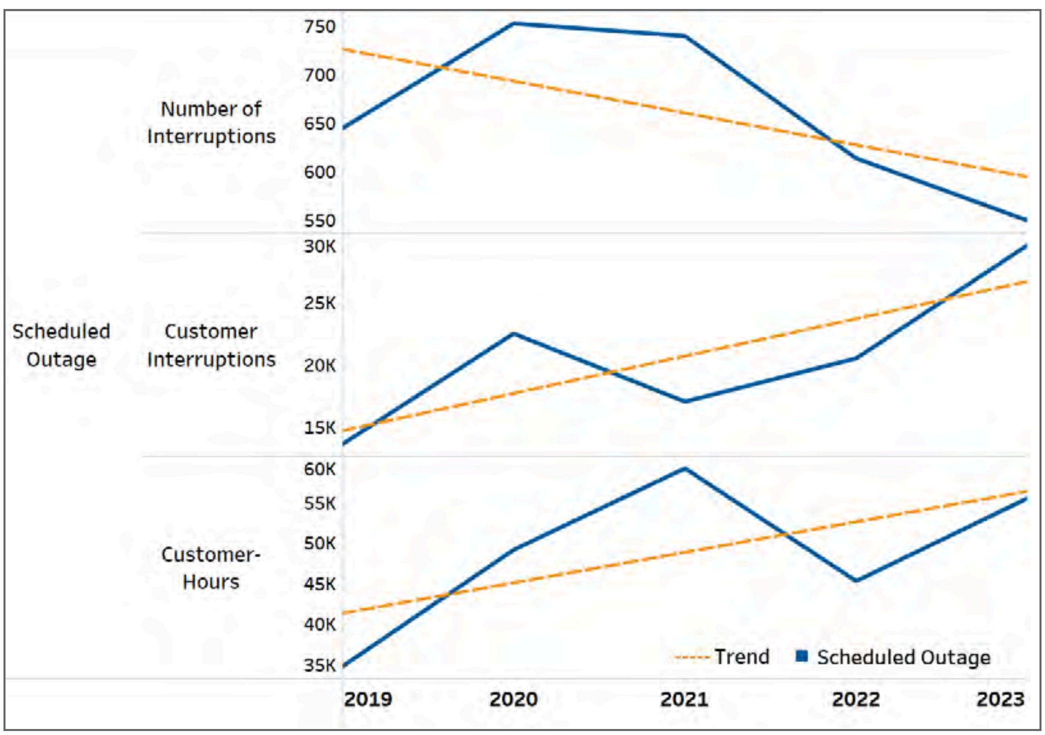


Outages due to Unknown/Other are on a slightly decreasing trend over the last five years with an increase of occurrences in 2023, Hydro Ottawa strives to identify the root causes of unknown outages through line patrols and fault point analysis, however, there are occasions where the cause cannot be identified leading to outages being classified as Unknown/Other. Investment in observability technology under the Distribution System Observability program will lead to a decrease in Unknown/Other outages as more data becomes available for pinpointing and assessing root cause. For more information on observability investments please refer to Section 3.5.4 of Schedule 2-5-8 - System Service Investments.

4.5.2. Scheduled Outages

The OEB defines a Scheduled Outage as a customer interruption due to disconnection at a selected time for the purpose of construction or maintenance. These outages include maintenance and construction work to maintain the assets, as well as, repair work and vegetation management to address the aftermath of MEDs and other events. Figure 11 presents trending for scheduled outages leading to customer interruptions over the past five years. The trends include the number of interruptions, the number of customers interrupted, and the total customer interruption hours.

Figure 11 - Scheduled Outage Historical Trend



While the number of interruptions has decreased, as a result of improved work planning, both the number of customers interrupted and the total customer interruption hours have increased. These increases are primarily attributed to:

- **Major infrastructure upgrades:** Complex riser rebuilds and pole replacements for radial lines, close to highways and in backyards which results in longer outage duration and customer impact.
- **Power restoration activities:** Forced switching and sectionalizing to allow for attending to emergencies such as pole fires and major events.
- **Post-storm recovery:** Extensive vegetation management, with the need to trim outside of the regular trim zone due to vegetation damage from storms.

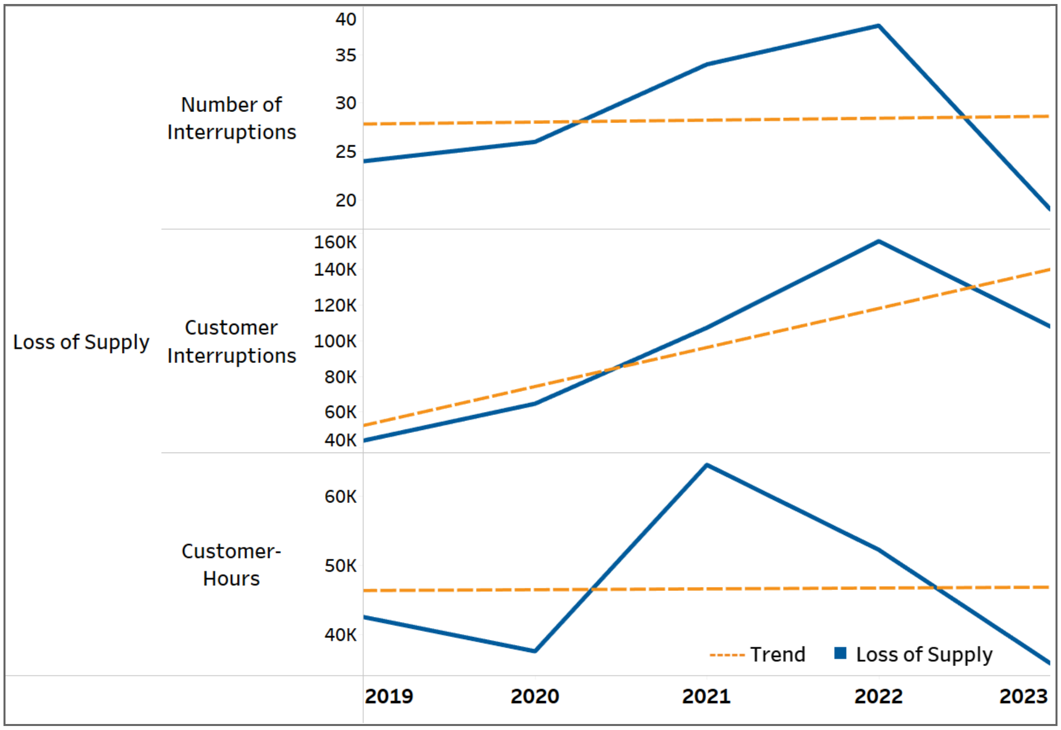
These drivers highlight the lasting impact of major weather events on the distribution system and the ongoing need to maintain and replace deteriorating infrastructure which drives further work.

To mitigate the impact of scheduled outages, Hydro Ottawa endeavours to install temporary switches and employ live-line work methods to reduce the number of affected customers whenever possible. However, due to feeder configuration, some planned work necessitates extended outages. To address this, Hydro Ottawa is taking proactive steps, as part of this application, by planning to reconfigure high-risk radial lines and strategically increase control points to reduce the impact of future planned outages. Refer to Section 3 of Schedule 2-5-8 - System Service Investments for more details.

4.5.3. Loss of Supply

The OEB defines LOS as customer interruptions due to problems associated with the distribution system owned and/or operated by another distributor, and/or in the transmission system. These outages are attributed to issues upstream with Hydro Ottawa's transmission provider, Hydro One. Figure 12 presents trending for LOS (excluding MEDs) leading to customer interruptions over the past five years. The trends include the number of interruptions, the number of customers interrupted, and the total customer interruption hours.

Figure 12 - Historical SAIFI and SAIDI Contribution from LOS Outages



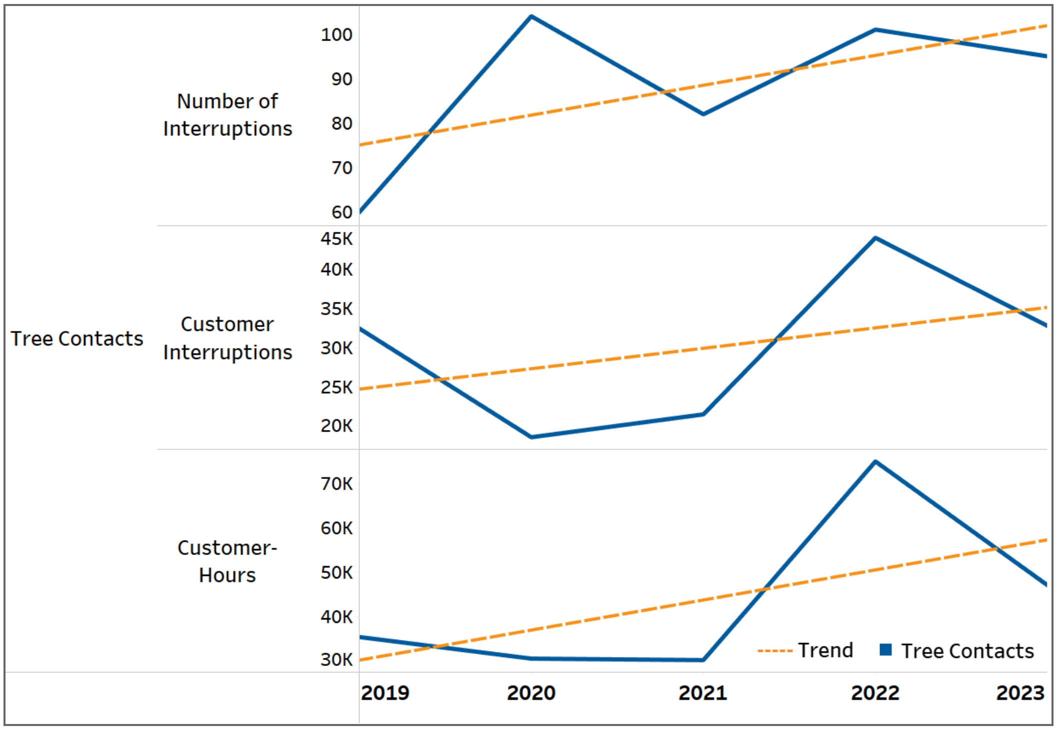
Over the past five years, Hydro Ottawa has maintained relatively stable performance in managing LoS events, particularly with respect to the number of interruptions and customer interruption hours. However, the number of customers affected has trended upward, due to LoS events impacting circuits and stations serving larger customer bases. A notable spike occurred in 2022, with significant increases in both the number of interruptions and customer interruptions, resulting from a surge in LoS events affecting densely populated areas. In 2021, customer interruption hours were significantly impacted by a single LoS event caused by Hydro One crews inadvertently tripping one of Hydro Ottawa's supply stations. Given the projected increase in severe weather events, as discussed below in Section 6.4 - Current and Future Climate, LoS events are expected to continue.

Hydro Ottawa actively monitors and analyzes LoS-related interruptions to proactively identify and address supply reliability issues and minimize customer impact. The primary mitigation strategy involves collaborating with Hydro One through recurring meetings and the Integrated Regional Resource Process (IRPP). This collaboration focuses on Hydro One's investigation and subsequent infrastructure maintenance and upgrades to support Hydro Ottawa's needs. Additionally, Hydro Ottawa explores opportunities to reduce LoS impact through distribution system mitigation like the installation of tie switches between feeders to reduce the impact of LoS events though partial load transfers to unaffected feeders. These improvements are considered opportunistically within other projects under the Distribution Enhancements Program. For further details, please refer to Section 3 of Schedule 2-5-8 - System Service Investments.

4.5.4. Tree Contacts

The OEB defines Tree Contacts as customer interruption caused by faults resulting from tree contact with energized circuits except for the interruptions under the conditions described under Adverse Weather and excluding MEDs. Figure 13 below is a visual representation of the trend in outages caused by tree contacts over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year.

Figure 13 - Tree Contacts Outage Historical Trend



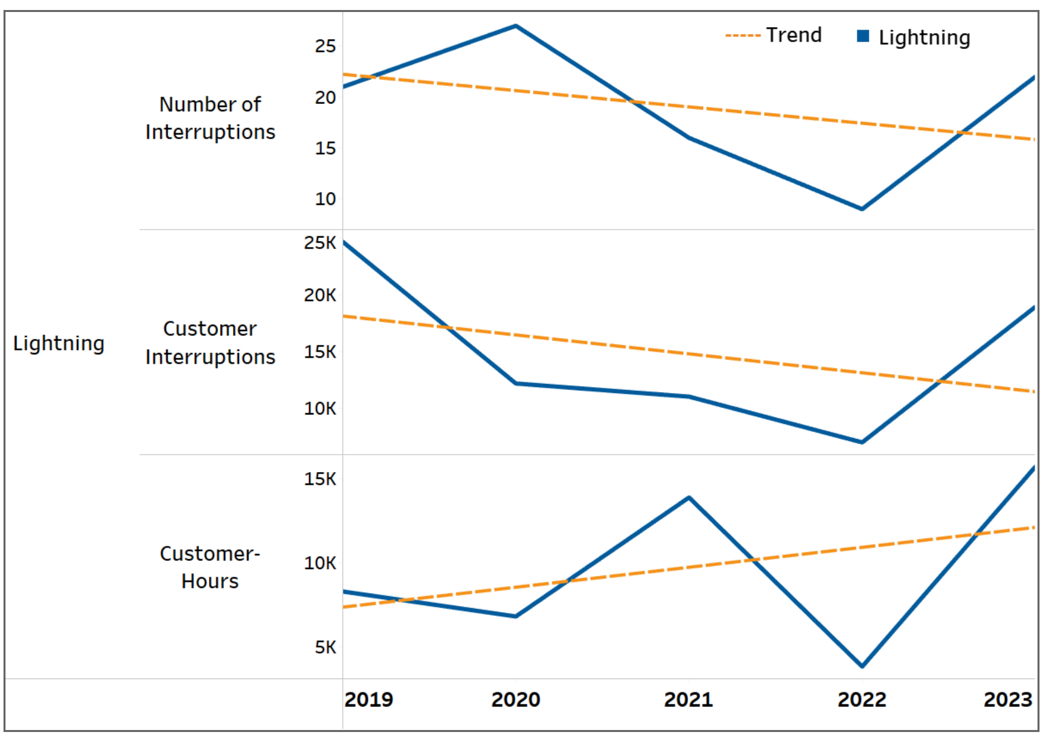
Hydro Ottawa experienced a sharp increase in tree-contact outages in both 2020 and 2022. The 2022 outages were particularly disruptive for customers, impacting both the number of customers affected and the duration of their outages. This disruption stemmed from the lingering effects of the 2022 Derecho Storm on the tree canopy, compounded by other storms (not classified as MEDs) and tree contact with main trunk lines. Contact with main trunk lines (the primary arteries for electricity flow) resulted in widespread customer outages.

To mitigate the impact of tree contacts, Hydro Ottawa has adopted Overstory, a software solution that optimizes vegetation management. Overstory uses Artificial Intelligence (AI) and remote sensing data, such as satellite and aerial imagery, to map vegetation within Hydro Ottawa's service area. Additional information on the application of Overstory is outlined in Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement. Furthermore, increased investment in vegetation management through the OM&A Program, please refer to Section 3.2 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs, is enabling Hydro Ottawa to address the heightened vegetation management needs following severe weather events. This enhanced approach allows Hydro Ottawa to better manage the risk of tree-related outages and improve the reliability of power delivery, even with the rising prevalence of severe weather.

4.5.5. Lightning

The OEB defines all interruptions caused by lightning excluding MEDs as lightning causes. Figure 14 provides a visual representation of the trend in outages caused by lightning over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year, offering insights into how lightning impacts Hydro Ottawa's service reliability.

Figure 14 - Lightning Historical Trend

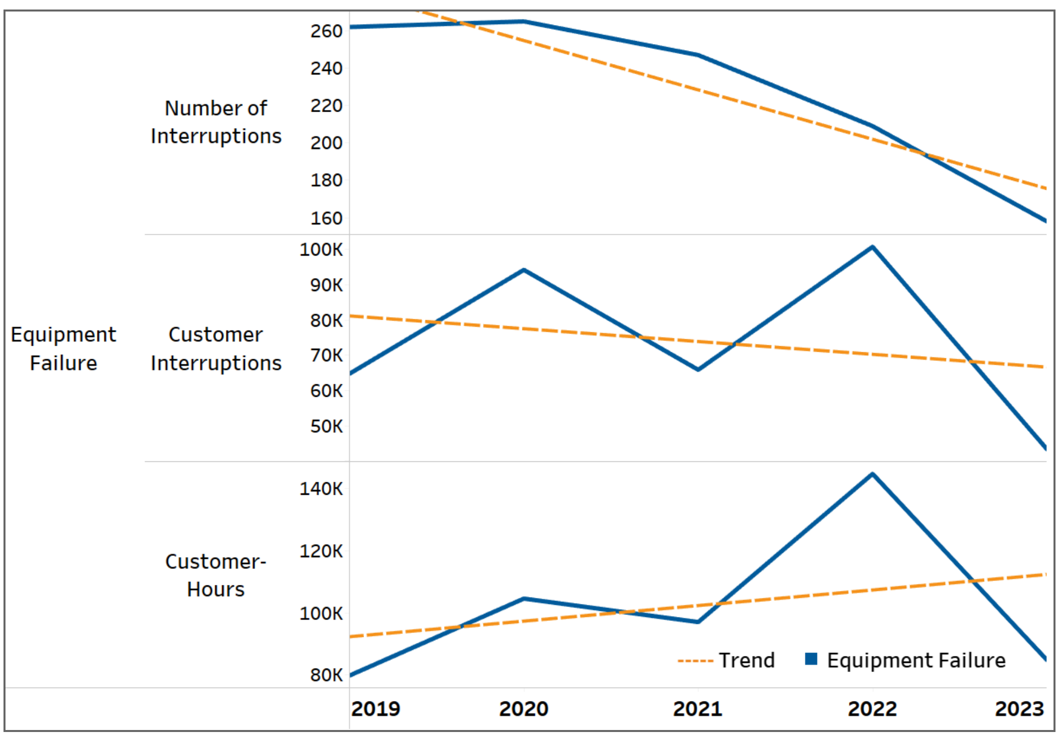


Outages caused by lightning strikes are generally decreasing. Hydro Ottawa proactively mitigates the impact of lightning on its system through robust system design and the application of lightning protection and shielding measures in designs. These measures help to minimize the number and duration of outages caused by lightning, contributing to improved system reliability.

4.5.6. Equipment Failure

The OEB defines Equipment Failure as Customer Interruption resulting from the failure of distributor owned equipment due to deterioration, insufficient maintenance or defective equipment/material. Figure 15 shows equipment failure trends over the last five years with respect to the number of interruptions, number of customers interrupted and customer interruption hours.

Figure 15 - Equipment Failure Historical Trend



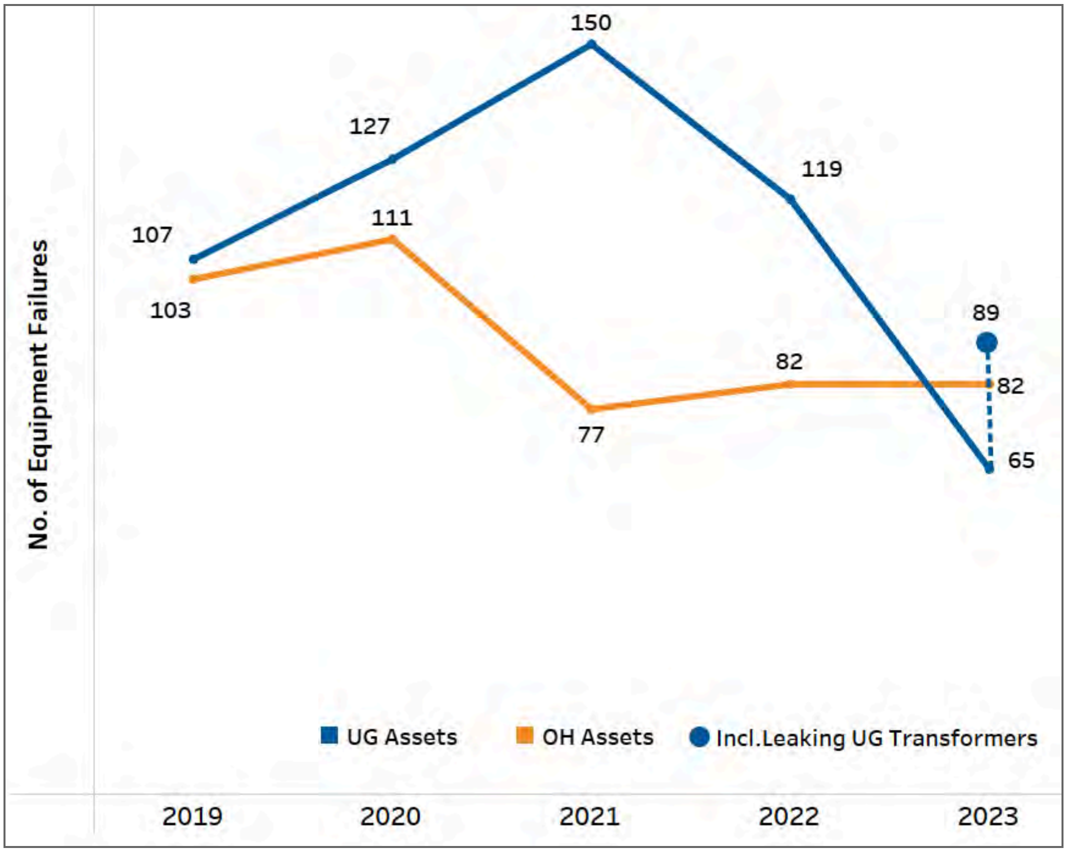
Hydro Ottawa has observed a decline in equipment failure-related outages since 2020, attributed to enhanced maintenance programs and asset condition assessments. To further mitigate equipment failures as asset deterioration progresses, an enhanced asset risk assessment framework has been implemented to determine asset replacement needs over the next five years. This framework utilizes Predictive Analytics, incorporating data from condition assessments and asset failure curves, to assess the risk of failure, for details please refer to Section 5.1.4 of Schedule 2-5-4 - Asset Management Process. The risk-based approach, combined with analysis of observed failures of specific asset types, has informed investment proposals for targeted renewals. For further details, please refer to Schedule 2-5-7 - System Renewal Investments and for enhanced maintenance programs, please refer to Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. Furthermore, the Distribution System Observability Program as outlined in Section 3.5.4 of Schedule 2-5-8 - System Service Investments aims to improve the detection, localization, and restoration of failed equipment through the deployment of additional observation devices.

4.5.6.1. Equipment Failure by Asset Orientation

Building on the strategy of a Predictive Analytics supported risk assessment framework, a detailed analysis of different equipment types and their associated failure modes can provide valuable insights for informing mitigation strategies.

Figure 16 below provides a closer look at equipment failure trends, specifically analyzing failures based on asset orientation (overhead versus underground).

Figure 16 - Equipment Failure by Asset Orientation



Overhead and underground assets face different stressors and thus will have different failure drivers. Analysis of the failure trend for underground and overhead assets reveals a peak in underground (UG) asset failures in 2021, followed by a decrease in 2022. This peak was primarily driven by an investigation into leaking transformers from a specific manufacturer, which led to a significant equipment replacement program.

In 2023, leaking transformers were reclassified as scheduled outages, resulting in a notable drop in UG equipment failures recorded for that year as equipment replacement to address leaking transformers continued to be reported under the Schedule Outage category. The inclusion of leaking transformers under the Equipment Failure category would have resulted in 42 UG transformer-related outages in 2023, resulting in a consistent trend.

4.5.6.2. Equipment Failure by Asset Orientation & Asset Type

A more granular analysis of equipment failures, based on both asset type and orientation, can highlight asset types requiring closer attention. Table 26 presents equipment failure trends from 2019 to 2023, categorized by asset orientation (overhead vs. underground) and specific equipment type. This detailed breakdown provides a deeper understanding of the factors contributing to equipment failures and outages.

Table 26 - Equipment Failure by Primary Apparatus

Primary Apparatus	2019	2020	2021	2022	2023
OH Conductor	17	21	13	9	24
OH Switchgear	34	46	27	26	25
OH Transformers	34	26	19	24	20
Pole	4	6	7	8	2
Pole Attachment	14	12	11	15	11
UG Cable	63	44	48	51	34
UG Cable Attachment	8	12	7	8	8
UG Switchgear	1	2	1	6	3
UG Transformers	34	67	92	49	41 (24 leakers)
Vault Equipment	1	2	2	5	3

Table 26 reveals several key trends in equipment failures. While UG cable failures decreased significantly in 2023, following a steady trend since 2020, overhead (OH) conductor failures saw a slight increase compared to 2022. The increase in OH conductor failures reflect the impact of extreme weather events in 2023, compounded by the ongoing deterioration of overhead infrastructure. The data also indicates that UG transformers, UG cables, and OH switchgear experienced the highest number of failures between 2019 and 2023.

To address these issues, Hydro Ottawa has dedicated renewal programs, which will continue through 2026-2030. Also, based on the information gathered through preventative maintenance, the Emergency Renewal program shall cover the replacement of leaking transformers, to reduce the proportion of known leakers.

The proportion of UG cross linked polyethylene (XLPE) cables in a deteriorated condition is projected to increase from 36.4 km in 2024 to 336 km in 2030, necessitating significant investments, as outlined in Section 2.3.2 of Schedule 2-5-1 - Distribution System Plan Overview. Hydro Ottawa has adopted a forward looking approach to reduce the burden on customers by proposing investments in the UG cable renewal program to maintain system reliability and manage the remaining proportion of deteriorating infrastructure through corrective renewal investments and improvements to preventative maintenance programs as outlined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

The proposed UG distribution asset renewal spend can be found in Section 4 of Schedule 2-5-7 - System Renewal Investments and specifics on the Emergency Renewal program in Section 6 of Schedule 2-5-7 - System Renewal Investments. Additionally, the observed trend in OH switchgear failures has led to increases to the renewal program for this asset type, as detailed in Section 3.5.2 of Schedule 2-5-7 - System Renewal Investments.

4.5.6.3. Unplanned Asset Replacements

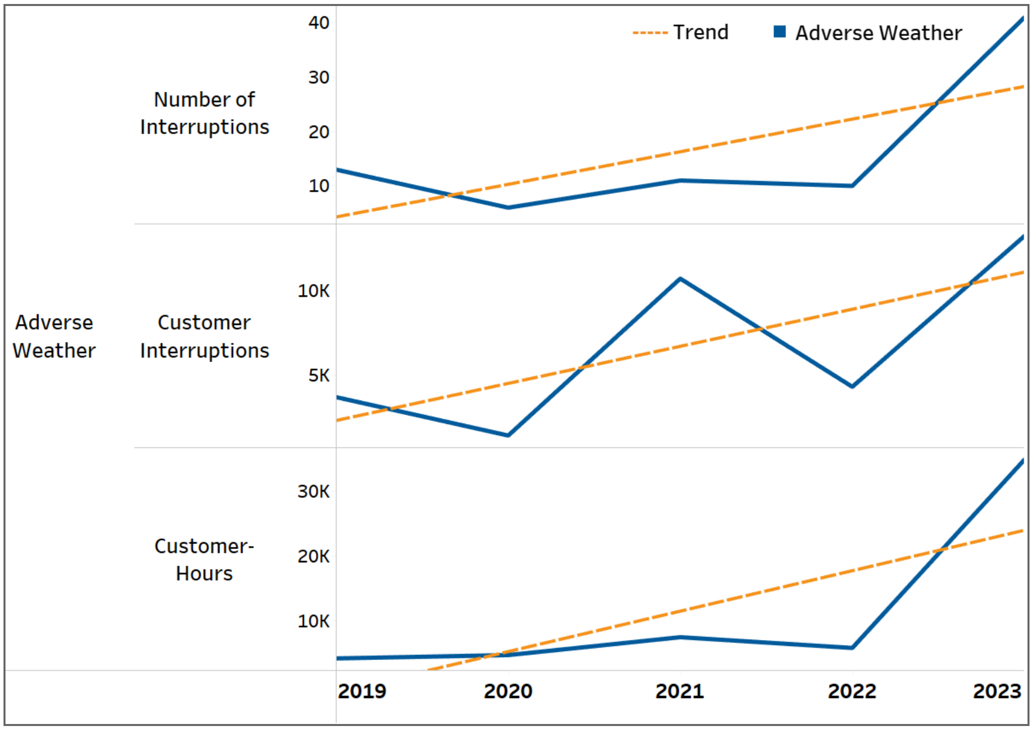
Not all equipment failures cause an outage to customers. Hydro Ottawa's proactive approach to addressing functionally deteriorated assets before they fail has supported the decreasing reliability trend in the number of equipment failures, whereas there is still the impending risk of failure of assets in poor or very poor condition. Corrective renewal, an asset intervention/replacement investment program, is prompted by specific risks that could compromise the asset's performance or system reliability, informed by the routine maintenance programs and subsequent asset condition assessment/health indexing. This means that assets that pose an immediate or imminent risk of failure are replaced or remediated before they cause an unplanned outage. The information gathered through preventative maintenance programs has been instrumental in this regard and Hydro Ottawa will continue to make further improvements in the OM&A programs through 2026-2030, as outlined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. Further information on Hydro Ottawa's asset condition assessment framework is provided in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process. Further details on Hydro Ottawa's Corrective Renewal program can be found in Section 6 of Schedule 2-5-7 - System Renewal Investments.

4.5.7. Adverse Weather

The OEB defines Adverse Weather as a customer interruption resulting from severe rain, ice storms, heavy snow, severe windstorm (~90 kilometres an hour or greater), extreme temperatures, freezing rain, frost, hail or other extreme weather conditions excluding lightning and MEDs.

Figure 17 below provides a visual representation of the trend in outages caused by adverse weather over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year, offering insights into how weather impacts Hydro Ottawa's service reliability.

Figure 17 - Adverse Weather Historical Trend



Outages attributed to adverse weather have been on the rise over the past five years. These outages are primarily caused by extreme winds, wet snow and ice accumulation, and freezing rain, which can damage overhead equipment and disrupt service.

To address this growing concern, Hydro Ottawa analyzes these weather-related outages, along with those occurring during MEDs, to identify vulnerable infrastructure and prioritize projects that enhance system resilience. These projects, which are part of the broader resiliency program, are informed by several key resources:

- **Resilience Investment Business Case Report (Attachment 2-5-4(E)):** This study provides insights into the potential benefits and costs of strategically relocating vulnerable overhead infrastructure underground.

- **Section 6.4: Historic and Future Climate (Schedule 2-5-4 - Asset Management Process):** This section assesses the potential impact of climate change on the distribution system and helps identify areas that may require increased resilience measures.

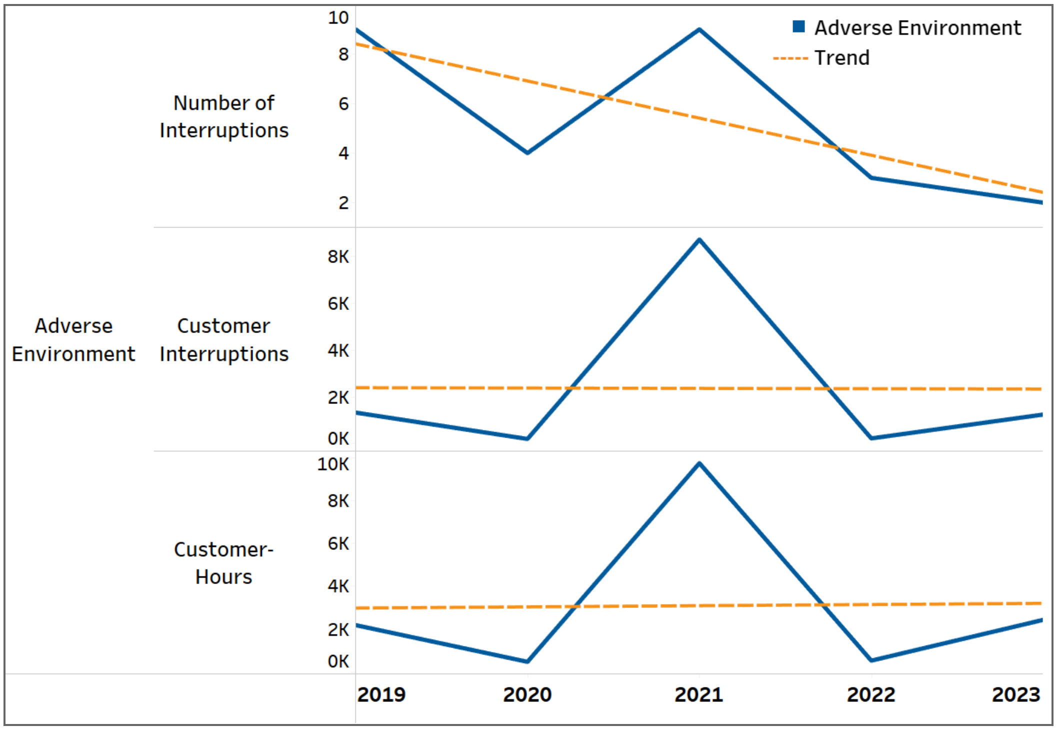
- **Section 3: Distribution Enhancement (Schedule 2-5-8 - System Service Investments):** This section outlines specific projects and initiatives aimed at improving the overall resilience of the distribution system, including targeted upgrades and undergrounding.

By leveraging these resources and analyzing outage data, Hydro Ottawa is proactively working to mitigate the impact of adverse weather on its system and improve service reliability for customers.

4.5.8. Adverse Environment

The OEB defines interruptions from Adverse Environment as customer interruption due to distributor equipment being subject to abnormal environments, such as salt spray, industrial contamination, humidity, corrosion, vibration, fire or flooding (excluding MEDs). Figure 18 below provides a visual representation of the trend in outages caused by adverse environmental factors over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year, offering insights into how environmental factors impact Hydro Ottawa's service reliability.

Figure 18 - Adverse Environment Historical Trend

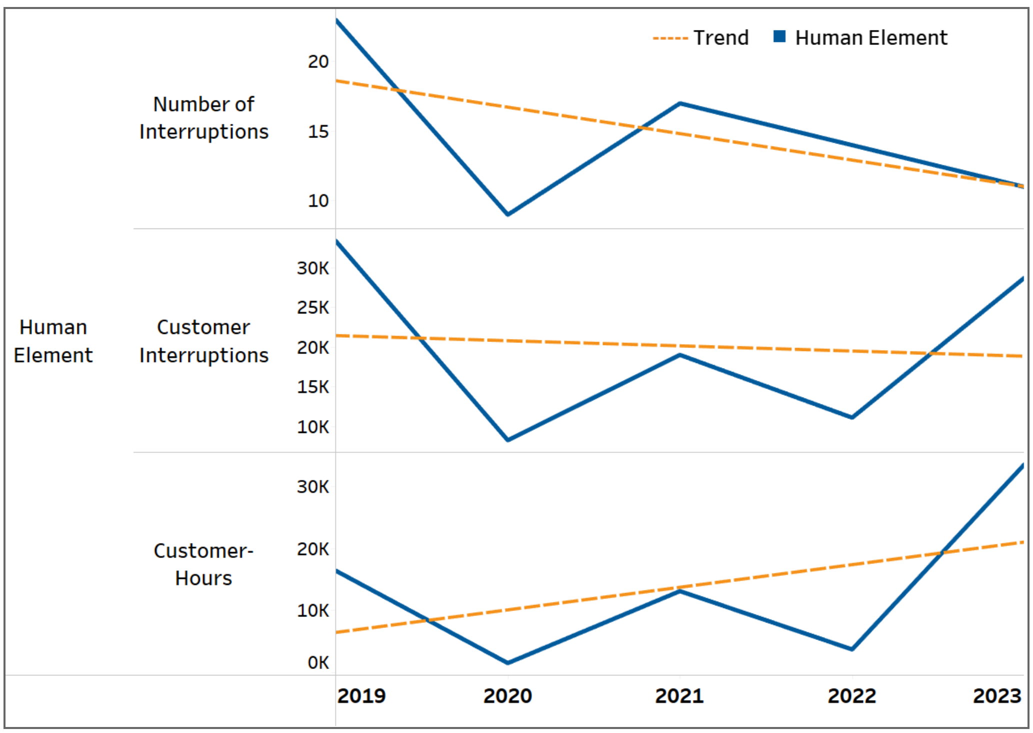


Outages caused by adverse environmental conditions have shown a declining trend over the past five years. Historically, these outages were largely attributed to pole fires resulting from salt contamination on insulators, a by-product of the City of Ottawa's winter de-icing efforts. The maximum impact/peak in 2021 was due to two outage events (one due to a fire started by grass/vegetation beneath a pole and the other related to a pole fire from salt contamination). To primarily mitigate the risk of pole fires, Hydro Ottawa has implemented a bi-annual insulator wash program to remove salt and other contaminants. Additionally, the ongoing renewal and replacement of older insulators with polymer insulators and prompt clearing of vegetation around poles further reduces this risk.

4.5.9. Human Element

The OEB defines interruptions from Human Elements as customer interruption due to the interface of distributor staff with the distribution system. Only interruptions caused by distributor staff should be reported under this cause code, including improper protection settings, improper system operation and improper construction & installation. Figure 19 shows human element trends over the last five years with respect to the number of interruptions, number of customers interrupted and customer interruption hours.

Figure 19 - Human Element Outage Historical Trend



The high number of interruptions Hydro Ottawa experienced in 2019 were primarily caused by commissioning and switching errors, which have since been addressed and prevented. Despite a general downward trend in human-caused outages since 2019, Hydro Ottawa experienced a peak in customer impact (measured in both hours and number of customers affected) in 2023. This was attributed to two major outages: one stemming from an out-of-phase system condition and another triggered by a Dual Element Supply Network (DESN) station alarm issue. Root cause analysis has been conducted for both these incidents, and system-wide measures have been implemented to prevent similar occurrences.

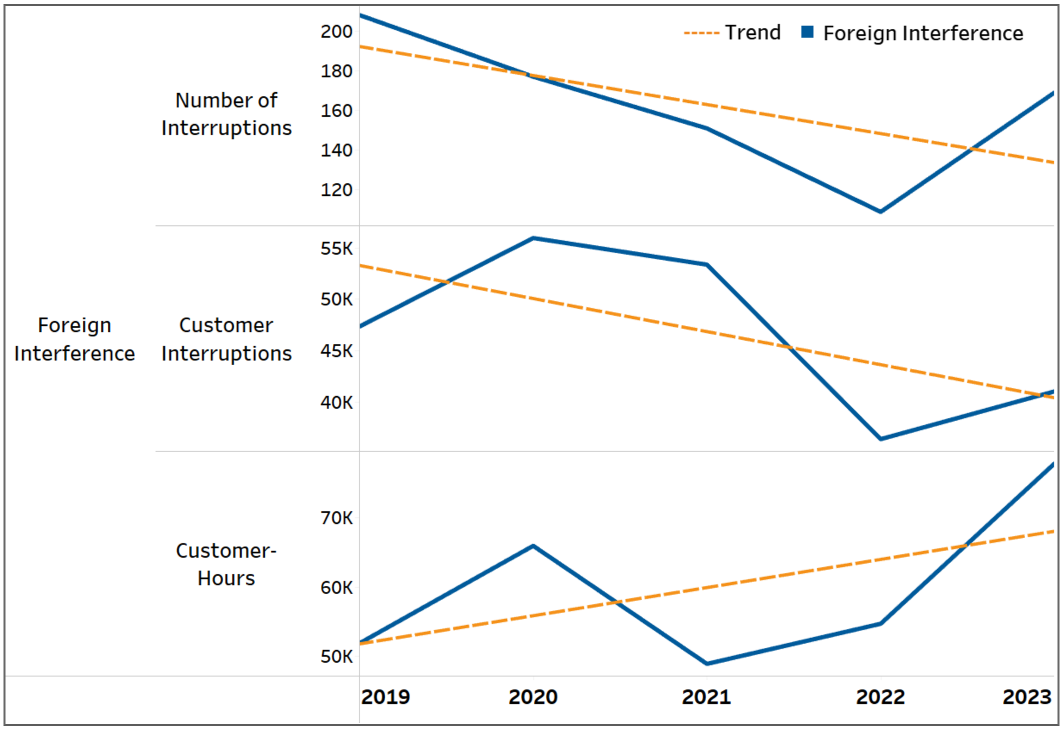
To mitigate further occurrences, Hydro Ottawa is committed to continued collaboration with its contractors to ensure that work methods, training, and internal procedures are all current and aligned with best practices.

4.5.10. Foreign Interference

The OEB defines an outage caused by Foreign Interference as a customer interruption caused by external factors, such as those caused by customer equipment, DERs not owned by distributors, animals, vehicles, dig-ins, vandalism, sabotage, foreign objects and cyber security events excluding MEDs.

Figure 20 provides a visual representation of the trend in outages caused by foreign interference over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year, offering insights into how foreign interference impacts Hydro Ottawa's service reliability.

Figure 20 - Foreign Interference Historical Trend



While foreign interference outages show a general downward trend in the number of interruptions and customers affected, there was a notable spike in 2023. Additionally, the overall duration of these outages has been increasing, suggesting that individual incidents cause longer service disruptions.

The majority of foreign interference customer interruptions can be attributed to animal contact. To address this Hydro Ottawa is making targeted investments through its Worst Feeder Betterment program to install animal guards on equipment in areas prone to such incidents. For further details, please refer to Section 3 of Schedule 2-5-8 - System Service Investments. In addition to this, continued efforts by the damage prevention team to avoid dig-ins, along with a sustained focus on cyber security, contribute to preventing other forms of foreign interference. This proactive approach aims to reduce outages caused by foreign interference, ultimately improving system reliability and customer experience.

5. CONTINUOUS IMPROVEMENT

Hydro Ottawa is committed to enhancing system reliability and resilience, particularly in the face of deteriorating infrastructure, increasing climate-related challenges (e.g., the May 2022 Derecho storm) and increasing demand. As highlighted in Schedule 2-5-4 - Asset Management Process, a significant portion of the existing infrastructure is nearing or exceeding Typical Useful Life (TUL), increasing the risk of equipment failures and service disruptions.

Hydro Ottawa's continuous improvement initiatives are guided by the KPIs outlined in Section 3 and Section 4. These initiatives focus on mitigating the risks associated with deteriorating infrastructure and improving system resilience against extreme weather events.

A summary of Continuous Improvement Initiatives is as follows:

- **Post-Derecho Review:** A comprehensive review of the storm response identified key successes, lessons learned, and recommendations to strengthen Business Continuity Management and incident response. This analysis forms the foundation for ongoing process optimization. The report is available in this Application as Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report.
- **Enhancing Resilience:** Recognizing the increasing frequency and intensity of weather events in Ottawa, Hydro Ottawa has made enhancing grid resilience a priority. In 2019, a consultant completed a Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, which was reaffirmed following the 2022 Derecho, providing a foundation for understanding and addressing climate-related risks. In 2023, a consultant conducted a grid resilience assessment and proposed undergrounding investments in the Resilience Investment Business Case Report. However, due to the potential impact on customer rates, Hydro Ottawa developed guidelines with specific criteria to determine when undergrounding is critical. These guidelines also outline alternative measures to enhance

resilience when undergrounding is not the most cost-effective solution, such as line reinforcement, feeder reconfiguration, station egress undergrounding, and line relocation. Please refer to Section 6.4 of Schedule 2-5-4 - Asset Management Process for more details including the Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan and Resilience Investment Business Case Report.

- **Proactive Asset Management:** Hydro Ottawa is implementing proactive measures such as:
    - Prioritizing the replacement of deteriorating assets at risk of failure through a robust Capital Investment Planning Process, as outlined in Section 5 of Schedule 2-5-4 - Asset Management Process.
    - Continued improvements to the UG cable maintenance program and monitoring of performance/condition based on the Very Low Frequency (VLF) Tan-Delta, Partial Discharge and Time Domain Reflectometry test methods to better understand UG cable condition and regional degradation patterns, to manage the condition and risk projections accordingly, as outlined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.
    - Comprehensive testing, inspection, and maintenance programs, as defined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs, which ensure the longevity of distribution assets and identify any necessary corrective actions.
    - More accurate asset condition assessments, with a focus on continuous improvement of data collection and analysis.
    - Increased inspection and replacement of deteriorating underground transformers to reduce environmental risks, incorporating lessons learned from previous incidents.
- **Data-Driven Decision Making:**
    - Hydro Ottawa implemented Predictive Analytics to forecast equipment degradation and optimize system renewal investments based on each individual asset condition and risk (considering reliability, safety, environmental, financial and compliance risk measures) for the 2026-2030 period, contributing to a data-driven continuous improvement cycle. Please refer to Section 5.1.4 of Schedule 2-5-4 - Asset Management Process for further details.

 - To address the potential for data misinterpretation due to fluctuations in asset population, Hydro Ottawa has implemented a more nuanced perspective on asset health. Data-driven asset failure curves (implemented as a part of Predictive Analytics) are utilized for capital investment planning, in forecasting asset degradation patterns. These curves forecast asset degradation over time and provide valuable insights into asset performance trends. A detailed report on this asset failure curve analysis is available in Attachment 2-5-4 (D) - Failure Curves Review.
 - Root cause analysis of equipment failures informs targeted maintenance and replacement strategies, facilitating proactive identification and resolution of recurring issues.
- **Adoption of Station and Feeder Load Index:** Hydro Ottawa has refined its approach to assessing station and feeder capacity. While historically, four KPIs were used — Stations Exceeding Planning Capacity, Stations Approaching Rated Capacity, Feeders Exceeding Planning Capacity and Feeders Approaching Rated Capacity — Hydro Ottawa has adopted the Station Load Index and Feeder Load Index to provide a more comprehensive and simple evaluation. Further details regarding the methodologies for these indices can be found in Section 8.4 of Schedule 2-5-4 - Asset Management Process.
- **Strengthened Internal Governance:** Hydro Ottawa has reinforced its internal financial reporting and controls for capital programs, with a focus on transparency and accountability. Monthly program and portfolio meetings ensure collaborative discussions and data-informed decision-making for project optimization, aligning corporate and OEB objectives. Further details can be found in Schedule 2-5-4 - Asset Management Process and in Schedule 1-3-4 - Facilitating Innovation & Continuous Improvement.
- **Productivity Management:** Recognizing the significance of pole and cable renewal programs, Hydro Ottawa is committed to optimizing program efficiency. This includes tracking unit costs to identify constraints, proactively mitigate risks, and ensure fiscally responsible resource management. New KPIs are being implemented to support monitoring, transparency, and continuous improvement in productivity. Further details can be found in Schedule 1-3-4 - Facilitating Innovation & Continuous Improvement.

- **Improving Outage Restoration:** Based on analyzing the reliability trends between 2019 and 2023, Hydro Ottawa has observed an overall increase in the annual outage duration aspect, despite a decrease in the number of customer interruptions and outage count (with the SAIDI targets not met in 2022 and 2023). Overall, the 5-year averages of both SAIDI and SAIFI have been declining since 2014, indicating a positive trend.

When analyzing the factors impacting SAIDI, Hydro Ottawa has observed:

- Delays in making the outage area safe (coordinating with the City of Ottawa and Emergency Services);
- Increase in adverse weather events (not classified as MEDs) requiring increased patrolling and safety measures prior to restoration;
- Need for more fault locating equipment and SCADA switches;
- Tree contact due to deteriorating vegetation outside of the regular trim zones (requiring additional support and time for clearing); and
- Foreign interference due to motor vehicle accidents and failure of customer owned equipment causing delays in restoration due to the coordination involved.

The number of customer interruptions (measured through SAIFI) have continued to improve due to the prioritization of asset renewals in a deteriorated condition that impact system reliability and factors such as continued improvements to protection coordination, feeder reconfigurations, improving redundancy etc.

As a part of continuing to reduce outage restoration times, Hydro Ottawa is proposing investments in the Distribution Enhancements program, with the following intended benefits:

- **Faster Restoration Times**: Distribution enhancements like automated switches, additional feeder ties, and system reconfiguration provide system operators with more options for isolating outages and restoring load. This leads to faster restoration times and reduces the duration of outages for customers.

- **Backup Supply Options**: Feeder ties and network reconfiguration provide backup supply options during contingency scenarios, such as equipment failures or storm damage. This ensures that customers can be re-energized more quickly, even if part of the system is damaged.
- **Improved System Observability**: Enhancements to system observability allow for real-time monitoring of distribution asset performance. This enables early detection of issues, proactive intervention to prevent failures, and more efficient outage response and troubleshooting.
- **Increased Resilience**: Investments in grid resilience, such as strategic undergrounding and pole line reinforcement, reduce the likelihood of damage from adverse weather events. This minimizes the number of outages and speeds up the restoration process when outages do occur.

Investments in the distribution enhancements program are targeted to improve the speed and efficiency of outage restoration by providing System Operators with more tools and options, thereby enhancing system visibility and increasing the overall resilience of the grid. More information regarding Hydro Ottawa's distribution enhancements program can be found in Section 3 of Schedule 2-5-8 - System Service Investments.

Hydro Ottawa is committed to ensuring grid resilience and providing reliable service to customers by proactively mitigating potential risks. This is achieved through a multifaceted approach that incorporates continuous improvement initiatives, robust governance structures, and effective productivity management. Recognizing that risk is a function of both the probability of an event and its potential impact, Hydro Ottawa proactively manages risk by prioritizing strategies that both minimize the probability of known risks and mitigate the impact of unforeseen events to safeguard its infrastructure, maintain operational efficiency, and provide a consistent and dependable service to its customers.

6. PERFORMANCE MEASUREMENT FRAMEWORK

Hydro Ottawa maintains a strong commitment to transparent monitoring and reporting of its performance in alignment with the rules, regulations and guidance provided by the OEB. This commitment is demonstrated through comprehensive annual reporting, including RRRs, the Electricity Utility Scorecard submission, and annual Custom Incentive Rate (CIR) reports.

For the 2026-2030 DSP, Hydro Ottawa has transitioned to a risk-based asset management framework, augmented by advancements in data analytics capabilities. This evolution has informed the approach to performance measurement.

The adoption of risk-based asset management, coupled with strategic investments in analytics, enables a more comprehensive assessment of Hydro Ottawa's network assets. The 2026-2030 DSP performance outcomes are specifically designed to directly evaluate plan performance at the Material Investment Plan (MIP) level, ensuring greater accuracy and alignment with the company's evolving operational context. Hydro Ottawa has defined MIPs across the four key investment categories:

- System Access - Schedule 2-5-6 - System Access Investments
- System Renewal - Schedule 2-5-7 - System Renewal Investments
- System Services - Schedule 2-5-8 - System Service Investments
- General Plant - Schedule 2-5-9 - General Plant Investments

The performance of each MIP aligns with the performance outcomes established by the OEB. The relationship between OEB performance outcomes, investment categories, and KPIs is detailed in Table 27 below. Further details regarding the expected performance of each MIP are provided in the referenced schedules.

The alignment between Hydro Ottawa's Asset Management Objectives, Corporate Strategy, and the OEB's performance outcomes is visually represented in Figure 5 of Section 4.2 in Schedule 2-5-4 - Asset Management Process.

Table 27 - KPI Names and Categories

Investment Category	OEB Performance Outcome	KPI Name	KPI Target
System Access (Schedule 2-5-6)	Public Policy Responsiveness Customer Focus	New Residential & Small Business Services Connected on Time	≥ 95%
System Renewal (Schedule 2-5-7)	Operational Effectiveness	Reliability Risk Reduction - All Assets	Monitor
		Number of 4kV Feeders Converted	30
		Length of Cable Replaced	≥ 90%
		Number of Poles Replaced	≥ 90%
		Percentage of Metering Assets reaching EOL	≤ 56%
System Service (Schedule 2-5-8)	Operational Effectiveness Customer Focus	Incremental System Capacity	577 MVA
		Station Loading Index	0%
		Controllability & Observability	≥ 30%
		Resilience Risk Mitigated	≥ 15,000
		Worst Performing Feeders	≤ 6
		Percentage of Field Area Network (FAN) assets centrally managed	≥ 60.0%
		Field Area Network (FAN) System Service Level Agreement	99.9%
General Plant (Schedule 2-5-9)	Operational Effectiveness	Percentage of Medium and Heavy Duty Fleet Vehicles at End of Life (EOL)	10-15%
		Network & Service Uptime	≥ 99.9%
		Percentage of Systems that are Supported	≥ 95%
		Percentage of Systems that are Current	≥ 75%

6.1. SYSTEM ACCESS

New Residential & Small Business Services Connected on Time

This KPI, as defined in Section 7.2 of the Distribution System Code and discussed in Attachment 1-3-3(C) - Electric Utility Scorecard Analysis, tracks percentage of new service connection requests for low-voltage customers (less than 750 volts) completed within five business days after all applicable service conditions are satisfied, or at a later date agreed upon by the customer and distributor.

Hydro Ottawa’s target is to meet this timeline for a minimum of 95% of these connection requests.

6.2. SYSTEM RENEWAL

Reliability Risk Reduction - All Assets

This KPI measures the overall reliability risk associated with all major assets. It tracks the reduction in this risk as compared to the 2024 baseline level.

Hydro Ottawa's target is to monitor the overall reliability risk score for assets by 2030 compared to the 2024 baseline.

Number of 4kV Feeders Converted

This KPI tracks the feeder conversions driven by the planned decommissioning of EOL 4kV station assets during the 2026-2030 rate period.

Hydro Ottawa's target is to convert 30 4kV feeders by 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-7 - System Renewal Investments.

Length of Cable Replaced

This KPI measures the percentage of the actual length of cable replaced versus the planned length, in km, through the Cable Replacement program.

Hydro Ottawa's target is to replace at a minimum 90% of the planned length of cable, in km. This is a five-year target based on the initiatives outlined in Schedule 2-5-7 - System Renewal Investments.

Number of Poles Replaced

This KPI measures the percentage of the number of poles replaced versus the planned number of poles through the Pole Renewal program.

Hydro Ottawa's target is to replace at a minimum 90% of the planned number of poles. This is a five-year target based on the initiatives outlined in Schedule 2-5-7 - System Renewal Investments.

Percentage of Metering Assets reaching EOL

This KPI measures the proportion of metering assets that have reached or exceeded their EOL. The goal is to meet or achieve a reduction in the 2030 projected percentage of assets reached or exceeded EOL. This indicates improved asset health and reduced risk of failure.

Hydro Ottawa's target is to achieve a percentage of metering assets reaching EOL at or below 56% by 2030. This is a five-year target based on the initiatives outlined in the MIP.

6.3. SYSTEM SERVICE

Incremental System Capacity

This KPI measures the increase in incremental system capacity achieved through Hydro Ottawa owned stations and Non-Wires Solutions (NWSs) planned upgrades. The target is to increase capacity by 577 MVA through a combination of new station construction or upgrades, and Hydro Ottawa owned Battery Energy Storage System (BESS) unit installations. Note that this target is gross, and does not include the decommissioning of station assets.

Hydro Ottawa's target is to achieve a total capacity increase of 577 MVA by 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Station Load Index

This KPI measures the percentage of stations operating with a load index of 4 or 5, as defined in Section 8.4 of Schedule 2-5-4 - Asset Management Process. A load index of 4 or 5 signifies that a station is operating near or exceeding its capacity rating, posing a risk to reliability and stability.

Hydro Ottawa's target is zero stations with a Load Index of 4 or 5 by 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Controllability & Observability

This KPI tracks the percentage of normally-open overhead and underground distribution switches that are equipped with automation capabilities. This measures the extent to which the distribution grid can be remotely controlled and its status remotely monitored.

Hydro Ottawa's target is to achieve a minimum of 30% of all normally-open overhead and underground switches to be automated by 2030, measured against the 2024 baseline. This is a 5-year year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Resilience Risk Mitigation

This KPI measures the effectiveness of investments in enhancing the resilience of the distribution grid to adverse weather events. Specifically, it quantifies the monetary value of the enhanced resilience achieved through risk mitigation resulting from undergrounding and other storm hardening projects. The unit of measurement is the Copperleaf value point, where one point is equivalent to approximately $1,000, as defined in Section 5.3.2.2 of Schedule 2-5-4 - Asset Management Process.

Hydro Ottawa's target is to achieve or exceed a resilience risk mitigation score of 15,000 by 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Worst Performing Feeders

This KPI measures the number of distribution feeders classified as "worst performing" based on their Feeder Performance Index (FPI) score. A feeder is considered "worst performing" if its FPI score falls below 30, indicating "Very Poor" performance, as defined in Section 4.3 Worst Feeder Analysis.

Hydro Ottawa's target is to not exceed six feeders classified as worst performing. This target is based on the historical average number of worst-performing feeders from 2019-2023.

Percent of Field Area Network (FAN) Assets centrally managed

This KPI measures the percentage of eligible Remote Terminal Units (RTUs) within the Field Area Network that are centrally managed. Hydro Ottawa's target is to achieve at or above 60% of eligible RTUs centrally managed by the end of 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Field Area Network (FAN) Service Level Agreement for Class A Systems

This KPI measures the system's performance against a predefined maximum allowable downtime (Recovery Time Objective) and a maximum data loss in the event of a failure (Recovery Point Objective).

All IT systems are categorized by the business process they support. Class A systems support Mission Critical business processes which are defined as a business process if stopped, or becomes unavailable for any period of time, directly affecting the delivery of core product and/or time critical operations. Full restoration of normal functionality must be in place otherwise it will:

- Put employee and public health and safety at risk;
- Significantly impact public perception of Hydro Ottawa;
- Result in customer service levels falling below acceptable levels;
- Result in regulatory, legal or contractual infractions that will have significant financial/negative consequences to Hydro Ottawa;
- Result in significant damage/loss to Hydro Ottawa assets;
- Result in finable environmental damage; and/or
- Result in unacceptable backlog or lost work.

The performance target for Hydro Ottawa's Field Area Network (FAN), which supports mission-critical business processes, is 99.9% availability. This target is defined as a maximum allowable downtime of 4 hours and a maximum allowable data loss of 24 hours.

6.4. GENERAL PLANT

Percentage of Medium and Heavy Duty Fleet Vehicles at End of Life

This KPI measures the proportion of medium and heavy-duty fleet vehicles that have reached or exceeded their end of useful life (EOL). The target range is 10% to 15%. This range acknowledges that some vehicles may remain functional and safe beyond their typical lifespan due to condition-based replacement, minimizing maintenance costs and supporting operational efficiency. However, these heavy and medium-duty vehicles are critical workhorses, representing approximately 80% of the capital expenditures in the 2026-2030 fleet program. Therefore, maintaining the EOL percentage below 15% is crucial. Exceeding this threshold poses a significant risk due to the long lead times required for replacing these specialized vehicles. Unlike lighter-duty assets, readily available rentals or replacements for equipment like bucket trucks are not typically an option, making fleet availability paramount for uninterrupted operations. A target range of 10-15% is considered optimal to balance cost-effectiveness with the critical need to maintain a reliable fleet.

Infrastructure & Cyber Security

There are a few key KPIs that can be used to measure the performance of Infrastructure & Cyber Security Programs. These KPIs have been incorporated into KRIs that are defined in Section 8 of Schedule 2-5-9 - General Plant Investments, including:

- **Network & Service Uptime**
  This KPI will measure the overall service uptime of Hydro Ottawa's core network to ensure defined SLAs are met for Class A, B & C networks. This is a quantitative metric.
- **Systems that are Supported**
  The % of network systems that are currently running at a vendor supported level and not EOL. Systems that are EOL result in greater risk to the organization. This is a quantitative metric.

- **Systems that are Current**

  The % of network systems that are running software/firmware/baseline that are at the Vendor's recommended level. Maintaining systems at the Vendor's recommended level ensures the latest features, bug fixes and security updates have all been incorporated. This is a quantitative metric.

7. RELIABILITY TARGETS

In alignment with OEB requirements and the Electricity Utility Scorecard, Hydro Ottawa will continue to utilize SAIDI and SAIFI performance benchmarks, derived from historical averages, to establish reliability targets for the 2026-2030 period.

Attachment 2-5-3(A) - OEB Appendix 2-G - Service Quality and Reliability Indicators

(Refer to the attachment in Excel format)

ASSET MANAGEMENT PROCESS

1. OVERVIEW

Hydro Ottawa's 2026-2030 capital expenditure plan, as developed through the asset management process, demonstrates a comprehensive and forward-thinking approach to asset management. It is guided by the corporate Eight point strategy in Section 3.2 - Corporate Strategy Objectives, the plan aligns with the OEB's performance outcomes and prioritizes customer preferences identified through engagement as in Section 3.3 - Customer Preference and Priorities. Hydro Ottawa advances the corporate objectives and customer priorities through five core business strategies—Asset Management, Grid Modernization, Digital, Facilities, and Fleet—which provide a framework for the development of targeted investment plans. Notably, the Grid Modernization strategy effectively bridges Asset Management and Digital initiatives, ensuring a cohesive approach to technological advancement as described in Section 3.4 - Business Strategies.

This strategic framework is operationalized through Hydro Ottawa's ISO 55001-certified Asset Management System (AMS). The AMS employs a structured four-stage process (prepare, plan, optimize, execute) to ensure methodical asset management, aligning expenditures with the four Investment Priorities: Growth & Electrification, Renewing Deteriorating Infrastructure, Grid Modernization and Enhancing Resilience as described in Section 4.3 - Asset Management Process Overview. Hydro Ottawa's commitment to continuous improvement, as demonstrated by ongoing enhancements to the AMS, includes the implementation of predictive analysis, refined inspection programs, and comprehensive asset health indexing as in Section 4.4 - Asset Management Process Enhancements. This commitment extends beyond the AMS, encompassing a Decarbonization Study projecting future electricity demand, a Climate Study reaffirming the efficacy of existing adaptation measures, and a Resilience Assessment informing a multi-faceted resilience program as described in Section 4.4 - Asset Management Process Enhancements.

These initiatives are critical for managing the complexities of Hydro Ottawa's distribution system, a substantial network encompassing over 364,000 customers and facing diverse challenges, including geographic constraints, the evolving impacts of climate change, and escalating demand as described in Section 6 - Overview of Distribution System. Regional-based planning rigorously considers Ottawa's unique landscape, including its intricate river systems, the protected Greenbelt, and federal lands, while addressing the region's challenging soil conditions and seismic activity detailed in Section 6.3 - Geographic Planning Considerations. Within this context, the utility maintains a vigilant watch on climate change impacts, including temperature extremes and the increasing frequency of high wind events, proactively implementing adaptation measures to bolster grid resilience as in Section 6.4 - Historical and Future Climate. Furthermore, to effectively accommodate escalating demand-driven by residential expansion, the electrification of transportation, and the growing adoption of electric space heating - Hydro Ottawa is strategically augmenting system capacity as described in Section 6.5 - System Demand and Growth Planning Considerations.

Hydro Ottawa is committed to providing a sustainable and dependable electricity service by optimizing asset lifecycles and ensuring reliability and cost-effectiveness through informed asset management practices. A comprehensive analysis of managed assets provides detailed insights into their demographics, condition, failures, and risk profiles, highlighting the critical need for proactive replacement of deteriorating infrastructure, detailed in Section 7 - Overview of Assets Managed. To this end, Hydro Ottawa methodically optimizes asset lifecycles by establishing robust typical useful life (TUL) values, conducting thorough asset replacement and refurbishment analyses, and actively monitoring asset utilization through key performance indicators (KPIs) such as the Station Load Index (SLI) and Feeder Load Index (FLI), as described in Section 8 - Asset Lifecycle Optimization Policies and Practices. Stringent inspection and maintenance programs further ensure the continued safe and reliable operation of the electrical grid as in Section 8.2 - Asset Replacement and Refurbishment Policies.

Hydro Ottawa undertakes a comprehensive System Capacity Assessment, incorporating detailed load forecasting that considers customer growth and electrification, as shown in Section 9 - System Capacity Assessment. Immediate capacity constraints are strategically addressed through the construction of new stations, targeted upgrades, and the implementation of Non-Wires Solutions (NWSs), while medium and long-term needs are met through voltage conversions, strategic distribution transfers, and additional NWSs as described in Section 9.2 - Non-Wires Solutions to Address System Needs. Hydro Ottawa will actively leverage NWSs, including utility owned battery storage solutions and a comprehensive Non-Wires Customer Solutions Program, to proactively manage peak demand, enhance grid reliability, and seamlessly support the integration of distributed energy sources (DERs) as detailed in Section 9.4 - Planning Load Forecasting. Through this holistic and integrated planning process, Hydro Ottawa is strategically investing in its electricity grid to ensure its reliability, resilience, and customer-centricity for the long term.

Hydro Ottawa's asset management practices leverage forward-thinking strategies that anticipate the complexities of a future grid. By incorporating considerations for increased electrification, seamless DER integration, and the evolving impacts of climate change, alongside the asset renewal drivers, this comprehensive strategy enables Hydro Ottawa to not only meet the needs of its customers but also to ensure the long-term sustainability and resilience of its electricity distribution system.

2. INTRODUCTION

This document provides a comprehensive overview of Hydro Ottawa's Asset Management Process. It outlines the strategic framework that guides asset management and integrates decisions with core business strategies and customer preferences.

Hydro Ottawa's systematic approach encompasses lifecycle optimization, risk mitigation, and system capacity assessment. It enables the utility to effectively plan, prioritize, and optimize expenditures.

The planning processes result in a capital expenditure plan that delivers on four Investment Priorities: Growth & Electrification, Renewing Deteriorating Infrastructure, Grid Modernization, and Enhancing Grid Resilience.

The following sections detail Hydro Ottawa's asset management process and how the utility ensures the reliability, resilience, and customer-centricity of its electricity grid.

- **Section 3:** Describes Hydro Ottawa's integrated business planning process
- **Section 4:** Presents Hydro Ottawa's asset management system
- **Section 5:** Explains the detailed asset management process
- **Section 6:** Provides an overview of Hydro Ottawa's distribution system
- **Section 7:** Details the assets managed by Hydro Ottawa
- **Section 8:** Describes the policies and practices for asset lifecycle optimization
- **Section 9:** Presents Hydro Ottawa's system capacity assessment

3. PLANNING PROCESS

This section provides a comprehensive overview of Hydro Ottawa's integrated business planning process, the foundation upon which the utility built its capital expenditure plan for the 2026-2030 period. As detailed in Section 3.1 - Business Planning Process, this plan is not developed in isolation; it is the direct result of a robust and iterative process that aligns strategic objectives, as detailed in Section 3.2 - Corporate Strategic Objectives, incorporates extensive customer engagement in Section 3.3 - Customer Preferences and Priorities, and addresses the specific needs of various asset categories.

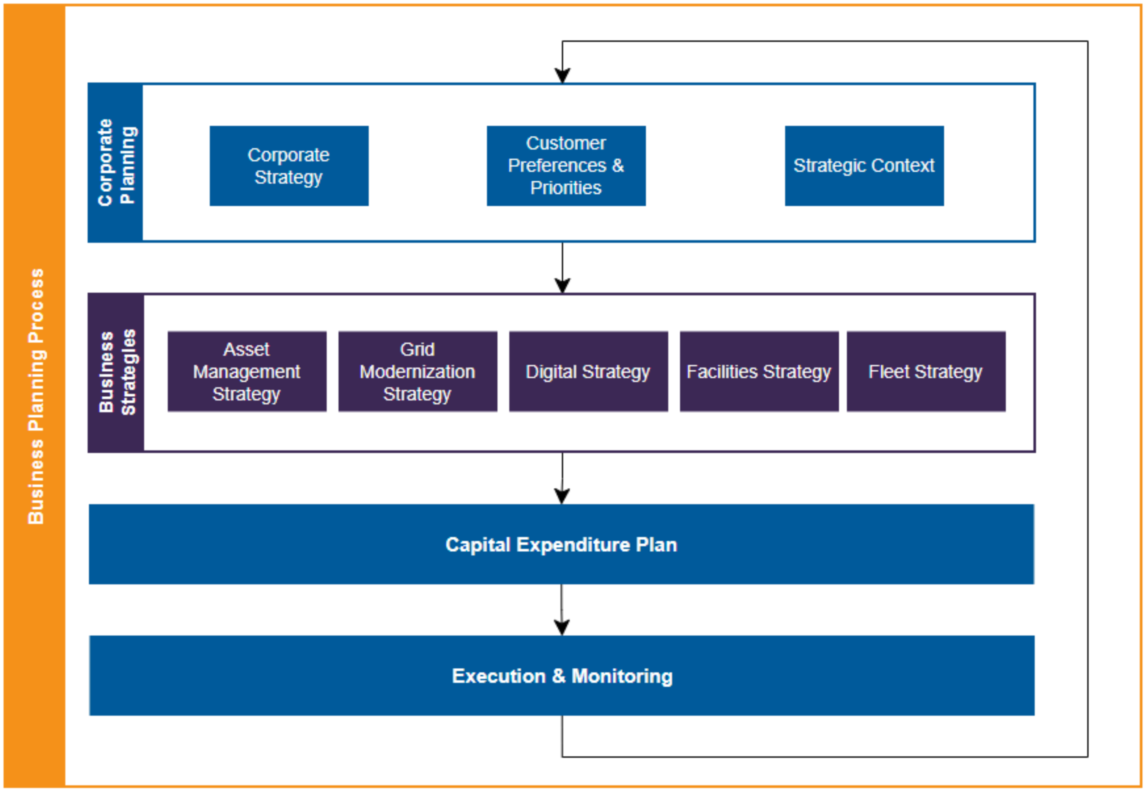
Hydro Ottawa's approach emphasizes a cascading structure, where high-level corporate planning informs specific business strategies, which in turn guide the development of detailed investment plans. This section will explore the key drivers behind Hydro Ottawa's 2021-2025 Strategic Direction, including the "5 Ds" (Decarbonization, Digitization, Decentralization, Diversification, and Demographics) and the utility's overarching Eight point plan (see Figure 2).

It will delve into the customer engagement process, as detailed in Section 3.3 - Customer Preferences and Priorities, highlighting how customer feedback shapes investment priorities and ensures that the plan reflects the needs and expectations of the community it serves. Furthermore, this section details the five core business strategies: Section 3.4.1 - Asset Management Strategy, Section 3.4.2 - Grid Modernization Strategy, Section 3.4.3 - Digital Strategy, Section 3.4.4 - Facilities Strategy, and Section 3.4.5 - Fleet Strategy. Finally, it will examine the capital expenditure planning process itself in Section 3.5 - Capital Expenditure Planning Process, from the development of individual investment plans to their consolidation and prioritization within the broader Capital Expenditure Plan as detailed in Schedule 2-5-5 - Capital Expenditure Plan. This section aims to provide a clear understanding of how Hydro Ottawa strategically plans for its future, ensuring a reliable, sustainable, and customer-centric electricity grid.

3.1. BUSINESS PLANNING PROCESS

Hydro Ottawa's capital expenditure plan is an output of the utility's integrated business planning process. Through this process, Hydro Ottawa advances its overall strategic objectives and provides value to customers by establishing goals and priorities, allocating resources, monitoring performance, identifying areas for improvement, and adapting to developments in the external business environment. Figure 1 outlines the top-level inputs and flows through the business planning process to ultimately deliver a final capital expenditure plan for the four investment categories: System Access, System Renewal, System Service, and General Plant. See Schedule 2-5-5 - Capital Expenditure Plan, for the 2026-2030 Capital Expenditure Plan.

Figure 1 - Business Planning Process



3.1.1. Corporate Planning

Attachment 1-2-3(A) - Corporate Memorandum - 2024-2030 Priorities and Budget Guidelines provides an overview of the business planning process employed by Hydro Ottawa to prepare for this application, including the capital expenditure plan.

The memorandum comprises a set of formal guidelines prepared by the Chief Financial Officer for five-year budgets covering the 2026-2030 rate period. This internal guidance was circulated more than one year in advance of the expected filing date of the rebasing application.

The document serves a number of purposes:

- laying out the timeline for the development of preliminary capital and operational budgets;
- finalizing spending plans based on customer feedback;
- outlining considerations for capital investments and operational expenditures;
- identifying constraints and expectations with respect to such matters as inflation, compensation and headcount;
- stipulating requirements related to productivity, continuous improvement and cost control; and
- directing the alignment of spending with customer interests and outcomes, see Section 3.3 - Customer Preferences and Priorities, the utility's strategic objectives, see Section 3.2 - Corporate Strategic Objectives, and OEB's policy and direction.

The process mapped out in this Corporate Memorandum attests to the rigour, discipline, and customer-oriented focus of Hydro Ottawa's business planning activities.

Affordability was a key consideration when preparing and evaluating preliminary capital and operational budgets. "Affordability" refers to both customer ability and willingness to pay, as well as Hydro Ottawa's financial ratios and capacity to deliver. Throughout the planning process, affordability was essential to optimize the proposed capital expenditure plan and balance rate impacts with the achievement of outcomes valued by customers.

3.1.2. Business Strategies

Hydro Ottawa's five business strategies — Asset Management, Grid Modernization, Digital, Facilities, and Fleet — guide the objectives of its expenditure plan. These strategies share a consistent framework, beginning with corporate planning and then incorporating specific objectives tailored to the scope of each strategy and the assets it oversees. This ensures resulting investment plans contribute to Hydro Ottawa's overall strategic objectives. Because the Grid Modernization Strategy's objectives are achieved through the Asset Management and Digital Strategies, rather than through distinct assets, it does not generate a separate, independent set of investment plans. Instead, it informs and shapes the investment plans developed within the Asset Management and Digital strategies. See Section 3.4 - Business Strategies of this schedule for details on each of the five business strategies.

3.1.3. Capital Expenditure Plan

The investment plans developed for each business strategy (except Grid Modernization, as described above) translate the Strategic Direction, customer insights, and asset-specific objectives into concrete investment needs. These needs are then consolidated through the expenditure planning process, which serves as the mechanism for prioritizing and coordinating the various investment needs identified for each asset category.

3.1.4. Execution & Monitoring

During the 2026-2030 rate period, Hydro Ottawa will continuously monitor and evaluate its execution of the capital expenditure plan, and will consider adjustments to the plan as part of the annual refresh of its business plan and budget. These adjustments may be required during a given calendar year based on a variety of factors (e.g. prior year results; macroeconomic pressures such as interest rates or inflation; and major shifts in the business or operating environment, including severe weather events). Hydro Ottawa is committed to ensuring effective execution of its capital expenditure plan and will continue to implement appropriate controls through annual business planning in support of this priority.

3.2. CORPORATE STRATEGIC OBJECTIVES

Hydro Ottawa's Strategic Direction sets the organization's overarching objectives, which, in turn, drive the planning practices.

Hydro Ottawa's corporate strategy[1] was formulated, and continues to be implemented, against the backdrop of major shifts in the company's operational, business, and policy environments. These key change drivers are collectively referred to as the "5 Ds" and consist of the following:

[1] Hydro Ottawa Holding Inc., 2021-2025 Strategic Direction.

- **Decarbonization** - the removal or reduction of carbon dioxide emissions; the switch to usage of low-carbon energy sources;
- **Digitization** - the conversion of information and processes from analog to digital form;
- **Decentralization** - the transition from large, centralized production and networks to smaller, more distributed production and networks;
- **Diversification** - the process of enlarging a business or varying its range of assets, products, services, business lines, and operational fields; and
- **Demographics** - the 'people' side of the electricity business – customers, community, employees.

The utility's strategy is anchored in an Eight point plan for responding to these external change drivers, while providing value to customers, growing the business, and embedding sustainability into all areas of operations. These eight strategic objectives are outlined in Figure 2.

Figure 2 – Hydro Ottawa's Strategic Objectives

Hydro Ottawa's strategic objectives are aligned with the four core performance outcomes established by the OEB for electricity distributors under the Renewed Regulatory Framework (RRF). This mapping is shown in Table 1.

Table 1 – Alignment between Hydro Ottawa's Strategic Objectives and OEB RRF Performance Outcomes

RRF Performance Outcomes	Corporate Strategic Objectives
Financial Performance	Continue to grow and diversify our revenue sources
	Become the partner of first choice for signature green energy and carbon reduction projects in our community
Customer Focus	Continue to provide best-in-class customer service
	Leverage and promote distributed energy resources
Operational Effectiveness	Accelerate digital transformation to ensure sustainable business practices
	Ensure organizational capacity, culture and leadership to deliver
Public Policy Responsiveness	Achieve net-zero operations by 2030
	Grow our social license to operate

For additional information on Hydro Ottawa's corporate strategy, please see Schedule 1-2-3 - Business Plan.

3.3. CUSTOMER PREFERENCES AND PRIORITIES

As described in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application, Hydro Ottawa engaged Innovative Research Group (Innovative Research), a national consulting firm with expertise in public opinion research and experience in energy policy. They were hired to collaboratively design, test, and implement a strategy for engaging customers on Hydro Ottawa's 2026-2030 rate application proposals.

An iterative, two-phase customer engagement process was undertaken, with the following key principles adopted in order to maximize the effectiveness of the process:

- Ensure all Hydro Ottawa customers have an opportunity to be heard
- Ensure a representative sample of customers are engaged
- Create an open, voluntary process to allow any customer the opportunity to provide comment
- Focus on the key outcomes and customer preferences
- Inform customers about the distribution system and electricity industry

Phase I

Phase I of the Customer Engagement process surveyed Hydro Ottawa's residential customers, small business customers, Commercial & Industrial (C&I) customers, and key accounts. The purpose of this survey was to gather feedback and insights on priorities, preferences, and needs from these customers. The information collected through this survey helped inform the inputs used to develop the Focus Areas of the Distribution System Plan (DSP) and Business Plan, which were shared in draft with customers in Phase II.

For each customer class, Innovative Research conducted online surveys and focus groups in Phase I. Using these results, Innovative Research established baselines and developed weights that allowed a move to an online methodology for Phase II of the customer engagement program.

Engagement results and key findings from Phase I, in relation to satisfaction and general priorities, include:

- Customer satisfaction has improved relative to 2019 for residential and small business customers.

- Residential and small business customers prioritize very similar general outcomes, with both ranking “maintaining reliable electricity service” as their top priority.
- Commercial and industrial and key account customers have more distinctive prioritizations, with reliable service being important, but outranked by the related and more specific objective of hardening the grid to withstand severe weather. Capacity to meet future demand was also a high-ranked priority of these customer classes.

This feedback helped Hydro Ottawa develop the four themes around which its investment plan is organized for communication with customers:

- Aging Infrastructure
- Grid Resilience
- Growth & Electrification
- Grid Modernization

Phase II

Phase II of the Customer Engagement process focused on gathering customer feedback on Hydro Ottawa's proposed investment plan. This was achieved through an online survey that presented the plan's four key categories: Growth and Electrification, Aging Infrastructure, Grid Modernization, and Grid Resilience. The survey aimed to gauge customer investment preferences across these categories and assess the overall level of support for the proposed plan by outlining priority investment options with varying paces and cost impacts, enabling them to directly influence the final plan by providing feedback on their preferred balance of cost, timing, and system outcomes (reliability, resilience, renewable integration).

Key Findings:

- **Strong Support for the Plan:** The results demonstrated strong overall support for the plan, particularly among commercial customers who recognize the value of a reliable and modern electricity grid. An average of 87% of customers, across all rate classes, gave Hydro Ottawa social permission to proceed with its draft plan. These customers provided social permission by indicating either:

  - 16% think Hydro Ottawa should accelerate spending beyond the level in the draft plan to deliver better system outcomes.
  - 28% support the proposed rate increase that is reflected in the draft plan, or
  - 43% They feel that the proposed rate increase in the draft plan is necessary, even though they don't like the proposed rate increase.

- **Acceptance of Necessary Increases:** While many customers expressed a general dislike for bill increases, a majority within each customer category acknowledged the necessity of these increases to fund critical system investments.
- **Desire for Accelerated Investment:** A significant minority of respondents favoured an even faster pace of investment, indicating a willingness to absorb higher near-term costs to expedite system upgrades and realize their associated benefits sooner.

Phase II of the Customer Engagement process successfully gathered valuable customer feedback on Hydro Ottawa's proposed investment plan. The results demonstrated strong overall support for the plan, particularly among commercial customers, and provided insights into customer perspectives on affordability and the need for continued investment in a reliable and sustainable electricity system.

This feedback provided valuable insight into customer perspectives on the balance between affordability and the need for continued investment in a reliable and sustainable electricity system, which is outlined in Table 2.

Table 2 - Support for Proposed Investment Plan per Rate Class[2]

Support for Proposed Investment Plan	Residential	Small Business	C&I and Key Account (GS>50 kW)
I think Hydro Ottawa should accelerate spending beyond its proposed draft plan to deliver better system outcomes	19%	20%	8%
I support the proposed bill increase when it comes to preparing Hydro Ottawa's grid for the future	28%	25%	32%
I don't like the proposed bill increase, but I think it's necessary to maintain the grid to a reasonable standard and prepare for the future	37%	39%	54%
Total Social Permission for Investment Plan	**84%**	**83%**	**94%**
I oppose the bill increase and think Hydro Ottawa needs to scale back its plan	11%	13%	2%
I don't know	5%	4%	4%

3.4. BUSINESS STRATEGIES

This section outlines business strategies that oversee the key asset categories: Asset Management, Grid Modernization, Digital, Facilities, and Fleet. These strategies are grounded in a consistent framework that aligns corporate Strategic Direction and customer feedback with individual asset needs. The following sections detail the specific strategies for each category.

3.4.1. Asset Management Strategy

Hydro Ottawa's Asset Management Strategy, which covers distribution assets, creates the crucial link between the company's overarching strategic objectives and customer preferences and priorities down through to the Asset Management Objectives, as illustrated in Figure 5. These objectives then guide the development of individualized asset management plans

[2] Totals may not sum due to rounding.

(AMPs) that support the foundation of the capital investment planning process. See Section 4.2 - Asset Management Scope, Strategy and Objectives for further details on the strategy.

3.4.2. Grid Modernization Strategy

Hydro Ottawa's Grid Modernization Strategy is a comprehensive plan to address evolving challenges in the utility sector. Developed in response to deteriorating infrastructure, decarbonization, and changing customer expectations, the strategy aims to enhance grid reliability, flexibility, resilience, and customer engagement while promoting sustainability. The strategy promotes five grid modernization objectives, and aligns with the company's Eight point strategy, see Section 3.2 - Corporate Strategic Objectives, emphasizing data-driven and technologically-advanced grid management.

A reliable and modernized grid is at the core of Hydro Ottawa's Strategic Direction. To enable the company's Eight point strategy, the grid modernization plan outlines five grid modernization objectives:

1. **Enhanced Reliability**
   Improve grid reliability through advanced monitoring, proactive failure detection, fast fault detection, automated power control, automated system restoration, and reduced outage times.
2. **Adaptive Grid Flexibility**
   Enable the grid to adapt to the changing energy demand and incorporate diverse energy sources.
3. **Fortified Resilience & Robust Security**
   Improve the grid's ability to withstand disruptions caused by system faults or extreme weather and protect its assets from cyber threats.
4. **Strengthened Customer Engagement & Empowerment**
   Engage and empower customers by providing them with real-time data, efficient billing, and tools to manage their energy use.

5. Sustainable Decarbonization & Renewable Integration

Reduce carbon emissions and promote sustainability by optimizing grid planning and operations to support the integration of renewable energy sources.

Table 3 illustrates how each of the five objectives contribute to the Eight point strategy.

The Grid Modernization Strategy translates the corporate priorities into actionable objectives, which are then achieved through the Asset Management and Digital Strategies. This strategy informs the objectives of both the Asset Management and Digital Strategies, ensuring coordinated investment and avoiding duplicated effort or inefficiencies that could arise from shared asset accountabilities. Specifically, it allows for sole oversight and coordination of distribution assets under the Asset Management framework and information technology (IT) assets under the Digital framework.

The Grid Modernization Roadmap operationalizes the Grid Modernization Objectives in conjunction with the Capital Expenditure plan. The Strategy defines the needs, which are then translated through the Asset Management and Digital strategy processes into concrete investment plans. These plans are consolidated within the capital expenditure planning process and monitored through the Grid Modernization Roadmap to ensure the Grid Modernization Objectives are achieved.

Table 3 - Comparative Analysis of Grid Modernization Objectives and Eight Point Strategy

		Eight Point Strategy							
		Achieve net-zero operations by 2030	Become the partner of first choice for signature green energy and carbon reduction projects in our community	Accelerate digital transformation to enable sustainable business practices	Leverage and promote distributed energy resources	Continue to grow and diversify our revenue sources	Grow our social license to operate	Ensure organizational capacity, culture, and leadership to deliver in a post-pandemic environment	Continue to provide best-in-class customer service
Grid Modernization Objectives	1. Enhance Reliability			✓	✓		✓	✓	✓
Grid Modernization Objectives	2. Adaptive Grid Flexibility	✓	✓	✓	✓			✓	✓
Grid Modernization Objectives	3. Fortified Resilience & Robust Security			✓	✓		✓	✓	✓
Grid Modernization Objectives	4. Strengthened Customer Engagement & Empowerment		✓	✓	✓	✓	✓	✓	✓
Grid Modernization Objectives	5. Sustainable Decarbonization & Renewable Integration	✓	✓	✓	✓	✓	✓	✓	✓

3.4.3. Digital Strategy

The 2026-2030 Digital Strategy is built on the overarching Strategic Direction of Hydro Ottawa. There are five key themes of the digital strategy:

Customer Experience

Providing customers with the tools to understand their consumption patterns and costs, giving them more control over their usage. Generative AI will be able to assist customers 24/7, creating a faster and more convenient way for customers to get answers.

Employee Experience

Employees expect to be able to access the tools they need where they are, when they need them, in a secure manner. Touch-screen devices and modern applications, on web or mobile, augment workflow efficiency for employees in the field. HR and safety platforms will continue to be improved as a core aspect of the employee experience.

Productivity & Operational Effectiveness

The new Enterprise Asset Management (EAM) System referred to in Attachment 4-1-1(A) - Transition to Cloud Computing will improve lifecycle management and optimize resource planning. Planned enhancements to the ERP system will streamline workflows.

Grid Automation

Increasing demand for electricity, combined with the increasing threat of severe weather events, require a reliable and responsive grid. Automation and the integration of technology like DERs, have the potential to meet these needs.

Cyber Security & Business Continuity

The risks from cyber threats are growing as the world becomes more interconnected. Hydro Ottawa, as a critical infrastructure company, must invest not only protection from these threats, but proactive detection and response.

For more details on the Digital Strategy, please see Attachment 1-3-4(B) - Digital Strategy.

3.4.4. Facilities Strategy

The facilities strategy is a key pillar of Hydro Ottawa's Eight point plan by supporting the organization's capacity to deliver its programs and moving toward its goal of achieving Net-Zero Operations. The overall facilities strategy is to maintain facilities in a suitable condition for their intended purpose and to achieve the lowest overall lifetime cost of ownership. The Facilities Program manages a portfolio of administration, operations, and substation building components needed to provide the environment necessary for employees to work safely, effectively and efficiently as well as to protect and store inventory and operating equipment. For clarity, the substation building components refer to the building shell and supporting systems such as fencing, ground surfaces - asphalt / concrete, roofing, and HVAC Systems. Facilities are strategically located throughout Hydro Ottawa's service territory to provide operational coverage and allow for a central location for administration and for training functions.

Hydro Ottawa invests in building improvements that are critical to the operation of the utility's electricity distribution system. Capital expenditures in the Facilities Program relate to structures, systems, and site work necessary for a facility to reach its operational service life or capital expenditures that extend service life enhance capacity or functionality of the facility. For example, expenditures on window and roof replacement help to ensure an ongoing safe and effective work environment and also avoid the potential cost of building structural damage or deterioration and future costly repairs.

Operations and maintenance costs for these facilities are included in the Facilities Program and discussed in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

Hydro Ottawa's Facilities strategy is focused on two main types of facilities, as outlined below.

Administration Facilities

Hydro Ottawa's two main Administration centres are located at 2711 Hunt Club Road and 4565 Bank Street. The primary function of investments in these facilities is to help ensure productivity by replacing poor-condition and end-of-life assets that may otherwise cause hazards or business interruptions. Expenditures also include investments that support the utility's strategic objectives and outcomes, such as providing suitable space for new staff additions.

Stations and Operations Facilities

Stations and Operations facility capital investments are to sustain and improve buildings that house Hydro Ottawa's distribution stations and operations and manage risks that may arise from any facility's assets deteriorating to the point of poor condition or end of life. The integrity and operating condition of stations buildings may significantly affect safety and the reliability of distribution equipment housed within these assets, which are critical to grid safety and performance.

The Facilities Strategy considers both the condition of all facility assets in the process to develop the capital work program and the imperative to comply with legislative and regulatory requirements, as described below:

Asset Condition Assessment

Hydro Ottawa undertakes an Asset Condition Assessment (ACA) process to determine both (a) the risks that may be present in respect of facilities assets, and (b) plans to mitigate these risks. The results of this assessment and risk management prioritization process were used to inform the planned scope of the Facilities Program capital work for the 2026-2030 rate period. Without sufficient funding to make these investments, Hydro Ottawa's facilities would be exposed to the risk of structural failures, significant hazards, and/or damage, e.g. due to flooding or leaking. If these risks were to materialize, they could endanger Hydro Ottawa's employees and public safety and cause severe disruption to the utility's business activities and potentially prolonged outages.

Legislative and Regulatory Requirements

It is essential that Hydro Ottawa be compliant with applicable legislative and regulatory requirements, such as the *Occupational Health and Safety Act*, the Ontario Building Code and the Fire Code. The Facilities Program supports this by:

- Providing safe and functioning facilities by addressing deficiencies that may cause hazards;
- Addressing stations-related deficiencies such as the absence of secondary exits, non-compliant stairs, and inaccessible doors along pathways;
- Improving internal lighting conditions and external damaged lighting in work areas;
- Installing enhanced safety systems to deter theft, vandalism and reduce the risk of unauthorized access into work centres and stations; and
- Installing and improving security systems and technology.

Hydro Ottawa identified required work over the 2026-2030 rate period based on inspections and management judgement with respect to sound asset management practices. Capital expenditure decisions were also informed by Hydro Ottawa's Net-Zero Strategy. This includes replacements and upgrades of equipment that is reaching end of life with electrically powered equipment that meet certain standards and reduce environmental impacts, where it is feasible and cost effective to do so. These expenditures include electrical service upgrades that are necessary to support green initiatives and equipment such as electric heat pumps and water heaters. Further details on Hydro Ottawa's Net-Zero Strategy can be found in Attachment 4-1-3(E) - Health, Safety and Environmental Compliance, Sustainability and Business Continuity Management, Section 5.2. All identified work was prioritized and only critical projects are included in this plan. Projects that were identified but not funded in this plan will be brought forward in the next rate application.

3.4.5. Fleet Strategy

The fleet strategy is a vital component of Hydro Ottawa's Eight point plan by providing the vehicles and equipment that support the organization's capacity to deliver its programs and contribute toward its goal of achieving Net-Zero from operations. Hydro Ottawa's fleet management practices are governed by established corporate policies and procedures related to fleet operations and asset lifecycle management. Vehicle purchases are made in accordance with standard Hydro Ottawa procurement policies and procedures.[3] Hydro Ottawa's fleet is categorized as Light-duty (pick-up trucks, vans) for staff transport and inspections; medium-duty (dump trucks, step vans) for materials and mobile workshops; heavy-duty (bucket trucks) for line work; and specialized equipment (trailers, forklifts) for support.

The utility has a multi-year capital plan to effectively manage, replace and add to its fleet assets. The objectives of the fleet replacement/addition plan are as follows:

- **Safety:** Provision of safe, reliable, and efficient vehicles and equipment to meet operational requirements.
- **Regulatory:** Compliance with all applicable legislation and regulations, as well as accepted industry norms and practices. For example, Fleet must perform annual vehicle inspections to make sure vehicles are compliant with its Commercial Vehicle Operators Registration.
- **Financial:** Management of assets to the lowest overall lifecycle cost, while ensuring asset reliability and employee and public safety.
- **Environmental:** Environmental considerations from the point of procurement through the life of the vehicle. This includes consideration of fuel economy, exhaust emissions, route optimization, reducing idle time (through education of vehicle operators), and reviewing environmentally friendly options where feasible.
- **Operational:** Provision of readily available and reliable vehicles and equipment to meet the requirements of an expanding workforce.

A key objective is that capital investments be made at a level and pace that allows overall costs to be minimized. An optimally-timed vehicle replacement and growth strategy helps to ensure that the appropriate number of vehicles are available to support system maintenance and capital investment

[3] Please see Attachment 4-2-2(A) - Procurement Policy.

plans. The planned pooling program as described in Schedule 2-5-9 - General Plant Investments will further minimize costs and optimize vehicle utilization.

Hydro Ottawa's fleet replacement plan reviews all current vehicles and proposes future replacement dates and cost. The replacement plan is based on a vehicle-by-vehicle assessment weighing the following criteria:

- Vehicle age
- Mileage
- Engine hours
- Power take off (PTO) hours
- Operating and maintenance costs
- Repair history
- Availability of repair parts
- Overall internal mechanic assessment of vehicle condition
- Utilization

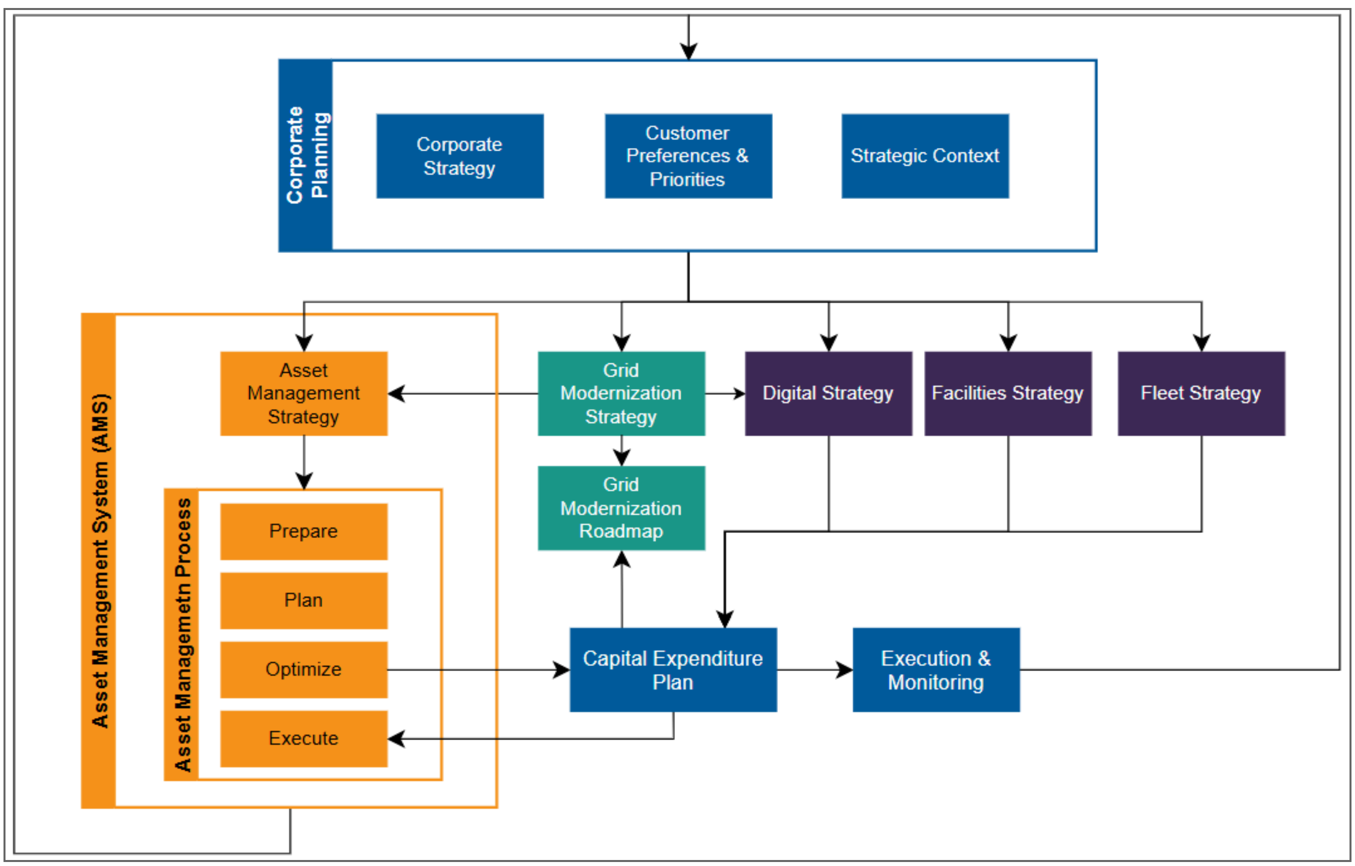
As a result of these assessments, vehicles may be retained longer due to being in better than average condition, while others may be replaced earlier due to being in poorer condition. Of note, Ottawa is subject to extremely hot and humid summers and harsh and cold winters. This has a direct effect on the life expectancy of engines and hydraulic equipment as well as on road conditions. Reactive repairs increase during the harsh months and vehicle condition can sometimes deteriorate ahead of projected schedules. Hydro Ottawa factors in conditions such as these, along with specific vehicle condition assessments, in order to determine which vehicles should be replaced and the appropriate year of replacement.

Hydro Ottawa continues to invest in green fleet vehicles and technology, where it is available for commercial fleets and cost effective. This includes replacing vehicles, as per the established fleet replacement schedule, with hybrid or more energy efficient vehicles, where available; hybrid technology to operate hydraulics for aerial devices, where it is effective; battery technology to eliminate idling for heating and lighting, while servicing underground cabling; and electric vehicles (EVs), where appropriate.

3.5. CAPITAL EXPENDITURE PLANNING PROCESS

Hydro Ottawa's business planning process uses a cascading structure: corporate objectives inform business strategies, which then guide investment plan development. These plans are then optimized and prioritized within the expenditure planning process, culminating in the Capital Expenditure Plan, as illustrated in Figure 3.

Figure 3 - Detailed Business Planning Process



Distribution asset management investment plans originate within the AMS and are also shaped by the Grid Modernization Strategy. These plans feed into the expenditure planning process, and approved plans are executed and monitored within the AMS through the core asset management process. Sections 4 through 9 of this Schedule details the AMS.

IT investment plans, governed by the Digital Strategy and aligned with the Grid Modernization Strategy, are combined with the Fleet, Facilities and Asset Management investment plans within the expenditure planning process. Selected plans are executed and monitored under their respective governance processes.

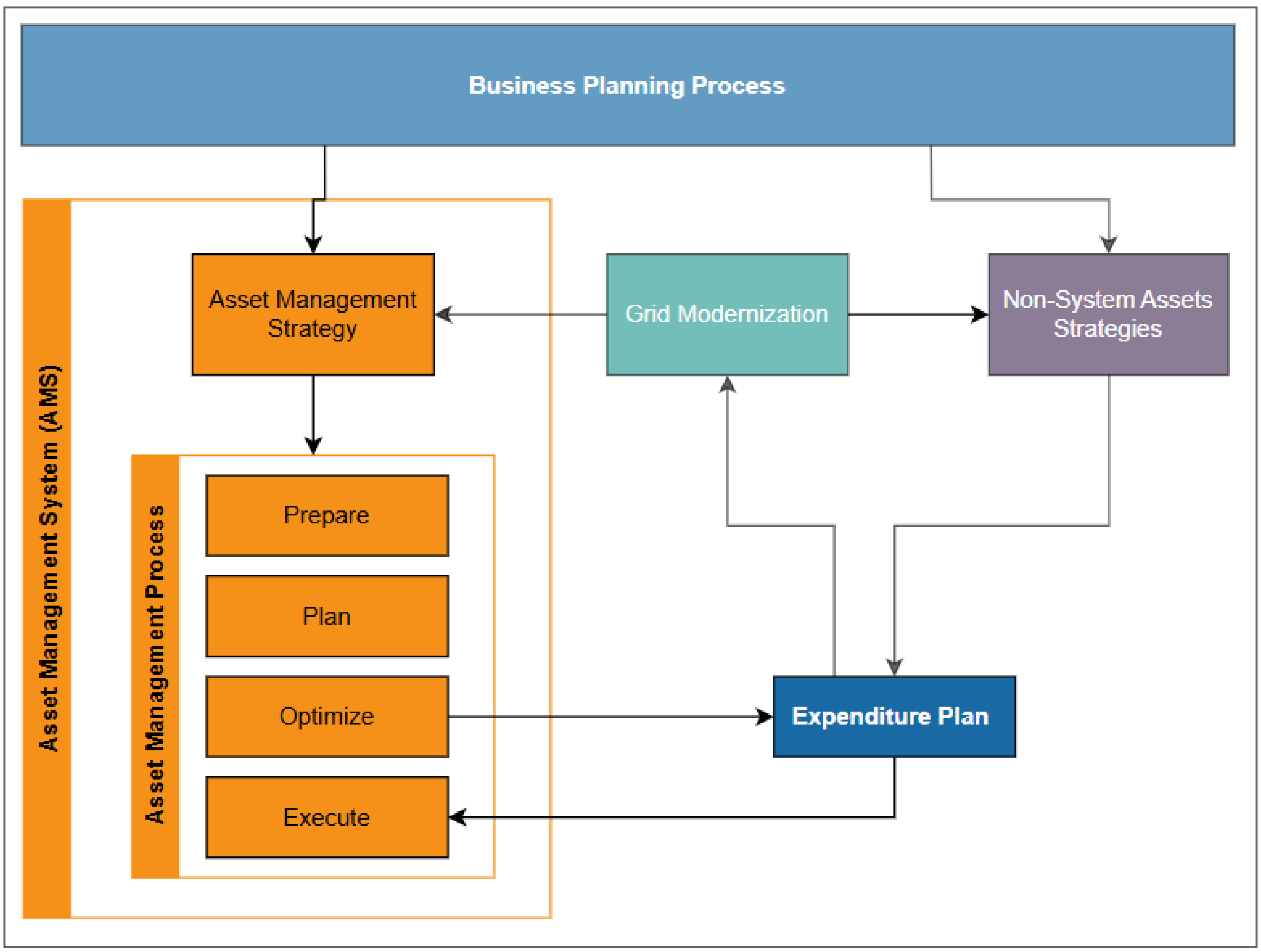
The Capital Expenditure Planning Process evaluates proposed investment plans and alternatives, balancing overall corporate risk to determine investment priorities for the Capital Expenditure Plan. This plan is handed back to the various areas of the business to implement through their asset management frameworks.

The remainder of this Schedule details the AMS, from the guiding Asset Management Strategy to the identification, execution, and monitoring of the capital expenditure plans for the distribution assets.

4. ASSET MANAGEMENT OVERVIEW

This section provides a comprehensive overview of Hydro Ottawa's AMS, outlining the strategic framework guiding the management of its distribution assets, which are critical to the utility's core operation. By effectively managing its assets, Hydro Ottawa ensures it can provide safe, reliable, and affordable electricity. Components of Hydro Ottawa's AMS are shown in Figure 4.

Figure 4 - Hydro Ottawa's Asset Management System



Hydro Ottawa's AMS, certified against ISO 55001, manages assets through a four-stage process: prepare, plan, optimize, and execute. The program-level output from the optimization stage is integrated with results from other non-system assets for optimization of the entire asset portfolio. This process, which is described in Section 3.5 - Capital Expenditure Planning Process, ensures that assets are used effectively and efficiently to provide value to customers and stakeholders and that non-system assets are planned to support the utility's core operations. Once the expenditure plan has been submitted and approved, it is used as a directive to develop a project-level list for annual execution.

Hydro Ottawa is committed to continuously improving its AMS to meet future challenges by leveraging data-driven insights and advanced technologies to optimize asset performance, enhance service reliability, and deliver long-term value.

The asset management processes culminate in a Capital Expenditure Plan that effectively delivers on the four Investment Priorities: Growth & Electrification, Renewing Deteriorating Infrastructure, Grid Modernization and Enhancing Grid Resilience. This is achieved through strategic mapping that aligns program-level decisions with the DSP Investment Priorities, see Section 2.3 of Schedule 2-5-1 - Distribution System Plan Overview, ensuring that all expenditures and activities contribute to achieving Hydro Ottawa's long-term goals for a reliable, resilient, and modern electricity grid.

This section provides a comprehensive overview of Hydro Ottawa's AMS, specifically tailored for the management of distribution assets. It is divided into the following key areas to provide a structured and detailed exploration of the AMS:

- **Section 4.1: Asset Management System Certification** delves into the processes and achievements related to the certification of Hydro Ottawa's AMS. It outlines the requirements and standards that the AMS has been certified against, as well as the benefits that certification brings to the organization and its asset management practices.
- **Section 4.2: Asset Management Scope, Strategy, and Objectives** defines the scope of Hydro Ottawa's AMS, outlining which asset classes and types are included within its purview. It articulates the overarching strategy that guides the AMS, including the goals and

objectives that the organization aims to achieve through effective asset management.

- **Section 4.3: Asset Management Overview** provides a holistic overview of the AMS, explaining its core components, processes, and how it integrates with other organizational systems and functions.
- **Section 4.4: Asset Management Process Enhancements** explores the ongoing efforts to improve and enhance Hydro Ottawa's AMS. It discusses new technologies, methodologies, or strategies that are being implemented to optimize asset performance, reduce costs, and improve overall asset management outcomes. It also includes information about lessons learned from past experiences and how they are being applied to future asset management initiatives.

4.1. ASSET MANAGEMENT SYSTEM CERTIFICATION - ISO55001

Hydro Ottawa's asset management process is certified against the ISO 55001 standard, as outlined in Section 4.2 - Asset Management Scope, Strategy, and Objectives. This international standard provides a framework for asset management systems, offering a structured approach for utilities to optimize the value and minimize the risks of their physical assets throughout their lifecycle.

This framework helps an organization manage the lifecycle of their assets, from acquisition to disposal. Hydro Ottawa's certification against ISO 55001 demonstrates that its AMS:

- Ensures that assets are managed systematically and consistently.
- Improves the efficiency and effectiveness of asset management.
- Reduces risks associated with asset ownership.
- Improves decision-making about asset investments.
- Ensures that asset management objectives are achieved.
- Demonstrates a commitment to asset management best practices.

In 2023 Hydro Ottawa's AMS was re-certified against the ISO 55001 standard, demonstrating that it has been independently audited and meets all requirements. For details, see Attachment 2-5-4(A) -

ISO 55001 Hydro Ottawa Certificate of Conformance 2023. This achievement showcases Hydro Ottawa's ongoing commitment to excellence in asset management.

The ISO 55001 certification process includes a rigorous evaluation of the utility's asset management practices, including planning, implementation, monitoring, and improving asset performance. The standard requires utilities to establish clear asset management objectives, develop strategies to meet these objectives, and implement processes to ensure continuous improvement and risk management. To maintain this certification, Hydro Ottawa undergoes scheduled internal and external audits to ensure that the standard is met on an ongoing basis. These audits help to identify areas for improvement and ensure assets are effectively managed to deliver value to customers and stakeholders.

By attaining ISO 55001 certification, Hydro Ottawa has demonstrated strength in managing its assets responsibly and effectively. The certification demonstrates that Hydro Ottawa has a robust AMS that optimizes the performance and value of its assets, minimizes risks, and ensures long-term sustainability.

4.2. ASSET MANAGEMENT SCOPE, STRATEGY, AND OBJECTIVES

As outlined in Section 3.2 - Corporate Strategic Objectives, Hydro Ottawa's Eight point strategic objectives outline the company's business strategy, and provides all stakeholders with visibility into trends shaping the business environment and how the company plans to respond.

The Eight point plan establishes a balanced program for robust performance in existing operations as well as sustainable and profitable growth, with a focus on customer centricity, financial responsibility, and responsiveness to a changing environment. This alignment underscores Hydro Ottawa's commitment to adapting to evolving market conditions and customer needs, ensuring continued success and relevance in a dynamic industry.

The company's Eight point plan serves as the foundation for developing the Asset Management objectives and the outcomes used to evaluate the risk and performance of the AMS.

4.2.1. Asset Management Scope

Hydro Ottawa's AMS covers distribution assets, metering, and specified telecommunications assets. Distribution assets are further categorized into several asset classes:

- Station Assets
  - Station Transformers
  - Station Switchgear & Breakers
  - Station Batteries, Protection & Control Equipment
- Overhead Assets
  - Poles, Fixtures & Primary Overhead Conductors
  - Overhead Switches
  - Overhead Transformers
- Civil Structures
- Underground Assets
  - Underground Primary Cables
  - Distribution Underground Transformers
  - Distribution Underground Primary Switchgear
  - Vault Transformers
- Telecommunications
- Metering

This categorization allows for targeted management and maintenance practices, which help to ensure the reliability and efficiency of the electrical infrastructure and a focused and effective approach to asset management in aligning with its Eight point strategic objectives.

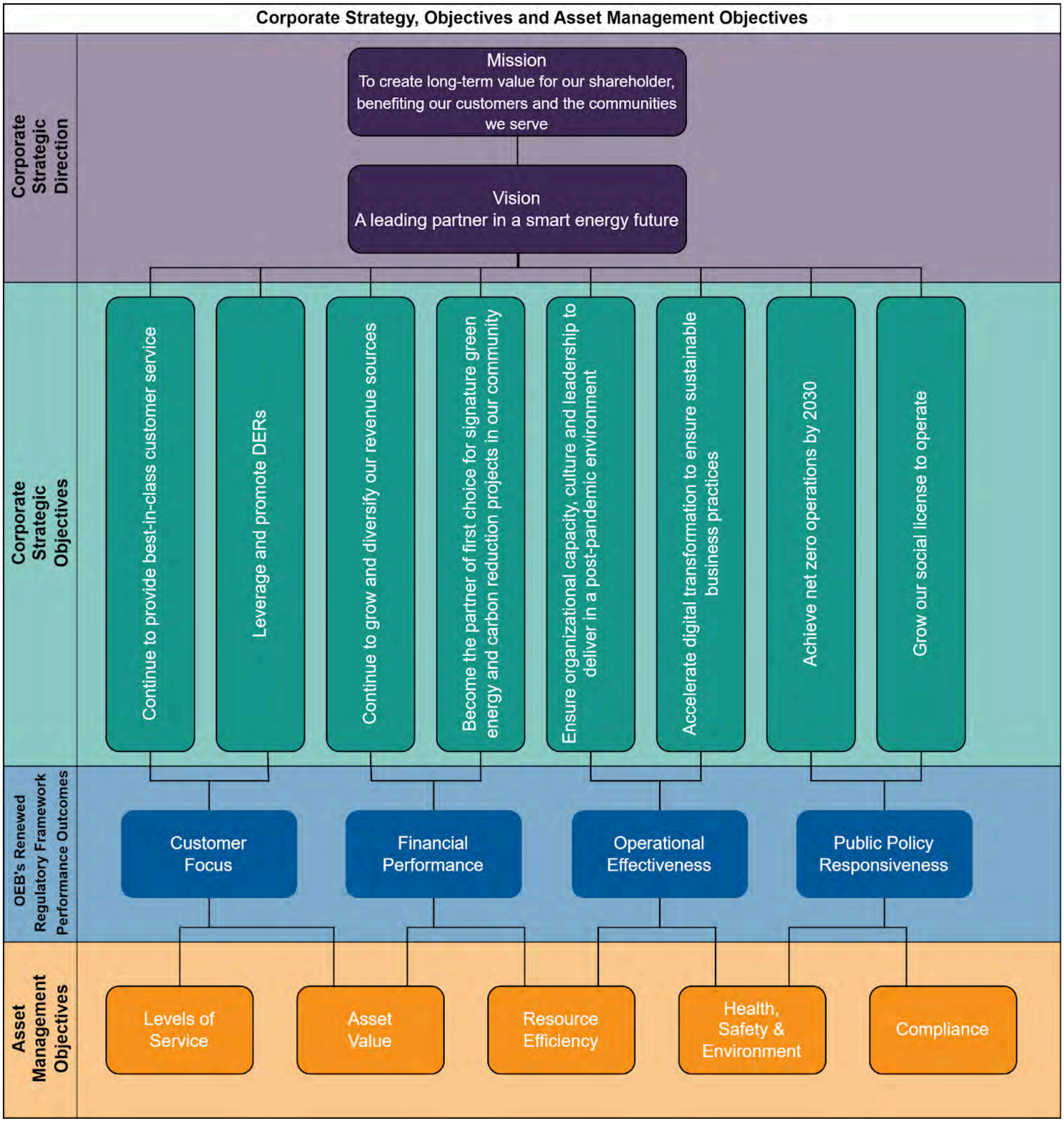
4.2.2. Asset Management Strategy

Hydro Ottawa's Asset Management Strategy provides a crucial link between the company's overarching strategic objectives and the focused goals of asset management. This strategy not only outlines the development of individualized AMPs but also emphasizes the critical role these plans play in achieving those objectives. A visual representation of this cascading hierarchy, from corporate Strategic Direction through to the asset management objectives, is illustrated in Figure 5. By establishing this framework, Hydro Ottawa ensures a cohesive and strategic approach, aligning all asset management endeavors with the company's broader vision and goals.

Hydro Ottawa's asset management strategy is based on data and a portfolio approach that balances risk reduction with level investments. The strategy gives priority to the following:

- **System Risk Mitigation:** Addressing assets that pose the greatest risk to reliability, environment and safety, in a proactive manner.
- **Maintaining Asset Performance:** Extending the life and value of assets through targeted renewals and upgrades, timely repairs, and proactive maintenance. Proactive maintenance includes making investments to improve data collection, quality, and condition assessments for critical assets, which prevents minor issues from becoming major problems.
- **Portfolio Investment Optimization:** Balancing program investments across the portfolio to achieve a level investment strategy for effective asset replacement and renewal targets.

1 **Figure 5 - Corporate Strategic Direction & Asset Management Objectives**



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4.2.3. Asset Management Objectives

Hydro Ottawa's AMS is built upon a foundation of five Asset Management Objectives, ensuring that investments and activities directly support both the company's Eight point plan and the four OEB Performance Outcomes. These five Asset Management Objectives, as detailed in Table 4, act as guiding principles for all asset-related decisions. They ensure a focus on maintaining high **Levels of Service**, maximizing **Asset Value**, driving **Resource Efficiency**, prioritizing **Health, Safety & Environment**, and maintaining **Compliance**. These objectives are not just abstract goals; they are actively pursued through Hydro Ottawa's established asset management processes and translated into tangible capital, operational, and maintenance programs.

Table 4 - Asset Management Objectives

Asset Management Objective	Description
Levels of Service	To maintain and enhance the leading performance of the distribution system through improving electrical service and alignment with customers' expectations.
Asset Value	To maximize the realization of value from distribution assets over their entire lifecycle through managing risks and opportunities.
Resource Efficiency	To maximize economic efficiency by minimizing costs associated with maintaining and operating the distribution system.
Health, Safety & Environment	To minimize employee and public health and safety risks and environmental risks from distribution system activities.
Compliance	To maintain compliance with all internal and external requirements while managing the distribution system.

The connection between overarching objectives and practical execution becomes even clearer when examining Hydro Ottawa's four strategic Investment Priorities for the 2026-2030 DSP. These priorities—Growth & Electrification, Renewing Deteriorating Infrastructure, Grid Modernization, and Enhancing Grid Resilience—are the direct result of a comprehensive analysis that considered customer feedback, system needs, historical performance, and future trends.

The four Investment Priorities serve as the practical application of the five Asset Management Objectives.

1. **Growth & Electrification - Powering a Growing Community:** This priority, focused on expanding grid capacity, relies on all five Asset Management Objectives. Levels of Service ensures the expanded grid meets growing demand reliably. Asset Value guides strategic investments in new infrastructure with long-term value. Resource Efficiency ensures cost-effective expansion. Health, Safety & Environment prioritizes safety and environmental responsibility during expansion. Compliance ensures all expansion activities meet regulatory requirements.

2. **Renewing Deteriorating Infrastructure:** This priority, focused on upgrading deteriorating infrastructure, is heavily driven by Asset Value, as the core goal is to maximize the remaining value of existing assets through strategic replacements and upgrades. Levels of Service is also crucial, as these upgrades aim to improve reliability and prevent service disruptions. Resource Efficiency plays a role in selecting replacements that are more efficient. Health, Safety & Environment is paramount, as older infrastructure may pose safety or environmental risks. Compliance ensures all upgrades meet current standards.

3. **Grid Modernization - Enabling the Energy Transition:** This priority, focused on technology adoption and infrastructure upgrades for the energy transition, relies heavily on Levels of Service, as modernization aims to improve grid capabilities and customer experience. Asset Value guides the selection of modern technologies with long-term value. Resource Efficiency is often a key driver, as modern grids can optimize energy flow and reduce losses. Health, Safety & Environment is essential, as new technologies must be implemented safely and with environmental considerations. Compliance ensures all modernization efforts adhere to regulations.

4. **Enhancing Resilience** This priority, focused on protecting against severe weather and cyber threats, is strongly linked to Levels of Service, as resilience measures aim to maintain service during disruptions. Asset Value informs investments in resilient infrastructure. Resource Efficiency guides cost-effective resilience measures. Health, Safety & Environment is crucial, as resilience efforts must consider safety and environmental impacts. Compliance ensures all resilience measures follow regulations and best practices.

In essence, the four Investment Priorities are the "how" – the concrete actions – that will enable Hydro Ottawa to achieve its "what" – the five overarching Asset Management Objectives. This strategic alignment ensures that every investment contributes to a more reliable, resilient, and future-ready electricity system for the community.

The Asset Management Objectives consider stakeholder expectations, business drivers, and compliance with relevant legislation, codes, licenses, and technical standards. Hydro Ottawa's commitment to delivering safe, reliable, and sustainable electricity to support community growth and prosperity is reflected in its approach to asset management. The AMS is revisited annually to ensure that it incorporates evolving industry best practices and maintains alignment with Hydro Ottawa’s Strategic Direction, regulatory changes, and emerging technologies. This process ensures that Hydro Ottawa's asset management practices effectively support the company's objectives, driving strong performance, sustainable growth, and value creation for stakeholders.

4.3. ASSET MANAGEMENT PROCESS OVERVIEW

Hydro Ottawa's asset management process for distribution assets, certified against the ISO 55001 standard, utilizes a risk-based approach to optimize the value and resource efficiency of its assets while ensuring compliance and effective risk management. This process is guided by asset management objectives outlined in Section 4.2 - Asset Management Overview, which covers the Scope, Strategy, and Objectives of Asset Management.

The asset management process at Hydro Ottawa consists of four main stages: prepare, plan, optimize, and execute, as illustrated in Figure 6.

Figure 6 - Hydro Ottawa's Asset Management Process

The **prepare** stage involves establishing the context of asset management by identifying assets and associated risks, reviewing results from testing and maintenance, analyzing assets condition, identifying regional growth, and analyzing performance metrics.

The **plan** stage encompasses the development of comprehensive AMPs that directly address the identified risks and objectives. This involves a strategic alignment of asset plans with the overarching system needs, ensuring that capacity constraints, reliability, resilience, and grid modernization requirements are all taken into account. A key component of this stage is the identification of both capital and operations, maintenance, and administration (OM&A) investments required to support the asset management strategy and achieve the desired outcomes.

The **optimize** stage consists of two parts: program-level assessment and project-level assessment. During program-level assessment, plans to address asset and system needs are allocated under specific investment categories and programs based on primary drivers. In addition, plan alternatives are evaluated in material investment plans (MIP) for evaluation and selection of the preferred alternative. Project-level assessment involves evaluating and scoring identified projects. This stage utilizes a portfolio optimization tool to further refine and optimize project selection.

The **execute** stage includes implementing the plan, tracking performance for ongoing improvement, and making necessary adjustments to ensure that the AMPs achieve their objectives. Additionally, any insights gained during this phase are integrated into the development of the subsequent plan.

Hydro Ottawa's asset management process is designed to align asset management practices with both organizational objectives and customer expectations, ultimately ensuring the safe, reliable, and cost-effective delivery of electricity. This risk-based approach enables the utility to maximize asset value, enhance operational efficiency, and bolster service reliability. Furthermore, it supports compliance with regulatory requirements and facilitates sound financial risk management. A more detailed exploration of the Asset Management process can be found in Section 5.

4.4. ASSET MANAGEMENT PROCESS ENHANCEMENTS

Hydro Ottawa continuously reviews its asset management process to identify opportunities for enhancements that would help to navigate the changing electrical distribution network landscape. In this regard, some of the asset management process enhancements introduced by Hydro Ottawa since the 2021-2025 DSP include:

4.4.1. Implementation of Predictive Analysis

In 2024, Hydro Ottawa enhanced its asset management framework by incorporating Predictive Analytics (PA) into its System Renewal investment planning. This involved creating a comprehensive distribution asset model within the Copperleaf Asset PA module. Copperleaf is an Asset Investment Planning and Management software solution that provides evidence-based support for strategic asset planning and budgeting decisions. This integrated, enterprise-wide solution connects and streamlines asset analytics, risk, financial and performance modeling, investment portfolio optimization, budgeting, and variance analysis, ultimately supporting a risk-informed approach to asset management.

In order to manage assets effectively, PA was required as a tool to predict the effects of asset degradation over time and the required spending on the remediation of the deteriorated assets. The PA module within Copperleaf forecasts system renewal investment needs for Hydro Ottawa's asset population and generates the risk and cost profiles of various sustainment levels. The output of Copperleaf PA can then be input into Copperleaf Portfolio, Hydro Ottawa's investment optimization software (refer to section 5.3.2 for more details) as investments. The information generated by Copperleaf PA will grow and be refined over time as there are improvements to asset risk information.

Copperleaf PA leverages age/Health Index information or condition assessments to determine the probability of failure and the risks associated with each asset. Based on the risk information at the individual asset level, Copperleaf PA can create an optimal strategic plan for the entire asset population.

Copperleaf PA utilizes various information such as asset nomenclature, condition data, probability of failure curves, risk consequences, and intervention data, to compute risk at an individual asset level. Key risk measures, such as those related to reliability, safety, environmental impact, financial implications, and compliance, are calculated by the model.

Deployed across Hydro Ottawa's major asset classes, this model forecasts the impact of asset degradation over time. This enables risk assessment and optimized replacement scheduling by evaluating the overall value of various intervention strategies, ultimately leading to more informed investment decisions. The PA module helps to determine the optimal timing for asset interventions like replacements or upgrades. It considers factors such as risk mitigation, cost-effectiveness, and resource constraints to guide investment decisions. By considering a comprehensive range of risk factors and optimizing intervention strategies, PA has enabled Hydro Ottawa to make more informed system renewal investment decisions for this application. Further details are available in Section 5.1.4 - Asset Risk Assessment of this Schedule.

4.4.2. Inspection Enhancements

Through 2024, Hydro Ottawa further improved its testing, inspection, and maintenance programs to capture additional inspection parameters down to the asset component level such as insulators, elbows, barriers, etc. As a result, Hydro Ottawa is gathering more granular visual inspection and infrared scanning data on its distribution equipment. Specifically, the overhead asset inspection program now captures information on pole-mounted transformers, switches, and related hardware at every pole inspected rather than only when an issue was found, though currently only from the ground level, as noted in Schedule 4-1-2 Operations, Maintenance and Administration Program Costs, a drone pilot program is planned for 2025.

For underground infrastructure, Hydro Ottawa enhanced its cable testing methodology by including advanced testing methods such as Very Low Frequency Tan-Delta, Partial Discharge, and Time Domain Reflectometry. These advanced techniques provide a deeper understanding of the condition of cable components, facilitating targeted remediation efforts, compared to the initial cable testing technique employed by Hydro Ottawa, which was solely based on the detection of water trees in the cable insulation. Furthermore, Hydro Ottawa has expanded its vault inspection program to include visual and infrared assessments of vault equipment, in addition to the civil inspection.

These improvements in data collection and analysis empower Hydro Ottawa to conduct more accurate condition assessments. This enhanced accuracy is essential for effective risk-based investment planning through PA and the proactive maintenance of Hydro Ottawa's critical asset infrastructure. Further details regarding Hydro Ottawa’s 2026-2030 preventative maintenance programs are available in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

4.4.3. Comprehensive Asset Health Indexing

In 2023, Hydro Ottawa started to enhance its ACA framework by incorporating parameters captured through existing testing, inspection and maintenance programs into the calculation of asset health index scores. This change was driven by a need for more precise condition assessments to inform risk-based investment planning to effectively maintain assets, based on information already captured through inspections, but not utilized in health indexing.

Previously, Hydro Ottawa's condition assessments relied on less granular data, focusing on reporting on exceptions or major issues identified during inspections. The new framework includes asset-specific parameters for calculating the health index score, based on data already being gathered through inspections. These parameters are tailored to reflect the specific degradation mechanisms and failure modes relevant to each asset class. These enhancements ensure that the relevant data required for calculating the updated health index is collected for each individual asset. This shift from exception-based reporting to individual asset assessment provides a much richer dataset.

Some other key improvements implemented to the asset health indexing process include:

- Reducing the heavy reliance on age as a major contributor to health index through two ways:
    - Decreasing the weighting assigned to age as a part of the health indexing process.
    - Translating age to condition based on the linear piecewise relationship established between age and condition through the failure curve development exercise outlined in Section 4.4.4 - Failure Curves and Typical Useful Life Update. This approach was used to determine the equivalent condition value for assets that had a known age, but lacked a valid health index.
- Implementing validity to the health index process to ensure that at least 70% of the condition information is available to define a health index value.

With improved condition data, Hydro Ottawa will make more informed, risk-based investment decisions through the use of PA. This means prioritizing System Renewal investments by the assets that pose the greatest risk to system reliability, safety, and performance. A third-party assessment of Hydro Ottawa's ACA implementation, completed in 2024, confirmed the robustness of its framework. The assessment, conducted by Hatch, found that Hydro Ottawa's ACA framework used best-practice formulations and was well-integrated with its broader asset management processes, procedures, and outcomes. For further information, please refer to Attachment 2-5-4(C) - Asset Condition Assessment Third Party Review. While Hatch identified minor calculation gaps with minimal portfolio impact, Hydro Ottawa has already implemented updates to address them. Hatch also provided recommendations for ACA methodological enhancements, and Hydro Ottawa is currently gathering additional data and exploring solutions to support advanced analytics and meet evolving data needs, through improvements to OM&A programs as outlined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

4.4.4. Failure Curves and Typical Useful Life Update

In 2024, concurrent with the PA implementation, Hydro Ottawa engaged Hatch to enhance asset failure curve knowledge and insights, aiming to refine the utility's risk-based and value-based asset management framework. This initiative involved:

- A thorough review of existing failure curves.
- The development of new, data-driven failure curves.
- Augmentation of existing age-condition curves using asset registry data to improve accuracy.
- Establishing the TUL values of the various asset types.

As the first step of the data-driven failure curve development process, Hydro Ottawa provided Hatch with the asset registry information for all major asset classes, including:

- All asset-related information such as the voltage class, current rating, insulation type, installation date, health index, etc.
- Existing asset failure curves and TUL information
- Number of assets replaced each year (since 2016) within each asset class under the different OEB investment programs (System Renewal - Planned and Corrective, System Service, and System Access)

Hatch employed statistical techniques to analyze and interpret the data provided by Hydro Ottawa to create a simulated asset population to align with Hydro Ottawa's actual asset registry. This analysis focused on deriving the best representative Weibull curve parameters (a matrix of shape and scale values), a common industry practice for failure curve development. The simulation results, including the TUL values obtained during this first phase, closely matched Hydro Ottawa's asset registry, and were identified as Data Driven Results.

Hatch identified that it is common in the utility sector that converging at an absolute steady state or the exact asset registry is a challenge, primarily due to variations in asset information maturity and quality. Hatch's model encountered this challenge with certain asset classes, which showed deviations from typical industry TULs. To refine the results, Hatch produced TUL Adjusted Results. This involved selecting the top 10% of matches that most closely aligned with Hydro Ottawa's asset registry, while still utilizing Hydro Ottawa data. These selected results were then used to generate adjusted failure curves and TUL values. Following this, Hatch conducted a workshop with Hydro Ottawa to review both the initial Data Driven Results and the TUL Adjusted Results.

Hydro Ottawa updated existing TUL values for asset classes exhibiting substantial variations (exceeding five years) between the Data Driven Results, TUL Adjusted Results, and the current TUL values. This resulted in changes to the TUL values for underground transformers, electronic relays, maintenance holes (manholes/cable chambers), and station VLA batteries.

For the remaining asset classes, the Data Driven or the TUL Adjusted Values were found to be either identical or very similar (within a few years) to Hydro Ottawa’s current TUL values. During the workshop, Hydro Ottawa and Hatch subject matter experts agreed to retain the existing TUL values for these asset classes. This decision stemmed from Hydro Ottawa’s high maturity asset survival records and less developed failure records. To confidently adjust the TUL values by a few years, it is necessary for Hydro Ottawa's asset failure records to mature further.

To enable future TUL value refinements, a workshop recommendation was for Hydro Ottawa to strengthen its asset tracking by consistently recording annual failures and renewals, including age, health index at failure, and replacement details. Hydro Ottawa has already begun this process, tracking age and condition at failure since 2023. The accumulation of this data over the next few years will support further TUL adjustments (even by a few years) for the relevant asset classes.

Section 8.1 - Asset Typical Useful Life outlines the TUL values finalized for the different asset classes. A segmented linear piecewise relationship was also developed to establish the relationship between Health Index and age across all asset types. A detailed report on this asset failure curve analysis is available in Attachment 2-5-4(D) - Failure Curves Review. The Copperleaf PA module uses the failure curves developed in this study to forecast asset degradation and determine future asset risk levels.

4.4.5. ISO 55001 - Asset Management System Recertification

Hydro Ottawa’s mature AMS is a robust framework that effectively directs, coordinates, and controls asset management activities. It incorporates interrelated and interacting elements to establish an asset management policy, asset management objectives, and the overarching processes necessary to achieve those directives. This framework strengthens the strategic asset decision-making processes by effectively balancing the weighting of cost, risk, and asset performance. It is designed to meet or exceed the service level expectations of customers; comply with applicable acts, licenses, and codes; improve asset value and resource efficiency; and minimize health, safety, and environmental impacts.

Hydro Ottawa's dedication to advancing asset management practices culminated in the adoption of the ISO 55001 Asset Management Standard in preparation for this application. Achieving initial certification in 2020, the organization further solidified its commitment through successful recertification in 2023. This achievement serves as a testament to the ongoing advancements and maturity of Hydro Ottawa's AMS, a fundamental element in the recertification process.

During the recertification process, Hydro Ottawa demonstrated enhancements to its AMS. These enhancements include:

- Utilization of a comprehensive risk register to proactively identify and mitigate potential issues.
- Implementation of a defective equipment tracker to facilitate efficient monitoring and resolution of equipment deficiencies.
- Development and execution of targeted mitigation plans for specific asset-related risks, exemplified by the comprehensive strategy for managing SF_6 switchgear leaks.

Furthermore, Hydro Ottawa maintains a commitment to continuous improvement through structured ongoing operational practices focused on assessing risks and mitigations, adherence to standards, consideration of emerging technologies and evolving industry standards, and other opportunities for enhancement.

4.4.6. Decarbonization Study

To gain an understanding of the evolving energy landscape and strategically navigate its associated complexities, Hydro Ottawa commissioned Black & Veatch in 2023 to conduct a Decarbonization Study. This study evaluated the potential impacts of societal electrification trends on the Hydro Ottawa distribution system, projecting outcomes in five-year increments through 2050 with a scenario based approach. Five scenarios with varying assumptions of decarbonization initiatives on the distribution system were assessed.

Completed in 2024, the study provides:

- Projections of electricity demand driven by the decarbonization-related electrification of buildings and transportation for 5 different scenarios.
- Rough-order-of-magnitude capital cost estimations.
- Strategic insights to inform future infrastructure investments.

Hydro Ottawa's capacity investment planning and forecasting initiatives leverage the insights from this study for the medium to long-term outlook (beyond 2030). Decarbonization and the subsequent electrification of key sectors necessitate a shift from traditional to scenario-based electricity demand forecasting. Hydro Ottawa is utilizing the Decarbonization Study's Reference Scenario, see details in Section 9.4.2.1 - Decarbonization Study, to inform its Integrated Regional Resource Plan (IRRP) forecast (details in 9.4.2. IRRP Forecast). This alignment is crucial for long-term regional transmission planning, given the extended lead times of transmission grid investments. This approach ensures that immediate capacity investments, guided by Hydro Ottawa's planning forecast, see details in Section 9.4.1 - Hydro Ottawa Planning Forecast, are strategically aligned with long-term regional transmission needs, thereby optimizing capital allocation and asset utilization.

Recognizing the uncertainties of government policies and technological advancements, Hydro Ottawa leveraged the IRRP forecast derived from the Decarbonization Study's reference scenario to augment investment decisions for the mid- to long-term. Hydro Ottawa prioritized investments in areas with existing capacity constraints and immediate, confirmed, and committed load requirements (as per the planning forecast) necessary to meet customer service obligations. These investments include upsizing new stations to align to a consistent 100 Mega Volt Ampere (MVA) design, converting voltage levels to 13kV when replacing deteriorated 4kV station assets to support intensification and other known large projects, utilizing NWSs, and implementing grid modernization initiatives. Hydro Ottawa will continuously monitor the impact of electrification to minimize disruptions and ensure the ability to connect new customers. This strategic approach also emphasizes driving efficiencies across investment programs by leveraging technological advancements and enhancing grid reliability, resilience, and adaptability. By strategically phasing investments, Hydro Ottawa ensures that immediate customer needs are met without compromising its ability to support future growth.

Further details are available in:

- Schedule 2-5-4 - Asset Management Process, Section 9 - System Capacity Assessment
- Schedule 2-5-4 - Asset Management Process, Attachment 2-5-4(F) - Decarbonization Study

4.4.7. Climate Study Reaffirmation

In 2023, Hydro Ottawa commissioned Stantec Consulting Ltd. (Stantec) to conduct a study to update the 2019 climate risk assessment,[4] incorporating the latest climate projection data and factoring in recent extreme weather events, including the 2022 Derecho.

[4] See Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020); and in this Applicaton, Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan.

This comprehensive assessment utilized updated climate models and regional projections to refine the probability estimations of extreme weather events. Notably, two new wind speed thresholds, exceeding 130 km/h and 180 km/h, were introduced based on updated criteria and empirical observations from the 2022 Derecho storm. This led to a reassessment of potential high-wind impacts on infrastructure, resulting in elevated consequence ratings.

Despite the increased risk scores associated with severe wind events, the overall risk level for the majority of Hydro Ottawa's infrastructure remained unchanged. This finding indicates that the adaptation and mitigation measures outlined in the 2019 plan retain their efficacy. Consequently, the primary areas of vulnerability within Hydro Ottawa's system, namely overhead assets, remain consistent with previous assessments.

As a result, Hydro Ottawa commissioned a further study, conducted by 1898 & Co., to explore strategic opportunities for undergrounding vulnerable sections of overhead lines to enhance the overall resilience of the electricity distribution system. Further details on the study's findings can be found below in Section 4.4.8 - Resilience Assessment.

4.4.8. Resilience Assessment

Following a series of severe weather events and recognizing that grid resilience is a priority for its customers, Hydro Ottawa engaged 1898 & Co. to conduct a comprehensive assessment and develop a Resilience Investment Business Case. This initiative aimed to enhance grid resilience by strategically burying vulnerable sections of the overhead distribution system. The resulting report underscored the escalating importance of grid resilience in the face of increasingly frequent major weather events and society's growing reliance on a stable power supply. Employing a data-driven model, the study identified and prioritized resilience investments, focusing on the strategic conversion of overhead lines to underground systems.

Hydro Ottawa integrated the study's findings with empirical evidence from recent storm events to proactively incorporate resilience investments into the capital plan. The resulting Distribution System Resilience program encompasses a multi-faceted approach, including:

- Strategic undergrounding of vulnerable overhead lines
- Reinforcement of existing overhead infrastructure
- Feeder reconfiguration
- Undergrounding of station egress points
- Relocation of lines

These investments are designed to mitigate system disruptions caused by severe weather events, ultimately minimizing restoration costs, customer outage durations, and overall system recovery time.

Hydro Ottawa's Distribution System Resilience program closely aligns with the OEB's ongoing consultation of a Vulnerability Assessment and System Hardening (VASH) framework[5] by using climate projections, conducting asset-based vulnerability assessments, employing quantitative analysis to prioritize investments, and focusing on maximizing customer value. This data-driven approach allows Hydro Ottawa to align with the VASH framework in order to strategically improve the grid's ability to withstand extreme weather while minimizing customer impacts.

A detailed description of the Distribution System Resilience program is provided in Section 3 of Schedule 2-5-8 - System Service Investments.

4.4.9. Capture Implementation

Hydro Ottawa utilizes Copperleaf Portfolio, Hydro Ottawa's investment optimization software, to optimize its decision-making processes and ensure the long-term sustainability of its infrastructure

[5] OEB, *Decision and Order*, EB-2024-0199 - Vulnerability Assessment and System Hardening Project (December 17, 2024).

assets. Further details can be found in Section 5.3.2 - Project Level Investment Planning. In 2022, Copperleaf significantly enhanced its software suite by introducing the Capture module. This module streamlines and optimizes the input of investment ideas and potential system risks from various stakeholders. By empowering stakeholders to directly submit these ideas or risks into the Copperleaf Investment Planning software through an intuitive and user-friendly form, the Capture module effectively simplifies and accelerates the initial stages of both project and risk management.

The form's intelligent design automates the creation of a draft project or risk, which can then be subjected to a thorough review and refinement process. This automation not only yields substantial time savings but also ensures that all submissions adhere to a standardized format, thereby making the subsequent review and approval processes significantly more efficient. Moreover, the Capture module fosters a culture of transparency and accountability by enabling the meticulous tracking of project and risk lifecycles throughout their various stages, from inception to completion. This comprehensive tracking functionality plays a pivotal role in ensuring that all projects and risks receive the requisite approvals and are managed in a manner that is both consistent and compliant with prevailing regulations and internal policies.

The Capture module's capacity to facilitate the seamless integration of stakeholder input directly into the Copperleaf Planning software holds the potential to catalyze a more collaborative and inclusive approach to decision-making. By breaking down traditional barriers to participation and affording stakeholders a direct and accessible channel for contributing their insights and perspectives, the module can foster a sense of shared ownership and commitment to the success of projects and the mitigation of risks. This, in turn, can lead to more informed and robust decision-making, as well as enhanced organizational agility and responsiveness to emerging opportunities and challenges.

4.4.10. Portfolio Management Enhancement

To enhance financial reporting and control over distribution sustainment projects, Hydro Ottawa implemented process improvements during 2021-2025. Benefits included enhanced reporting and oversight, improved project tracking, strategic alignment, contingency planning, and increased rigor in project and program delivery.

Budget Programs, as identified in Schedule 2-5-5 - Capital Expenditure Plan, were categorized into four Programs: Corrective Renewal, Distribution Construction & Maintenance, Stations, and Maintenance, and further grouped into a Portfolio. Hydro Ottawa uses a multi-stakeholder model composed of Distribution Design, Program Management, Asset Planning, Contractor Management, Maintenance & Reliability, Supply Chain, and Operations to oversee the execution of the programs/portfolios on a monthly basis. This group considers key issues and risks impacting execution, such as inflation, supply chain, impactful weather events, labour disruptions, safety, third-party coordination, and third party service availability. The core focus of this team is to proactively monitor and adjust the execution of the plan as needed to achieve project and program objectives in light of evolving conditions and circumstances on the ground.

Key topics impacting expenditures in the historical 2021-2025 period include inflation, unprecedented supply chain disruptions, customer connections (volume, complexity and cost), unforeseen externally-driven projects, increased emergency renewal work due to major storms such as the 2022 Derecho, equipment failure and new stations investments to address growing electricity demand. To mitigate these pressures, Hydro Ottawa implemented proactive financial management strategies, notably deferring planned projects such as Major Station Rebuilds, Voltage Conversions, ERP Upgrades, and Underground Switchgear Renewals. Please refer to variances in Section 4 of Schedule 2-5-5 - Capital Expenditure Plan.

Hydro Ottawa will leverage this framework and model through 2026-2030, continuing to refine financial reporting and control across investment categories.

4.4.11. Asset Management Technology

In addition to the aforementioned enhancements, Hydro Ottawa has recognized that many of its asset management processes are restricted by existing technology and disparate systems, with limited interoperability, unable to scale effectively to meet asset growth and customer demands. As a result, Hydro Ottawa is seeking an EAM platform as outlined in Section 3 of Attachment 4-1-1(A) - Transition to Cloud Computing, to address these challenges and further transform asset management processes over the 2026-2030 rate period.

5. ASSET MANAGEMENT PROCESS

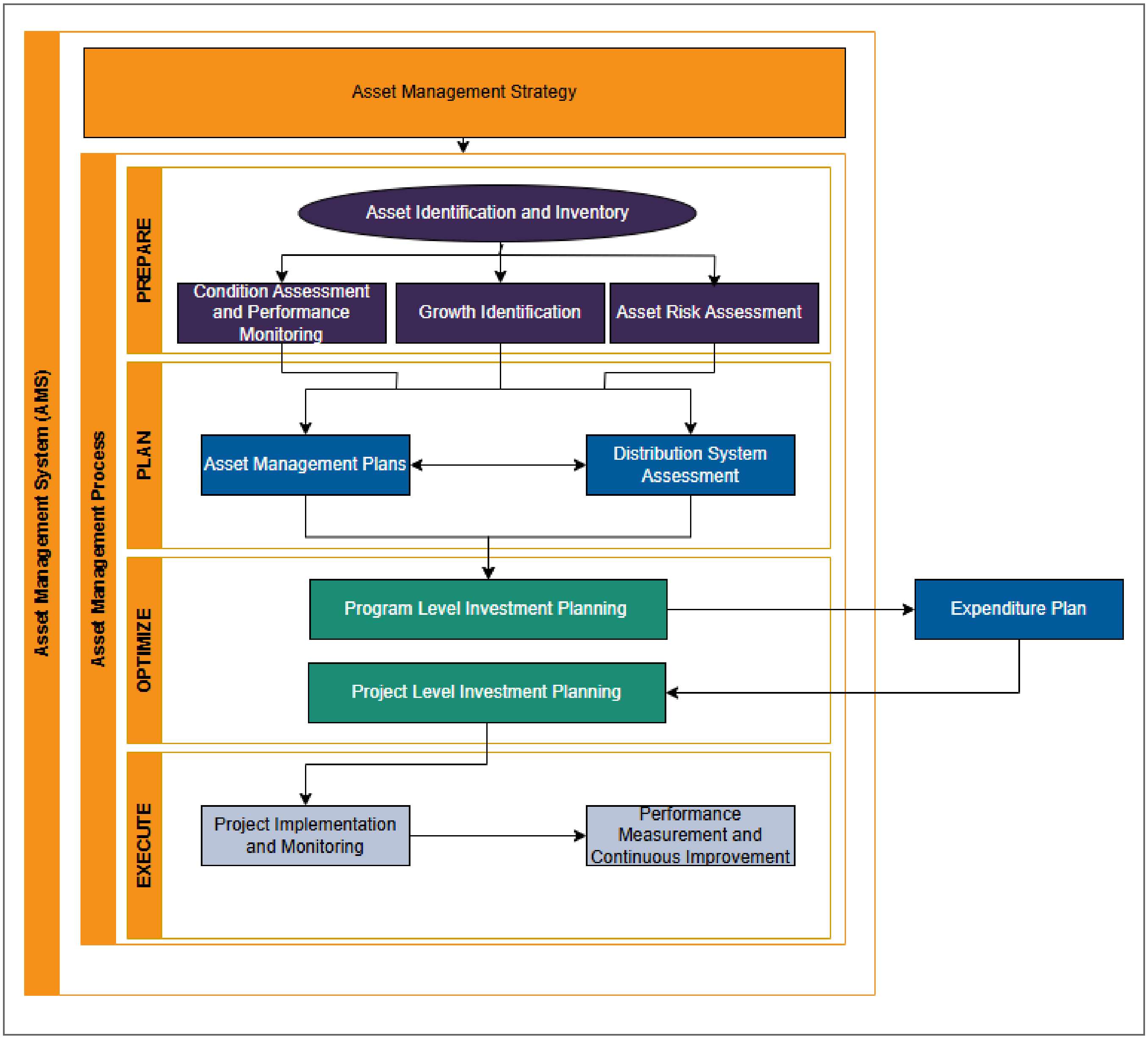
Section 5 describes the process used to plan, prioritize, and optimize expenditures related to distribution assets. This section speaks to the components of Hydro Ottawa's asset management process used to satisfy asset and system needs, in alignment with the asset management objectives described in Section 4.2 - Asset Management Scope, Strategy and Objectives. For each process, details are provided on the tools and methods used, inputs and outputs of information, and how opportunities are identified to coordinate for cost effectiveness.

The process involves several crucial stages that collectively contribute to the development of the investment plan for both Capital and OM&A activities. Each of these stages is described in the following sections:

- **Section 5.1: Prepare**
- **Section 5.2: Plan**
- **Section 5.3: Optimize**
- **Section 5.4: Execute**

Hydro Ottawa's asset management process is shown in Figure 7.

1 **Figure 7 - Asset Management Process Details**

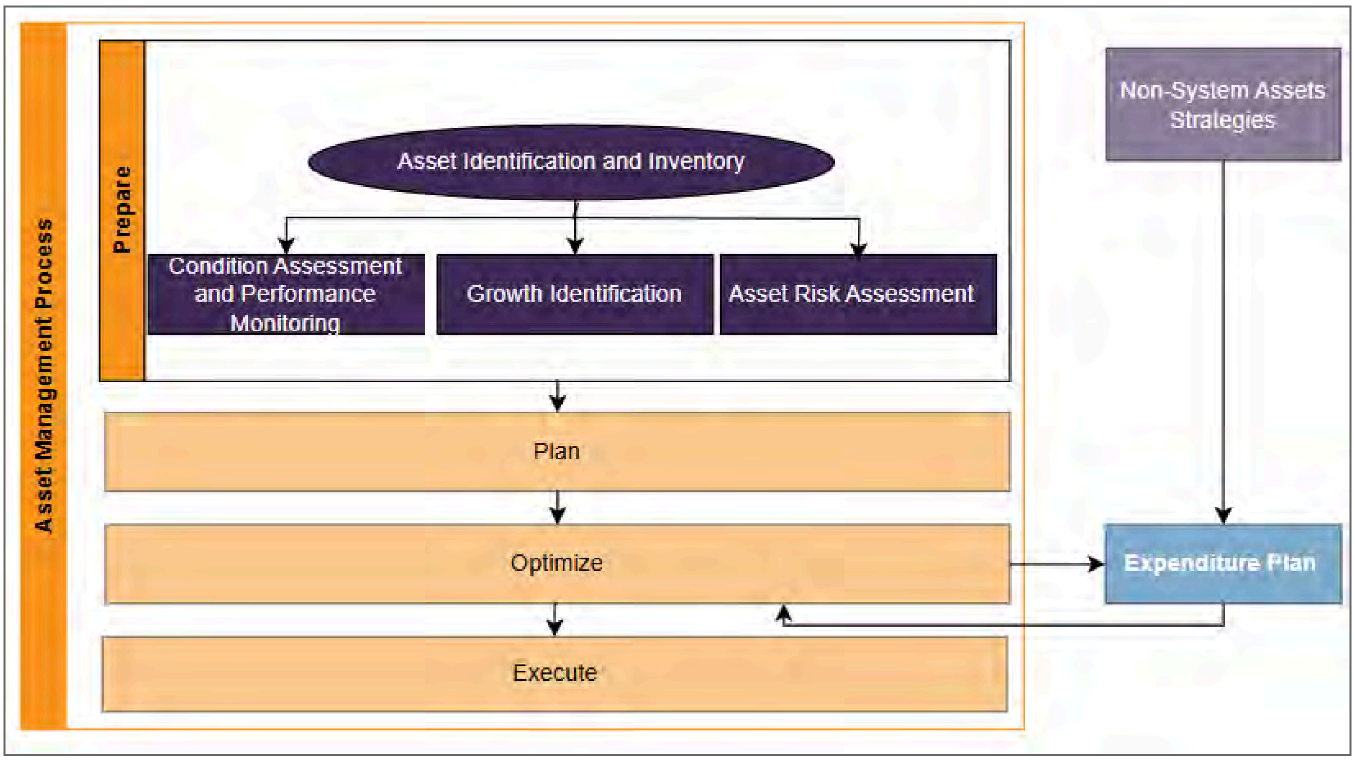


2

5.1. PREPARE

The preparation stage of asset management is a multifaceted process that lays the groundwork for effective and strategic decision-making. Figure 8 shows the components of this stage of the asset management process. It commences with a comprehensive identification of distribution assets, followed by a meticulous assessment of the risks associated with each asset, considering factors such as operational, financial, and environmental risks.

Figure 8 - Asset Management Process: Prepare Stage



Furthermore, the preparation stage entails a thorough review of the results gleaned from testing and maintenance activities. This involves scrutinizing maintenance records, analyzing test data, and identifying trends or patterns that may indicate potential asset degradation or failure. Additionally, the condition of each asset is evaluated, taking into account factors such as age, usage, and wear and tear.

Another crucial aspect of the preparation stage is the identification of regional growth patterns. This involves analyzing demographic trends, economic indicators, and infrastructure development plans to anticipate future demands and ensure that asset management strategies are aligned with regional growth objectives.

Finally, the preparation stage encompasses a rigorous analysis of performance metrics. This involves tracking KPIs such as reliability, asset condition, asset utilization and efficiency to assess the effectiveness of asset management practices and identify areas for improvement. By diligently executing these tasks, the preparation stage ensures that asset management is rooted in a comprehensive understanding of the organization's asset landscape, risks, and performance, enabling informed and proactive decision-making.

5.1.1. Asset Identification and Inventory

In this phase, Hydro Ottawa focuses on establishing and maintaining an inventory of all distribution assets under its ownership or management. The inventory process involves meticulously gathering detailed information about each asset, including its type, precise location, current condition, and criticality. This comprehensive inventory serves as the cornerstone for subsequent asset management activities.

Asset Register

The asset register is the system of tools used to capture, organize, and disseminate data pertaining to Hydro Ottawa's distribution assets. Hydro Ottawa maintains electronic repositories to store its technical, testing, inspection, and maintenance information, and geographic data for most of its distribution assets (buildings and other non-power delivery assets are excluded). These repositories allow the data to be collected, reported, and queried in a manner that enables efficient dissemination and reporting of information.

The system of record for Hydro Ottawa's power delivery assets is the Geographical Information System (GIS), based on Intergraph's G/Technology platform. With minor exceptions (i.e. secondary conductors in the downtown core), it forms a complete repository of Hydro Ottawa's assets used within its stations and distribution system. These minor exceptions do not reduce the effectiveness or usability of GIS as they are few in number and typically do not bring additional clarity during analysis. The missing data can be readily retrieved elsewhere if the need arises.

Hydro Ottawa's GIS is used to store, query, and provide reports to enable the analysis and development of investment plans. The data kept in the system is continuously improved through feedback from field staff and data collected through inspection programs. Using a graphical interface, it enables users to view distribution assets on a geo-referenced map showing location, technical nameplate data, and assess their relationship to other nearby assets, including electrical connectivity and relation to civil structures. Further, this system is used by resources in the field while collecting asset condition data, exclusive of station assets, before storing it within the same repository.

For Hydro Ottawa's Station assets, the PowerDB system is used for the collection of testing, inspection, and maintenance data as it allows for more complex collection forms. Technical data is stored through customized forms for each asset class and maintenance activity. This technical data can then be exported for further analysis, and is used as input into the health index formulation for specific assets described in Section 5.1.2 - Condition Assessment and Performance Monitoring. Each station's geographic information is stored in GIS.

To satisfy the increased inspection data demands for well-informed investment choices and the shift towards condition-based maintenance, a more effective tool for gathering asset data is necessary. The adoption of an EAM solution over the 2026-2030 rate period will facilitate this, among other key benefits. The resulting robust network model and automated field data collection will allow for sophisticated analytics, anomaly identification, and enhanced health assessments. For further information on the EAM project, please refer to Attachment 4-1-1(A) - Transition to Cloud Computing.

5.1.2. Condition Assessment and Performance Monitoring

Regular condition assessments are conducted to evaluate the current state of assets. These assessments involve inspections, testing, and data analysis to determine the physical condition, remaining useful life, and potential risks associated with each asset. Performance monitoring systems track asset performance indicators, enabling early identification of issues and proactive maintenance or replacement.

5.1.2.1. Asset Condition Assessment

Hydro Ottawa uses health index scores for its assets to rate their condition and understand the requirements for intervention. Hydro Ottawa engaged a third-party expert (METSCO) to develop its asset health indexing and condition assessment framework in 2015, which is a weighted addition of a number of degradation factors to determine an overall health index score. This framework has since been reviewed twice, once for the 2021-2025 DSP and again for the 2026-2030 DSP. The most recent review by Hatch, which is filed in Attachment 2-5-4(C) - Asset Condition Assessment Third Party Review, concluded that (i) Hydro Ottawa's ACA framework is comprehensive and that (ii) the calculations are aligned with methodologies that generally reflect industry best practices.

The health index is an indicator of an asset's condition and remaining life and is assigned a score from 100% to 0%. A new asset will have a health index of 100%, while an asset in very poor condition would have a health index below 30%. Table 5 presents the health index ranges, corresponding asset condition, and the required action generally associated with each health index band.

Table 5 – Asset Condition Based on Health Index

Health Index (%)	Condition	Description	Requirements
85-100	Very Good	Some aging or minor deterioration of a limited number of components	Normal maintenance
70-85	Good	Significant deterioration of some components	Normal maintenance
50-70	Fair	Widespread significant deterioration or serious deterioration of specific components	Increase diagnostic testing; possible remedial work or replacement needed depending on criticality and degradation pattern
30-50	Poor	Widespread serious deterioration	Replace or rehabilitate considering risk and consequences of failure
0-30	Very Poor	Extensive serious deterioration	Asset has reached its end-of-life; immediately assess risk; replace or refurbish based on assessment

To determine the health index for a given asset, an assessment specific to the asset under consideration is used to convert various condition parameters (such as visual inspection, electrical test results, infrared scan information, etc.) that describe the asset's condition down to a single value. These values are then used to prioritize asset replacement, when warranted, and are used to determine the probability of failure associated with each individual asset, alongside the related baseline risk as established by the PA process, see Section 5.1.4 - Asset Risk Assessment for more details.

As a part of the failure curve calibration exercise for the various asset classes, Hydro Ottawa engaged a consultant, Hatch, to review its existing asset failure curves and develop data-driven failure curves where applicable. Please refer to Attachment 2-5-4(D) - Failures Curves Review and Section 4.4.4 Failure Curves and Typical Useful Life Update of this Schedule. Statistical analysis leveraging Hydro Ottawa's asset registry and replacement information was instrumental in arriving at the best synthetic registry (aligned with Hydro Ottawa's asset population) and the corresponding Weibull curves. For the asset classes where the simulation model did not converge, recommended failure curves were developed based on ensuring an alignment with industry consensus and Hydro Ottawa's data maturity/asset registry demographics. Hatch categorized Hydro Ottawa as a utility with slightly low maturity specific to historical failure records but having robust asset survival information. Even prior to this exercise (from 2023), Hydro Ottawa started compiling detailed asset failure information, relating any asset failure to the nomenclature, age, and condition at the time of failure (apart from establishing the probable root cause). Also, the historical asset failure curves used by Hydro Ottawa were largely found to be in alignment with best industry estimates. As an output of the failure curve calibration initiative, Hatch recommended Hydro Ottawa to continue to improve the tracking of asset failure information and ensure continued health indexing across its asset fleet.

The failure curve results obtained through this exercise greatly aided in improving Hydro Ottawa's risk assessment process for system renewal investment planning by utilizing them in the Copperleaf PA module for forecasting asset degradation patterns and establishing the optimal time of intervention for each individual asset in the system. Also, the typical useful lives of all asset classes were established to highlight the expected duration an asset can reliably operate before it requires replacement or refurbishment.

Hydro Ottawa has made several key improvements to its condition assessment process since 2014. The health indexing framework now includes additional condition parameters captured from existing inspection and maintenance programs, and age is no longer as heavily weighted. Age is now translated to condition using the linear piecewise/linear relationship established between age and condition through the failure curve development exercise with Hatch. This approach was used to determine the equivalent condition value for assets that had a known age, but lacked a valid health index to be used in Copperleaf PA. Additionally, a validity measure was implemented to ensure that at least 70% of the condition information is available to define a health index value.

Hydro Ottawa has also assessed the maturity of its ACA implementation by a third party. The summary of this assessment can be found in Attachment 2-5-4(C) - Asset Condition Assessment Third Party Review. Overall, the third party, Hatch, found that Hydro Ottawa's ACA framework utilized robust formulations that are in alignment with best practices, and that it was tightly integrated with Hydro Ottawa's broader Asset Management related processes, procedures, and outcomes. Hatch identified minor calculation gaps with minimal impact to the overall asset portfolio and Hydro Ottawa found mitigation solutions, ultimately resulting in addressing all the calculation gaps as a result of the project. Hatch also provided suggestions for enhancing the methodologies, with Hydro Ottawa being in the process of gathering additional data and exploring solutions to support advanced analytics and meet evolving data requirements. The potential opportunities for improvement highlighted by Hatch as a part of this exercise include:

- Enhanced coding/modeling practice for asset health indexing, see Section 4.4.11 - Asset Management Technology
- Integrated analytics and/or EAM and/or Asset Performance Management solution, see Section 4.4.11 - Asset Management Technology
- Non-linear modeling to better reflect asset management philosophy
- Considering additional criteria for certain asset classes, if feasible (e.g. including short circuit/fault level information)

Hydro Ottawa has targeted plans to further advance its ACA process as a part of the 2026-2030 rate period, inclusive of enhancements in data collection and analysis (based on OM&A programs), exploring an EAM solution and investments in ADMS to have better visibility into system level information.

5.1.2.2. Testing, Inspection, & Maintenance Programs

Hydro Ottawa's planned testing, inspection, and maintenance programs are the utility's primary means of collecting condition data used to calculate the health index of assets and to identify corrective actions to ensure continued reliable operation.

Hydro Ottawa's planned programs can be divided into three groups:

1. Predictive: Assessing the condition of the asset
2. Preventative: Maintaining the condition of the asset
3. Corrective: Improving the condition of the asset

Predictive programs: Collect technical details, testing, and inspection data used to identify assets in need of corrective actions while determining the asset's overall condition. These programs use a combination of inspection techniques depending on the asset type being considered and the failure mode(s) that pose an increased risk to safety, reliability, or the environment. The deployment of communication and sensors on certain new or upgraded assets provides the ability to monitor the condition of assets and collect operational data in real-time. This can reduce or eliminate the need for predictive programs to physically collect asset data. Furthermore, the ongoing monitoring can support the eventual transition from time-based to condition-based maintenance.

Preventative programs: Maintain the existing condition of the asset. Some asset types require regular maintenance activities that are time-based, while other assets are maintained after a certain number of operations to ensure that they will continue to operate as designed. These include visual inspection/mechanical activities such as cleaning, tensioning, tightening, calibrating, and realigning various components, aside from electrical testing.

Corrective programs: Improve the condition of the assets by repairing, replacing, or refurbishing various defective or degraded components. This activity aims to ensure the asset maintains performance, particularly when premature degradation occurs, and may also extend the asset's TUL.

More information on Hydro Ottawa's testing, inspection, and maintenance programs can be found in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

5.1.2.3. Performance Metrics

Hydro Ottawa monitors the performance of its assets and systems to ensure the successful delivery of its Asset Management Objectives. Continuous improvement is achieved through the use of KPIs. Schedule 2-5-3 - Performance Measurement for Continuous Improvement outlines Hydro Ottawa's DSP performance measurement framework and associated KPIs.

5.1.3. Growth Identification

To power a growing community, Hydro Ottawa needs to expand grid capacity while ensuring the reliability and efficiency of its electrical network. Growth identification for Hydro Ottawa's service territory is informed by two types of forecasts — Hydro Ottawa Planning forecast and IRRP forecast.

Hydro Ottawa's planning forecast uses available information of known developments to predict future load increases at the station level, excluding systemic electrification impacts but including known large load requests, see Section 9.4.1 - Hydro Ottawa Planning Forecast for more details. These large load requests, ranging from 5 MVA to 57 MVA, are primarily driven by electrification of heating and transportation in large institutions and companies. The forecast also includes initial-stage customer requests to anticipate future load impacts, providing the foundation for capacity investment needs in the near term (until 2030) primarily driven by existing capacity constraints and committed load requests. However, this forecast, relying on historical consumption patterns and projected growth based on known and observable trends, fails to capture the impacts of decarbonization goals and the resulting electrification of space heating, water heating, and transportation.

Hydro Ottawa's IRRP forecast incorporates the Decarbonization Study's hourly system coincident peak forecasts to reflect the impact of electrification on future energy demands, see Section 9.4.2 IRRP Forecast for more details. This strategic shift is essential for medium to long-term (beyond 2030) transmission planning, as investments in the provincial grid require lead times exceeding five years. By aligning with the Decarbonization Reference Scenario, Hydro Ottawa ensures that immediate capacity investments are consistent with anticipated long-term needs, optimizing asset utilization and enabling efficient capital deployment. This approach facilitates a more robust and forward-looking planning process, critical for navigating the evolving energy landscape driven by decarbonization goals.

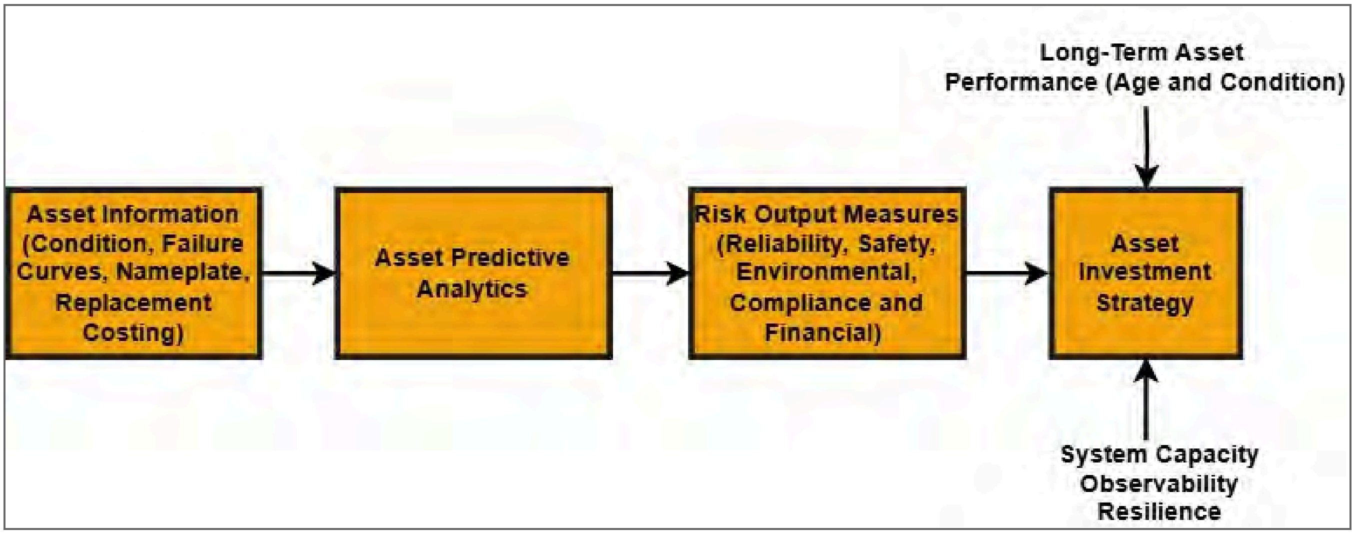
More details on the load forecasting approach are available in Section 9.4 - Planning Load Forecasting and details on capacity assessment in Section 9.1 - Capacity Needs Assessment.

5.1.4. Asset Risk Assessment

Risk assessments are performed to identify and evaluate the risks associated with asset failures. Factors such as asset criticality, failure consequences, and likelihood of failure are considered. Risk assessments help to prioritize assets requiring intervention based on their potential impact on service reliability, public safety, and financial implications.

Hydro Ottawa systematically follows the asset management process to ensure that its physical assets are managed proactively, risks are mitigated, and capital investments are made strategically to maintain a reliable and efficient electricity distribution system for its customers. Hydro Ottawa utilized the PA module within Copperleaf Asset to perform a comprehensive risk assessment considering various risk measures for capital investment planning, as shown in Figure 9.

Figure 9 - Asset Risk Assessment Framework



Hydro Ottawa’s risk assessment framework is two-fold:

- **Part One: Asset Risk Evaluation**
  The initial stage of the framework focuses on evaluating the risk associated with each asset. This is achieved through the application of the PA module within Copperleaf Asset.
  - **Asset Information (Condition, Failure Curves, Nameplate, Replacement Costing):** PA considers various factors such as the asset condition, failure curves, nameplate information, and replacement costing.
  - **Asset Predictive Analytics:** By quantifying the likelihood and consequence of asset failure in addition to the asset’s criticality to the system, PA provides a risk score for each asset, enabling a comparative analysis and prioritization based on risk levels.
- **Part Two: Asset Investment Strategy Development**
  The second stage builds upon the risk assessment conducted in the first part. It involves formulating an asset investment strategy that aligns with Hydro Ottawa's overarching asset management objectives.
  - **Risk Output Measures (Reliability, Safety, Environmental, Compliance and Financial):** The PA module calculates the overall value of intervening on an asset

based on key risk output measures - reliability, safety, environmental, compliance and financial.

  - **Long-Term Asset Performance (Age and Condition):** Long-term asset performance, in terms of the age and condition projections by PA into 2040 is a key consideration in defining underlying system renewal investment alternatives, to decide on the most optimal investment strategy.
  - **Asset Investment Strategy:** The most optimal investment alternative or strategy is finalized based on the objective of balancing long-term affordability and minimizing the failure risk associated with assets in degraded condition.

In addition to risk mitigation, the asset investment strategy considers other crucial factors that influence asset management decisions. These factors include:

- **System Capacity**: Ensuring that the system has sufficient capacity to meet current and future demand, while considering potential expansion and upgrades.
- **Observability:** Implementing monitoring and control systems that provide real-time visibility into asset performance, enabling proactive maintenance and issue detection.
- **Resilience:** Evaluating the ability to enhance the resilience of distribution assets (specifically OH infrastructure), in response to the increasing impact of extreme weather events such as ice storms, Derechos, and tornadoes.

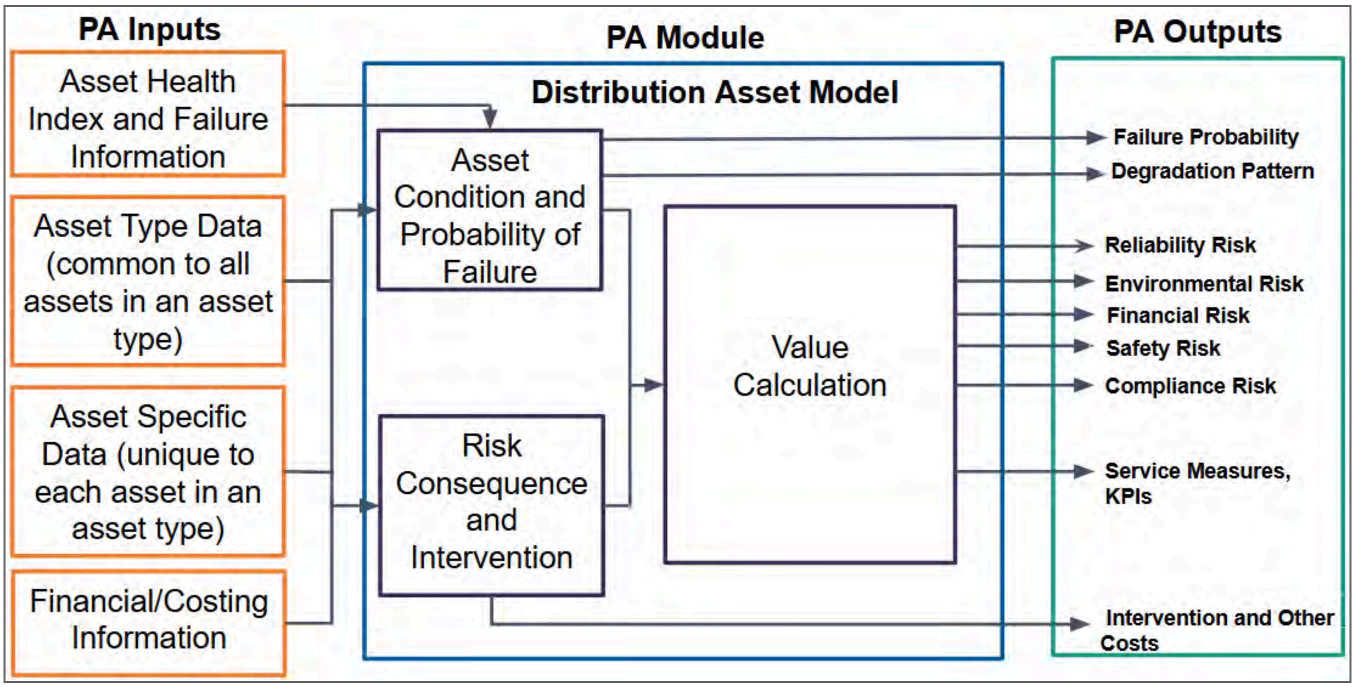
Table 6 provides the assets that are integrated into the PA module for each of the asset classes - Stations, Distribution Overhead, and Distribution Underground:

Table 6 - Assets Integrated with Predictive Analytics

Stations	Distribution Overhead	Distribution Underground
Batteries	Composite Poles	EPR Cables
Circuit Switchers	Concrete Poles	PILC Cables
HV SF_6 Breakers	Metal Poles	XLPE Cables
Metalclad Air Breakers	Wood Poles	Manholes
Metalclad Oil Breakers	Polemount Transformers	Underground Primary Pedestals
Metalclad SF_6 Breakers	Manual Loadbreak Switches	Padmount Switchgear (Air)
Metalclad Vacuum Breakers	SCADA Loadbreak Switches	Padmount Switchgear (Gas)
Station Outdoor Reclosers	Overhead Reclosers	Padmount Transformers
Station Transformers		Vault Switchgears
Station Transformer Tap Changers		Vault Transformers

Hydro Ottawa developed a distribution asset model within the PA module to determine its asset renewal needs, as shown in Figure 10. Asset information (including financial/costing), condition, probability of failure curves, risk consequences, and intervention data gets used in the distribution asset model towards calculating an overall value for risk assessment. Based on the calculated value, the distribution asset model determines the optimal replacement date for a given asset. This is achieved by balancing value maximization with risk and cost minimization, to establish the recommended asset replacement timeline. Utilizing the distribution asset model developed within PA allows Hydro Ottawa to minimize impact to customers by factoring in key risk measures as a part of asset renewal decision-making.

Figure 10 - Distribution Asset Model Architecture



The following sections describe in detail the inputs that feed into PA, the PA module, and the resulting outputs.

5.1.4.1. PA Inputs

Diverse inputs enable the distribution asset model within the PA Module to generate a comprehensive assessment of the asset's condition, risks, and associated costs. These inputs are described below:

a) **Asset Health Index and Failure Information:** PA considers the health index of an asset to establish the baseline condition. It further requires the probability of failure curves unique to each asset type to forecast the degradation pattern and future risk values. In the absence of health index information, it translates the age of an asset to its equivalent condition, based on the established age-condition curves.

b) **Asset Type and Asset Specific Data:** PA considers data pertaining to all asset types (e.g. age, condition, manufacturer, voltage, etc.) in addition to asset-specific data (e.g. oil quantity of oil-filled equipment, SF_6 quantity related to gas-filled equipment etc.).

c) **Financial & Costing Information:** PA considers the replacement cost of an asset between planned and corrective renewals (critical/emergency replacements) for like-for-like or like-for-better scenarios. It also considers the maintenance cost of an asset, to recommend the relevant intervention strategy that derives the maximum value.

5.1.4.2. PA Module

a) **Asset Condition and Probability of Failure:** PA uses the asset health index information/age of an asset to establish the failure probability/degradation pattern, unique to each individual asset in the system.

b) **Risk Consequence and Intervention:** Within PA, the risk consequence calculations are performed unique to each individual risk being considered (reliability, safety, environmental, financial, and compliance). The relevant intervention strategy can also be defined in PA based on constraints and the nature of replacement required (like-for-like or like-for-better).

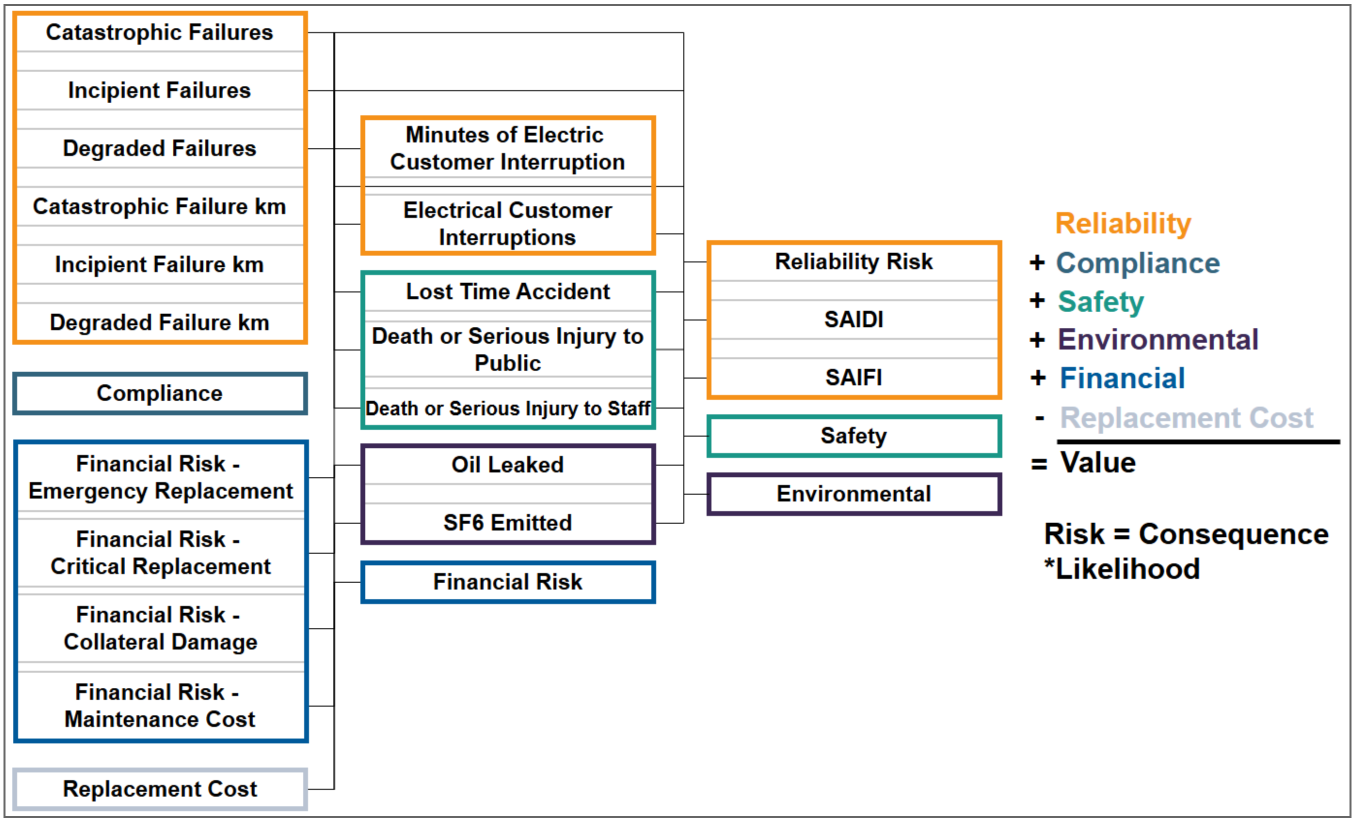
c) **Value Calculation:** PA calculates the overall value of intervening on an asset at a given point in time based on the probability and consequence of the risk measures considered (reliability, safety, environmental, financial, and compliance).

5.1.4.3. PA Outputs

a) **Asset Failure Probability and Degradation Pattern:** Based on the asset condition and probability of failure curve, PA provides an output of the asset failure probability and the expected degradation pattern over time.

b) **Value Measures:** The value measures determined by PA are shown in Figure 11. These value measures are used to calculate the overall value of asset replacement at a given point in time and also support relevant asset renewal decisions.

Figure 11 - PA Module Value Measures



i) Risk Measures: The key risk measures (calculated by the PA module) used to compare the relative value of replacing different assets are shown below:

- **Reliability Risk** is the risk associated with the asset's ability to perform its intended function. It is calculated based on the consequences of failure (outage duration, lost redundancy duration, number and type of customers affected, peak load, and worst performing feeder) and the likelihood of failure (based on individual asset failure curves and the probability of emergency, critical, or expected failures).
- **Compliance Risk** is the risk associated with the asset not complying with regulations. The consequence is calculated based on the financial penalty for non-compliance and

the likelihood that the asset will need to be replaced to maintain compliance by a certain date.

- **Safety Risk** is the risk associated with the asset causing harm to the public or Hydro Ottawa crews. It is calculated based on the consequences of an incident (number of lost time accidents, deaths, or serious injuries to Hydro Ottawa staff and the public that occur per incident) and the likelihood of an incident (based on asset location, individual asset failure curves and the probability of emergency, critical, or expected failures).
- **Environmental Risk** is the risk associated with the asset causing environmental contamination or damage. It is calculated based on the consequences of an environmental incident (oil leaked, SF_6 emitted and oil containment present or not) and the likelihood of an incident (based on individual asset failure curves and the probability of emergency, critical, or expected failures).
- **Financial Risk** is the risk associated with the cost of replacing or repairing a given asset. It is calculated based on the consequences of different types of replacement (Planned Renewal, Emergency Renewal, Critical Renewal, Collateral Damage (tied to other widespread damages not limited to the asset failure alone) and Planned Maintenance Costs) and the likelihood of those replacements (based on individual asset failure curves and the probability of emergency, critical, or expected failures).

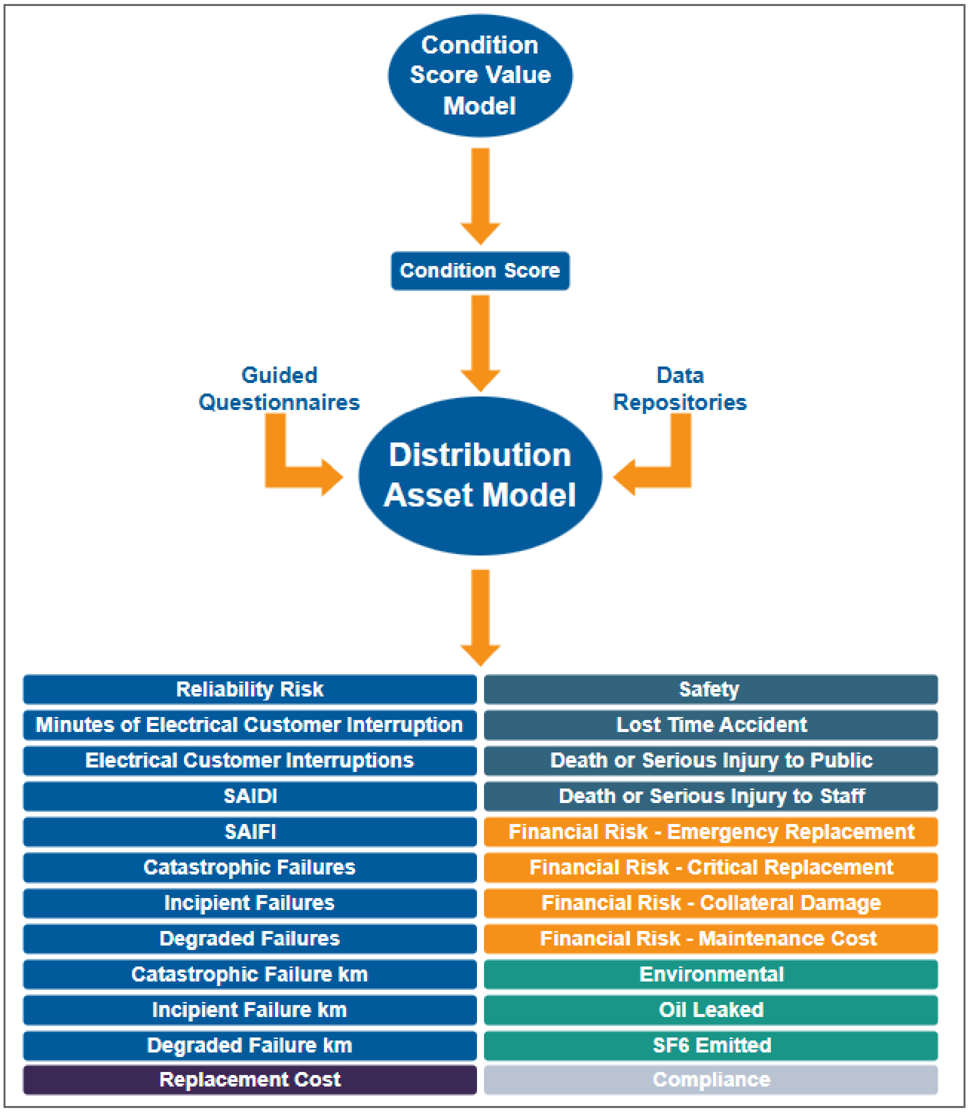
ii) Replacement Cost: PA considers the cost of replacing an asset under normal (planned) or emergency/critical conditions based on the desired nature of replacement (like-for-like or like-for-better).

c) **Service Measures:** Based on the distribution asset model calculation within PA, service measures such as SAIDI, SAIFI, Customer Minutes of Interruption or CMI, Customer Interruptions, forecasted number of failures, lost time accident, death or serious injury to staff/public, amount of oil leak, and amount of SF_6 emitted can be obtained. These service measures can be used as constraints within the distribution asset model to further optimize an investment scenario (e.g. defining SAIDI, SAIFI thresholds to establish the investment level required each year).

d) **Intervention and Other Costs:** PA forecasts the risk impact of asset deterioration over time. It optimizes asset remediation timing by evaluating the overall value of intervention strategies, guiding investment decisions. It shows the optimal and recommended intervention date for each individual asset in the system and the related costs.

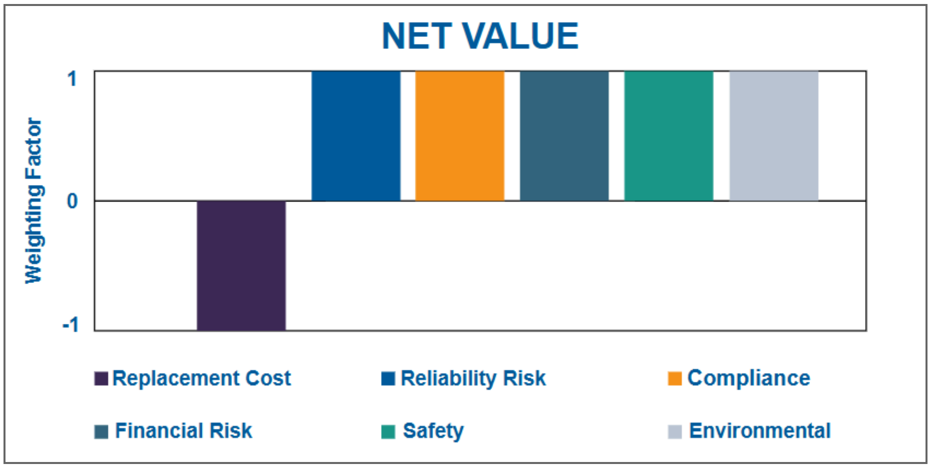
The distribution asset model within the PA module, including inputs and output measures, is illustrated in Figure 12 and details the specific inputs and calculations used to determine these output measures.

Figure 12 - Distribution Asset Model in Copperleaf PA Value Measures



Based on the distribution asset model implemented in Copperleaf Asset, the net value of intervening on any given asset is computed as a function of the various risk measures: reliability, safety, environmental, financial and compliance compared against the replacement cost. Figure 13 shows the weighting factors that are applied to the six value measures that contribute to the value function.

Figure 13 - Weighting Factors of Value Measures that Contribute to the Value Function



PA aligns Hydro Ottawa's investment plans with strategic goals, improves efficiency, integrates planning, and manages deteriorating infrastructure risk. This leads to higher-value decisions, improved business performance, and optimized resource allocation.

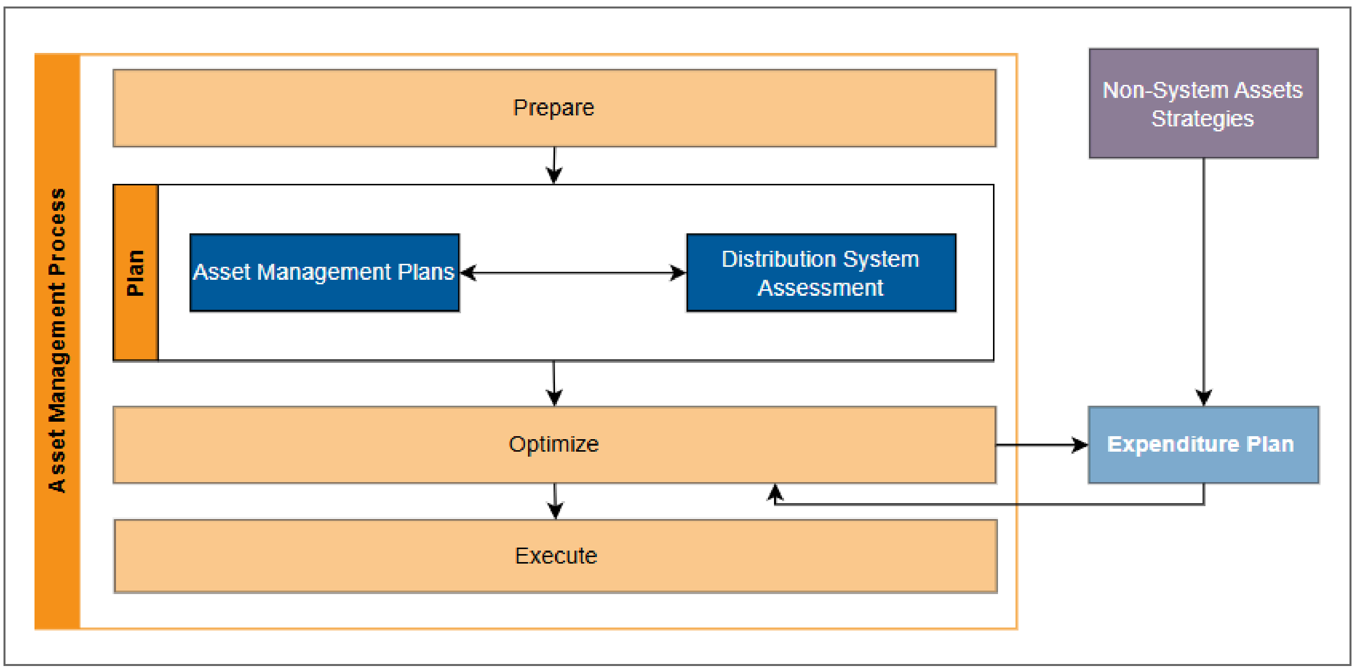
Hydro Ottawa's asset intervention assessment process in Copperleaf PA is centered around three primary alternatives at the program level: Cost Containment, Short Term Risk Mitigation, and Long Term Risk Mitigation. The alternatives undergo a thorough evaluation to review the ability to balance long term affordability and minimize the failure risk associated with assets in a degraded condition.

5.2. PLAN

This stage encompasses the creation of detailed AMPs that strategically align with the overarching system requirements while effectively addressing identified risks and objectives as shown in Figure 14. These plans take into account a multitude of factors such as capacity constraints, reliability requirements, resilience needs, and grid modernization initiatives. Furthermore, this stage includes a thorough analysis and identification of the necessary capital investments and OM&A expenditures that are essential to support the proposed asset management strategy and ultimately achieve the desired outcomes.

By meticulously considering these various aspects, the AMPs developed in this phase will provide a comprehensive roadmap for optimizing the performance, reliability, and longevity of assets while ensuring they are aligned with the broader system needs and objectives. This approach to asset management will not only mitigate risks but also enhance the overall efficiency and effectiveness of the system, leading to improved operational outcomes and long-term sustainability.

Figure 14 - Asset Management Process: Plan Stage



5.2.1. Asset Management Plans

Hydro Ottawa prepares AMPs for each asset group or class. An AMP is a comprehensive, multi-year plan designed to guide Hydro Ottawa in achieving its asset management objectives, outlined in Section 4.2 - Asset Management Scope, Strategy and Objectives. An AMP outlines the necessary activities, strategies, and timeframes, drawing upon principles stated in Section 4.2 - Asset Management Scope, Strategy and Objectives. AMPs incorporate insights from internal stakeholders, ensuring a thorough understanding of specific asset needs and management requirements.

AMPs focus on defining the required level of service for assets and ensuring alignment with the broader asset management objectives and performance measures. AMPs also include a detailed assessment of the current condition and performance of assets, enabling the identification of areas where improvements can be made. By pinpointing these gaps, the AMPs help to identify remedial actions to enhance asset performance and reliability.

AMPs are also forward looking and consider future demand and various drivers that may influence asset management practices. This forward-looking perspective allows Hydro Ottawa to anticipate changes and adapt its strategies accordingly. Finally, AMPs outline the lifecycle strategies and activities associated with managing assets effectively. They identify the resources needed to execute these strategies and present a financial plan that supports the overall asset management approach. AMPs serve as roadmaps for Hydro Ottawa to optimize asset performance, mitigate risks, and ensure the long-term sustainability of its infrastructure.

Hydro Ottawa has developed AMPs categorized as follows:

1. Underground Transformers
2. Underground Switchgear
3. Station Transformers
4. Station Switchgear and Breakers
5. Poles, Fixtures and Overhead Conductors
6. Overhead Switches
7. Overhead Transformers
8. Civil Structures
9. Underground Cables
10. Station Batteries, Protection and Control Equipment

11. Vault Transformers
12. Telecommunications
13. Revenue Meters

5.2.1.1. Program Planning Approach

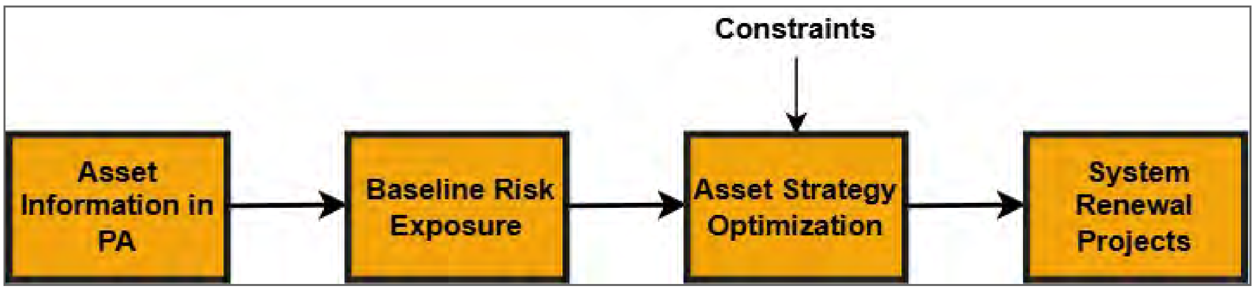
The AMPs are strategically aligned with the overall system requirements while proactively addressing identified risks and objectives. They serve as a comprehensive and actionable roadmap for optimizing asset performance, reliability, and longevity. Furthermore, they encompass a detailed analysis of the capital expenditures necessary to effectively support the overarching asset management strategy. Hydro Ottawa's DSP is informed by the AMPs, which also ensure that the resulting capital programs are monitored, implemented, and reported on annually through relevant AMP updates. Hydro Ottawa monitors the asset demographics (in terms of age/condition) and other impacts/risks to an asset type through the AMPs, which are key factors that drive the program planning process, in addition to the risk-based assessment outlined below for system renewal investments.

Hydro Ottawa leveraged the Copperleaf PA module to facilitate and enhance the decision-making process surrounding the allocation of financial resources towards system renewal program-level expenditures. As described in Section 5.1.4 - Asset Risk Assessment, Hydro Ottawa developed a distribution asset model by utilizing asset condition to forecast the degradation pattern based on the probability of failure. Asset-specific consequences and exposure factors were also established based on asset criticality with higher granularity.

Figure 15 below shows the system renewal planning process with Copperleaf PA. Hydro Ottawa loads asset information in PA, and the asset data is automatically run through the established distribution asset model. The PA module computes the baseline risk for all assets and establishes the risk exposure for Hydro Ottawa if no intervention were to be executed. PA also determines the most effective sustainment strategy to mitigate baseline risk exposure while considering constraints such as financial budgets, risk, resources, and service levels/measures. Copperleaf PA allows

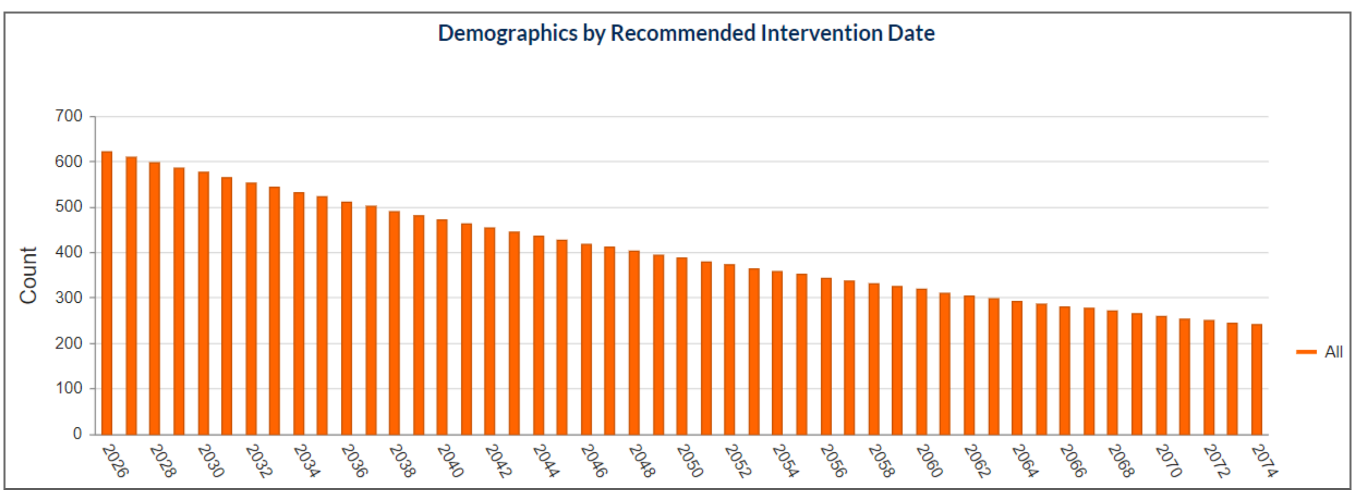
Hydro Ottawa to evaluate multiple scenarios, looking at various interventions and constraint levels on the asset sustainment strategy.

Figure 15 - System Renewal Planning Process with Copperleaf PA



Only direct asset replacement costs are considered in Copperleaf PA as a part of system renewal investment planning and establishing the recommended number of units to be replaced per year. Copperleaf PA determines an optimized spending level based on the underlying constraints in order to realize maximum value. Based on the example shown in Figure 16, for a given asset type, PA recommends more replacements in the initial years (driven by asset condition and risk), so the investment required tapers down in the future, as a part of the most optimal investment strategy.

Figure 16 - Yearly Recommended Interventions with Copperleaf PA



As a part of the optimization process in Copperleaf PA, Hydro Ottawa primarily considered the age and condition demographic projections into 2040, to develop three main alternatives with varying replacement levels. The major objective behind developing these alternatives was to balance long-term cost impacts to customers with the failure risk of assets in a degraded condition.

The following three alternatives were considered to plan the system renewal investments across the major distribution asset renewal programs:

1. **Cost Containment:** Cost impacts are minimized during the 2026-2030 period, however replacement rates will not allow Hydro Ottawa to balance long-term affordability or effectively manage risk associated with assets in degraded condition
2. **Short Term Risk Mitigation:** Cost impacts are more significant and replacement rates will allow Hydro Ottawa to mitigate only short term risk associated with assets in degraded condition
3. **Long Term Risk Mitigation:** Cost impacts are highest however replacement rates will allow Hydro Ottawa to most effectively balance long-term affordability and risk associated with assets in degraded condition

The aforementioned alternatives are evaluated against the corresponding evaluation criteria considered (such as safety, reliability, financial, system observability, resilience, etc.), to finalize an optimal investment alternative for a given asset type.

For additional details regarding investments planned for asset replacements for 2026-2030, refer to Schedule 2-5-7 - Asset Renewal Investments, Sections 1 through 5. The information from the Distribution System Assessment phase described in Section 5.2.2 - Distribution System Assessment is also considered to determine final investment asset renewal needs.

5.2.2. Distribution System Assessment

The distribution system assessment phase involves analyzing system constraints using the planning forecast from the growth identification phase to determine the need for capacity upgrades or reinforcements. The identification of system constraints is determined through evaluating the existing distribution system's capacity to meet the forecasted planning demand to identify bottlenecks and areas where upgrades or reinforcements may be needed. The assessments also aim to improve the reliability and resilience of the system. Hydro Ottawa's resilience assessment aligns with the OEB's future VASH framework by taking an asset-based approach that relies on data derived from climate forecast models developed by a third-party consultant. A quantitative analysis comparing asset threshold criteria to the probability of extreme weather events within the project evaluation stage ensures investments improve climate resilience within the distribution system. Section 5.2.2.4 - Resilience Assessment provides more detail on the resilience assessment.

5.2.2.1. Grid Modernization

Hydro Ottawa routinely reviews the existing system to identify opportunities for Distribution Enhancement projects that reduce operational constraints and improve system operability, through observability and controllability. Efficiency-driven projects are designed to reduce restoration times and reduce the number of personnel required for switching. As per Section 3.4.2 - Grid Modernization Strategy, the operability of the distribution system will be enhanced through advanced monitoring, rapid fault detection and localization, improved overload detectability, and automated/remote system restoration. System operability will also benefit from resilience measures that strengthen the distribution system and reduce the impact of outages from weather events.

The following criteria are used to identify areas that will benefit from projects related to operability:

- Asset Vulnerability
    - Areas prone to weather impacts
    - Areas with deteriorating infrastructure
    - Areas which are difficult to access or patrol
- Asset Criticality
    - Frequency of historical switching operations

  - Criticality of connected load
  - Number of customers connected and/or customer density
- Regional Considerations
  - Areas with loading constraints
  - Historical reliability performance
  - Density of DERs
  - Areas with high growth projections

These criteria are assessed within the grid modernization and resilience strategies for the purpose of increasing system observability and controllability where applicable. The aim of these initiatives is to bring greater real-time awareness of system performance to support both daily operations and inform system planning.

The following are the results of the system operability review process; these projects are further described in Section 3 of Schedule 2-5-8 - System Service Investment and Schedule 2-5-7 - System Renewal Investments:

- Critical switches identified for upgrades to remote operable units
- Decommissioning redundant/unused legacy equipment from the system upon renewal
- Relocation of equipment or normal-open points
- Installation of Fault Current Indicators (FCIs) to localize faults on long feeders and to optimize the use of remote switches

In addition to the immediate benefits around system operability, the installation of intelligent observation and control devices in the system will set the stage for future grid modernization, laying the foundation for future improvements and functionality contributing to further system operability improvements.

5.2.2.2. System Constraints

Transmission

The distribution system is designed and planned to supply existing and future customers reliably while conforming to system design constraints. These constraints include equipment thermal and short-circuit limitations, power quality, and restoration capability standards. System constraints must be considered in the design of the transmission supply network, station equipment, and distribution feeder configuration. Due to the large load and number of customers impacted by transmission system failures, the transmission system is constrained by standards designed to ensure a high level of reliability. To ensure the reliability of the bulk power system, transmission planning must consider both the adequacy and the security of wires and resources, as well as the supply mix requirements set out in the government's Powering Ontario's Growth plan. Planning and operation of the bulk power system must comply with all applicable standards and criteria established by IESO Ontario Resource and Transmission Assessment Criteria (ORTAC), North American Electric Reliability Corporation (NERC), Northeast Power Coordinating Council (NPCC) and the IESO Market Rules. Projects to address transmission system constraints are often driven by growth within the distribution system. Hydro Ottawa provides the IESO with updated growth forecasts for the distribution system to help identify and address transmission capacity and ORTAC constraints as part of the regional planning process. Details regarding the regional planning process can be found in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Station

Hydro Ottawa's station planning criteria are based on the worst-case N-1 contingency scenario, which ensures the grid can continue operating after the failure of any single major component. The loading limit in this scenario is calculated by summing the capabilities of the remaining transformers after the largest one fails. For planning purposes, the 10-day limited time ratings (LTR) are used when available, which represent the load a transformer can handle for 10 days under peak conditions with less than 1% life loss. If the LTR isn't provided, the highest fan rating is used. Hydro Ottawa designs stations to ensure that transformers - rather than cables, buses, or breakers - set the limit on capacity. In stations with only one transformer, the load is transferred to nearby stations through feeder lines.

Feeder

At the feeder level, the system is constrained by conductor thermal limitations and voltage drop. Each feeder is planned to supply connected customers and/or back up other connected feeders in an N-1 contingency while remaining under the thermal limitation of the conductor. On the 4kV system, this is achieved by having a dedicated backup feeder available at the station, while for all other systems, this is achieved through feeder ties. Additionally, conductor properties, size of loads, and location of loads may lead to voltage drop concerns. Feeders must be configured to deliver voltage levels within the limits stated in Canadian Standards Association Standard (CSA) CAN3-C235-83 - Preferred Voltage Levels for AC Systems, 0 to 50 000 V.

Constraints of various equipment types are determined by the equipment properties information stored in Hydro Ottawa's Asset Register. Projects and operation guidelines are created to address equipment forecasted to exceed their constraints. Current capacity limitations of Hydro Ottawa's electrical infrastructure are monitored through SLI and FLI calculations, see more details in Section 8.4 - Asset Utilization Policies and Practices. The system capacity assessment and the resulting needs for each planning region are described in Section 9 - System Capacity Assessment. Alternatives to mitigate capacity needs are evaluated in Material Investment Plans (MIPs), Section 2 of Schedule 2-5-8 - System Service Investments.

The following key variables inform the capacity planning process:

- Historical station transformer loading from the system-wide annual peak day (weather-normalized and adjusted to a one-in-ten-year peak for forecasting)
- Historical feeder loading from the system-wide annual peak day (weather-normalized and adjusted to a one-in-ten-year peak for forecasting)
- Station, station transformer, and feeder planning capacity and ratings

- Asset condition
- System configuration and operating characteristics (and restrictions)
- Number of Hydro Ottawa customers
- Historical energy purchased and delivered
- Summer and winter peak load
- City of Ottawa Official Plans and Community Development Plans
- Land use designation and population and employment projections
- Known developments through conversations with developers and City of Ottawa
- Forecasted load growth triggered by decarbonization driven electrification
- DER connections and capacity
- Station capacity to connect generation and plans in place to address any restrictions
- Details and plans resulting from the IRRP process with the IESO and Hydro One Networks Inc. (Hydro One)
- Details relating to Connection Cost Recovery Agreements (CCRAs) with Hydro One for station or transmission projects

For more detail, refer to Section 9 – System Capacity Assessment.

5.2.2.3. Reliability Assessment

Distribution system assessments also aim at bolstering the overall performance and reliability of the distribution system. These initiatives include strategic endeavors to augment system reliability, elevate system observability through advanced monitoring and control technologies, and foster technological innovations. By strategically investing in these multifaceted initiatives, Hydro Ottawa aims to proactively address existing challenges, such as feeders exceeding planning limits, feeder phase imbalances, and neutral ties in the 13.2kV delta subtransmission system. The lack of 13.2kV neutral ties on the subtransmission system causes reliability concerns when connecting pad mount transformers without a delta primary as there is no return path for current, potentially causing an imbalance on phase voltage and subsequent overvoltage or undervoltage. Through these targeted investments, Hydro Ottawa seeks to not only enhance the reliability of the electrical grid but also to improve operational efficiency, reduce energy losses, and ensure the overall longevity and sustainability of the distribution system. These assessments feed into investment planning and provide input to System Service Investments.

Reliability-driven projects are those designed to reduce outage frequency or duration. In general, work considered as part of the system reliability plan includes the following:

- Feeder reconfiguration and addition of feeder ties for feeders experiencing poor reliability and/or capacity constraints
- Phase balancing of feeders with high phase imbalance
- Deployment of remote sensors
- Deployment of remotely operable and autonomous devices
- Deployment of field devices to provide fault indications locally
- Supporting technologies for automation (e.g., communication & SCADA)
- Modifications of existing installations to address specific interference (e.g., animal guards, circuit spacing)

The reliability assessment process may also identify required asset replacements. Successful lifecycle management of Hydro Ottawa's assets has a direct impact on system reliability. These activities focus on assets that are optimally maintained throughout their life, asset replacement before failure, and system planning to increase operability and reduce downtime.

The following key variables inform the reliability planning process:

- Historical outage statistics (primary cause, secondary cause, duration, number of customers affected, circuit affected, station affected, date of interruption, number of momentary interruptions)
- Worst Feeder evaluation

The following are the results of the reliability assessment process; these projects are further described in Section 2 of Schedule 2-5-8 - System Service Investment:

- Projects to improve the Worst Feeders' reliability performance
- Initiatives to improve overall reliability (specifically targeting the top three causes of interruption from the previous year)
- Details on automation plans and how they will impact reliability

5.2.2.4. Resilience Assessment

Ottawa has become the weather-alert capital of Canada.[6] Extreme weather events such as high heat, high winds, flooding, and ice storms are increasingly straining and damaging the electricity grid. Due to this, focusing on enhancing grid resilience through proactive measures and infrastructure upgrades is essential to protect against the increasing frequency and intensity of severe weather events.

Hydro Ottawa's service territory has been impacted by adverse weather events in recent years as described in Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. In 2019, Hydro Ottawa commissioned Stantec to complete a Distribution System Climate Risk and Vulnerability Assessment, as well as a Climate Change Adaptation Plan due to the increasing number of extreme weather events. Stantec reaffirmed the results from these reports in 2023 to include more recent weather events and updated climate models, refer to Section 6.4.2 - Future Climate.

Leveraging the findings from the 2023 Stantec report, Hydro Ottawa engaged Burns & McDonnell's subsidiary, 1898 & Co, to complete a Resilience Investment Business Case Assessment to identify investments that would increase grid resilience focusing on strategic undergrounding. These reports were used to establish resilience criteria that align with the OEB's VASH framework and ensure the greatest value from resilience investments. The criteria were used to create a new resilience risk

[6] Environment and Climate Change Canada.

value measure to quantify the risk associated with the frequency and intensity of major weather events on the distribution system, calculated based on a storm's impact on the reliability of a given section of feeder. This feeds into the Project Evaluation process detailed in Section 5.3.2.2 - Project Evaluation. The orientation, configuration, vegetation encroachment, and historical outage information for a given section was assessed against the ability of those assets to withstand major weather events such as high winds, winter storms, and tornadoes. The impact of a major weather event was quantified using a climate change forecast correlated against historical customer outage times. Reliability risks such as types of customers, average number of customers impacted, expected peak lost load, worst performing feeders, number of failures per year, duration of outages, and redundancy lost were referenced to assess the project value. Investments identified by the Resilience Business Case report were evaluated using this new resilience value measure to prioritize projects with the greatest resilience benefit.

Attachment 2-5-4(E) - Resilience Investment Business Case Report underscores the escalating significance of grid resilience. This emphasis was made in light of the increasing frequency of major weather events, with the report documenting the findings of the assessment. It emphasizes that resilience is not just a technical issue, but a societal one, as the modern customer and integrated society are increasingly reliant on a consistent power supply. The impact of power outages today is far greater than in the past, necessitating proactive investment in grid resilience. The report provides a conceptual framework for understanding resilience, breaking it down into three components: stressors (major events), the state of the system (vulnerabilities), and utility actions (prepare, mitigate, respond, recover). It underscores the importance of a future-focused approach to resilience, considering the 'universe' of potential events and system vulnerabilities.

The core of the report lies in its Resilience Investment Model, a data-centric approach to identify, prioritize, and justify resilience investments. The model focuses on converting overhead lines to underground systems and considers factors like vegetation density, asset age, and customer type to identify projects with the highest potential benefits. The analysis presents the results of a resilience evaluation for Hydro Ottawa, focusing on overhead to underground resilience investments. The benefits of these investments are quantified in reduced storm recovery costs and reduced customer outages, measured in Customer Minutes Interrupted (CMI). The results highlight the potential for significant customer benefits through strategic resilience investments.

Hydro Ottawa has adopted a proactive and comprehensive approach to resilience investment. Inputs from the Resilience Investment Business Case Report were considered to frame Hydro Ottawa's resilience strategy.

The report identifies 1,743 projects to underground lines, with 57 projects having a Benefit to Cost Ratio (BCR) greater than 0.8. Projects with a BCR >1 offer a positive business case, with benefits outweighing the costs, and are therefore recommended to undergo a scope evaluation. To have a larger pool of projects for scope evaluation, and consideration for other resilience measures for inclusion under the Resilience program, Hydro Ottawa considered projects with a BCR threshold greater than 0.8. These projects significantly reduce both storm restoration costs and CMI. The projects proposed have been reviewed by Hydro Ottawa and used as a starting point to frame resilience investments. Adjustments to the investments proposed by the consultant were mainly based on Hydro Ottawa's knowledge of the distribution system, such as updating project costs based on unique site conditions, and to drive efficiencies by collating project scope where it provides greater benefit.

In addition, while the report focuses on undergrounding, it acknowledges that other resilience investment options could be considered as part of a larger resilience plan such as stronger pole structures, enhanced switching, and improved access to deep right of ways. Hydro Ottawa adopted this approach to build resilience criteria that not only look at undergrounding but an overarching strategy to make the grid more resilient. Based on this, the resilience investments plans cover:

- Strategic Undergrounding - Based on Undergrounding Study results, BCR larger than 0.8 and passing of Hydro Ottawa screening
- Line Reinforcement - strong structure poles, guying and anchoring

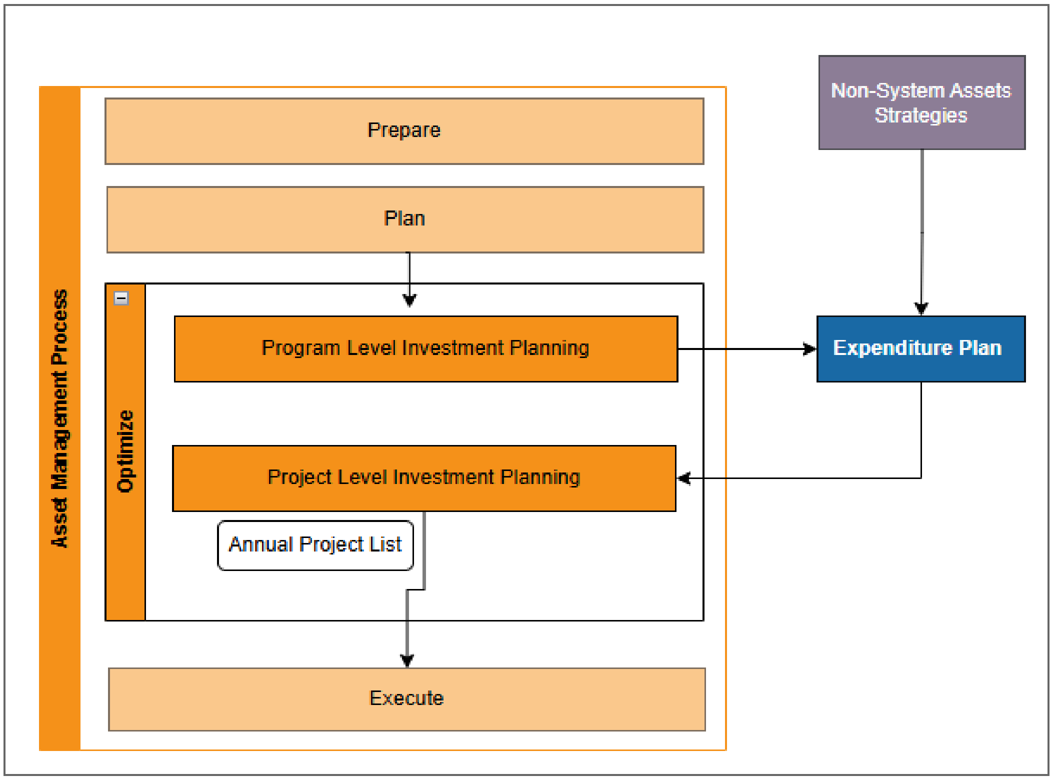
- Feeder Reconfiguration - reduce customer count on feeders heavily impacted by adverse weather conditions (radially fed customers, north-south arterials)
- Station Egress Undergrounding - undergrounding of overhead egress with more than two circuits up to a point where system flexibility increases
- Line Relocation - relocate lines with high vegetation and/or improve access to deep right of way.

More details on resilience investments can be found in Section 3 of Schedule 2-5-8 - System Service Investments.

5.3. OPTIMIZE

Hydro Ottawa organizes its Capital Expenditure Plan into four investment categories: System Access, System Renewal, System Service, and General Plant. Each category is divided into Capital Programs based on primary drivers, and then further subdivided into Budget Programs based on specific asset type or system need. Individual projects are created under Budget Programs for assets at specific geographic locations that require intervention or for specific initiatives. The investment planning process, which includes assessments at both the program and project levels, is part of the optimization stage. Figure 17 shows the components of the optimize stage for investment planning.

Figure 17 - Components of the Optimize Stage



During the program level assessment phase, the needs identified in the AMPs and the distribution system assessment during the planning stage are assigned to investment categories. Then, alternative solutions to address program needs are evaluated to select the solution that best meets asset management objectives. Selected programs are evaluated along with other non-system asset needs (IT, Facilities, and Fleet) through the Capital Expenditure Planning Process, described in Section 3.5, to create a balanced expenditure plan for rate application submission. After the Capital Expenditure Plan is finalized and approved, identified projects within each program are evaluated and scored for annual assessment during the project-level investment planning phase. A portfolio optimization tool is used to refine and optimize project selection using approved program-level constraints.

The optimization stage ensures a balanced and optimized investment approach that addresses system and asset needs identified through the distribution asset management process. This results in a Capital Expenditure Plan that prioritizes system capacity enhancements, renewal of deteriorating infrastructure, grid modernization, and increased overall resilience.

5.3.1. Program Level Investment Planning

The program-level investment planning phase involves a comprehensive integration of asset and system requirements that have been identified through the asset management process planning stage. This phase takes into account a multitude of factors, including but not limited to: investment priorities, risk mitigation strategies, regulatory compliance mandates, resource availability, and financial viability. Furthermore, the plan extends its purview to encompass requirements emanating from other non-system assets, ensuring a holistic alignment with the overarching needs of the distribution system.

The first step of this process, program definition, involves a thorough examination of the primary factors that influence each program within every investment category. This comprehensive analysis serves two key purposes:

- Ensuring that the budget is allocated appropriately and effectively to achieve the desired outcomes.
- Identifying areas where programs can be streamlined or optimized to enhance efficiency. These improvements in efficiency may also have the added benefit of addressing secondary drivers.

The second step of this process, program portfolio optimization, involves a comprehensive evaluation of how well identified programs align with the overarching investment priorities. These priorities, which include Growth and Electrification, Renewing Deteriorating Infrastructure, Grid Modernization, and Enhancing Resilience, serve as the guiding principles for investment decisions. Each of these priorities is further supported by underlying focus areas, such as Managing Rising

Costs and Investing in the Workforce, which highlight specific areas of concern within the broader strategic framework.

To facilitate the optimization process, MIPs are developed for each program. These plans provide a detailed breakdown of the financial resources required to implement the program to enable the assessment of the feasibility of different alternatives and their ability to meet the identified priorities. The assessment process involves a rigorous evaluation of the potential costs and benefits associated with each program, as well as its potential contribution to the overall strategic objectives. The evaluation criteria used to determine the preferred alternative differ depending on the program under consideration, but all follow components of the themes outlined in Table 7 below.

Table 7 – Alternative Evaluation Criteria

Evaluation Theme	Description
Regulatory and Legal Compliance	Adherence to all applicable laws, regulations, and industry standards, including specific acts, codes, and board requirements. Ensures legal operation and fulfills obligations to provide safe and reliable services.
Economic and Community Impact	Contribution to the city's growth and sustainability, supporting development projects, business expansion, and enhancing community well-being through reliable infrastructure and sustainable initiatives.
Environmental Sustainability	Promotion of environmental sustainability by supporting electrification, renewable energy integration, and energy efficiency initiatives. Aims to minimize environmental footprint, reduce greenhouse gas emissions, and promote clean energy sources.
Customer Experience and Empowerment	Enhancement of customer satisfaction through accurate billing, personalized service, transparent energy management, and providing direct control over energy usage and billing, fostering energy awareness.
Operational Efficiency and System Performance	Impact on operational processes and system capacity, focusing on optimizing power flow and ensuring the system can handle increasing loads without compromising service quality.
System Reliability	Management of asset performance to reduce the risk of failure and ensure consistent power delivery. Focuses on minimizing the frequency and duration of outages.
System Resilience	Evaluating the systems ability to withstand disruptions and quickly recover from extreme weather or unexpected events.
System Observability	Enhancement of the monitoring and diagnosis of system conditions to support grid modernization initiatives, real-time monitoring, and fault detection, enabling informed decision-making.
Financial Viability and Cost-Effectiveness	Financial implications, including upfront costs, ongoing maintenance, and risk mitigation, balancing infrastructure enhancements with minimizing rate impacts.
Safety and Public/Employee Protection	Mitigation of risks to employees and public safety, prioritizing the protection of both from electrical hazards and other potential dangers.
Asset Management and Renewal	Management of asset performance, including renewal, maintenance, and addressing aging infrastructure to ensure reliability and prevent failures.
Resource and Material Procurement	Ability to achieve successful project execution through optimized resource management and timely procurement of materials.
Cyber Security and Data Protection	Protection of customer data and safeguarding the grid from cyber threats through adherence to high industry standards for data security and privacy.

The results of the program-level investment planning assessment for the 2026-2030 rate period, which are detailed in Schedules 2-5-6 through 2-5-9, provide valuable insights into the effectiveness of the current program portfolio and its alignment with the strategic investment priorities.

5.3.1.1. Program Definition

Hydro Ottawa's Capital Expenditure Plan is broken into four Investment Categories, which are summarized in Table 8. These investment categories and definitions are in alignment with OEB Chapter 5 filing requirements.

Table 8 – Capital Investment Categories

Investment Category	Description
System Access	Modifications (including asset relocation) to a distributor's system to provide customers (including generator customers) with access to electricity services via the distribution system.
System Renewal	Replacing and/or refurbishing system assets to extend their original service life, maintaining the ability of the distribution system to provide customers with reliable and safe electricity services.
System Service	Modifications to the distribution system to ensure that it continues to meet the distributor's operational objectives while addressing anticipated future customer electricity demand and service requirements.
General Plant	Modifications, replacements, or additions to a distributor's assets that are not part of its distribution power delivery system, including land and buildings; tools and equipment; rolling stock, and electronic devices and software used to support day-to-day business and operations activities.

Table 9 outlines the description of the drivers by Investment Category. The Program Definition process assigns programs to appropriate investment categories based on the program's primary driver.

Table 9 – Driver Description

Investment Category	Driver	Description
System Access	Customer Service Request	Customer request for new connection (load or generation)
	Third Party Requirements	Request by a third party for plant relocation
	Mandated Service Obligation	Regulatory requirement to maintain distribution license under the OEB's Distribution System Code or requirement as per Hydro Ottawa's Conditions of Service
System Renewal	Failure	Asset no longer meets functional requirement
	Failure Risk	Asset is at risk to no longer meet functional requirements
	High Performance Risk	Asset is at risk of failure in a way that can cause harm or damage to other equipment or assets or would put the distribution system in a detrimental state
	Functional Obsolescence	Asset is functionally obsolete with no spare parts, tools, and/or software to continue operation
System Service	Capacity Constraints	Requirement for additional capacity (station transformation or circuit) due to planned or realized load increases
	Reliability	Requirements driven by poor distribution system performance such as abnormally high duration or frequency of interruptions
	System Efficiency	Requirements to improve both resource efficiency and power delivery reliability through strategic automation that minimizes manual intervention and streamlines data workflows.
	Observability	Requirements for improved system operability and visibility
	Resilience	Requirements for improved system resilience during major events.
General Plant	System Investment Support	Capital contributions to Hydro One for connection projects Requirement for fleet/vehicle acquisition
	Business Operations Support	Requirements for IT software and systems

5.3.1.1.1. System Access

System Access investments are obligatory activities. For this reason, they are not prioritized through the Capital Investment Planning Process, but rather based on available resources and in collaboration with the requesting party.

The main drivers for programs under System Access are:

- **Customer Service Requests:** Customer Service Requests arise from the needs of load or generation customers for new connections. This category includes servicing for new commercial buildings, residential subdivisions, or generators, and encompasses any system expansion required to supply the development site.
- **Third Party Requirements:** Third Party Requirements are initiated from requests received for the relocation or upgrade (modifications) of assets or infrastructure (e.g., pole relocation for road widening).
- **Mandated Service Obligations:** Mandated Service Obligations are requirements of a distributor as defined by the Distribution System Code (DSC), as well as any additional obligations outlined in Hydro Ottawa's Conditions of Service.

The System Access investment category is further broken down into Capital Programs and subsequent Budget Program. Table 10 shows the allocation of System Access drivers to programs.

Table 10 – System Access Programs

Capital Program	Budget Program	Primary Driver
Plant Relocation & Upgrade	Plant Relocation & Upgrade	Third Party Requirements
Customer Connections	Residential Subdivision	Customer Service Request
	New Commercial Development	Customer Service Request
	Infill (Res & Small Com)	Third Party Requirements
System Expansion	System Expansion Demand	Customer Service Request
	Asset Transfer	Third Party Requirements
Generation Connections	Embedded Generation	Customer Service Request
Metering	Suite Metering	Customer Service Request

5.3.1.1.2. System Renewal

System Renewal investments are identified through the distribution system assessment process described in Section 5.2.1 - Asset Management Plans. The objective of the comprehensive risk assessment is to confirm that the assets deliver the required functions at the desired level of performance, and that this level of performance is sustainable for the foreseeable future while operating within acceptable risk levels.

The System Renewal program is driven by a number of primary factors related to asset risk levels, each indicating a need for intervention to maintain the integrity and functionality of distribution assets. A description of Hydro Ottawa's methodology to determine asset risk is provided in Section 5.1.4 - Asset Risk Assessment. These factors include:

- **Failure:** This refers to an asset that has ceased to operate or function as intended. This may be due to a variety of reasons such as age, condition, or damage.
- **Failure Risk:** This indicates an asset that is at risk of imminent failure. This may be due to observed signs of deterioration, performance issues, or the results of predictive maintenance analysis.

- **High Performance Risk:** This refers to an asset that, while currently functional, poses a significant risk of failure that could have severe consequences. This may include damage to other equipment or assets, disruption of the distribution system, or safety hazards.
- **Functional Obsolescence:** This refers to an asset that, while still operational, is no longer considered efficient or effective. This may be due to technological advancements, the unavailability of spare parts or supporting software, or changes in operational requirements.

These factors are used to identify assets that require attention under the System Renewal program, ensuring the continued reliability, safety, and efficiency of the system.

The System Renewal investment category is further broken down into Capital Programs and subsequent Budget Program. Table 11 shows the allocation of System Renewal drivers to programs.

Table 11 – System Renewal Programs

Capital Program	Budget Program	Primary Driver
Stations and Buildings Infrastructure Renewal	Station Transformer Renewal	Failure Risk
	Station Switchgear Renewal	Failure Risk
	Station Major Rebuild	Failure Risk
	Station P&C Renewal	Failure Risk
	Station Battery Renewal	Failure Risk
	Station & Building Minor Asset Renewal	Failure Risk
	EOL Voltage Conversion	Failure Risk
OH Distribution Assets Renewal	Pole Renewal	Failure Risk
	OH Switch/Recloser Renewal	Failure Risk
UG Distribution Assets Renewal	Vault Renewal	Failure Risk
	Civil Renewal	Failure Risk
	Cable Replacement	Failure Risk
	UG Switchgear Renewal	Failure Risk
	UG Transformer Renewal	Failure Risk
Corrective Renewal	Damage to Plant	Failure
	Emergency Renewal	Failure
	Critical Renewal	Failure
Metering Renewal	Metering Upgrades	Functional Obsolescence

5.3.1.1.3. System Service

System Service investments are identified through the asset management plan process described in Section 5.2 - Plan. The main drivers for programs under System Service are:

- **Capacity Constraints:** The capability and reliability of the distribution system is regularly evaluated to ensure a stable and dependable power supply for customers. When gaps are found, the utility develops plans for system upgrades or expansions, ensuring compliance with regulatory standards and considering safety, environmental impact, costs, and the reliability and security of the power supply. The results of this process are outlined in Section 9 - System Capacity Assessment, which identifies both short and long-term capacity needs.

To maintain adequate system capacity, Hydro Ottawa evaluates the current and future supply demands in its service area. The system is divided into subsystems based on voltage levels and geographic boundaries for capacity planning purposes. The process factors in projected growth, asset replacement schedules, reliability, and modernization technologies to develop both short-term and long-term solutions.

- **Reliability:** Hydro Ottawa continuously assesses the distribution system's service reliability. When issues are identified, appropriate actions are taken. Service reliability is integral to all work undertaken as part of system planning and asset management. The reliability assessment process described in Section 5.2.2 - Distribution System Assessment provides a platform for a thorough review of system reliability and identifies planned work designed to directly impact system reliability.
- **System Observability:** As per Section 3.4.2 - Grid Modernization Strategy, the observability and controllability of the distribution system will be enhanced through advanced monitoring, rapid fault detection and localization, improved overload detectability, and automated/remote system restoration. The aim of this driver is to bring greater real-time awareness of system performance to support both daily operations and inform system planning.

The System Service investment category is further broken down into Capital Programs and subsequent Budget Program. Table 12 shows the allocation of System Service drivers to programs.

Table 12 – System Service Programs

Capital Program	Budget Program	Primary Driver
Capacity Upgrades	Stations Capacity Upgrades	Capacity Constraints
	Distribution Capacity Upgrades	Capacity Constraints
	Non-Wire Upgrades	Capacity Constraints
Distribution Enhancements	Distribution System Reliability	Reliability
	Capacity Voltage Conversion	Capacity Constraints
	Distribution Enhancements	Reliability
	Distribution System Observability	Observability
	Distribution System Resilience	Resilience
Station Enhancements	Stations Enhancements	Reliability
Grid Technologies	SCADA Upgrades	System Efficiency
	RTU Upgrades	N/A
	Communication Infrastructure	System Efficiency
Control and Optimization	Control and Optimization	Observability
Field Area Network	Physical Fiber Extension	System Efficiency
	Wireless Communication	System Efficiency
	Management of Grid-Edge Device	System Efficiency
	SCADA Network Cyber Security	System Efficiency

5.3.1.1.4. General Plant

The General Plant category encompasses a diverse set of capital programs essential for maintaining and advancing Hydro Ottawa's infrastructure, operational capabilities, and customer service excellence. These investments address areas such as critical infrastructure reliability, fleet renewal, IT and cyber security infrastructure, and customer engagement.

The main drivers for programs under General Plant are:

- **System Investment Support:** Capital contributions to Hydro One for transmission upgrades required to service new and upgraded stations, in addition to requirements for fleet/vehicle acquisition.
- **Business Operations Support**: Requirements for IT software and systems

Table 13 lists the programs and primary drivers within General Plant.

Table 13 – General Plant Programs

Capital Program	Budget Program	Primary Driver
CCRA	CCRA	System Investment Support
Fleet Replacement	Fleet Replacement	System Investment Support
Tools Replacement	Tools Replacement	System Investment Support
Buildings - Facilities	Buildings -Facilities	System Investment Support
Grid Technology	Grid Technology	Business Operations Support
Meter to Cash	Meter to Cash	Business Operations Support
Customer Engagement Platform	Customer Engagement Platform	Business Operations Support
Enterprise Solutions	Enterprise Solutions	Business Operations Support
Infrastructure and Cyber Security	Infrastructure and Cyber Security	Business Operations Support
Data and System Integrations	Data and System Integrations	Business Operations Support

5.3.1.2. Program Optimization

Strategic planning involves optimizing the program portfolio by evaluating how well the identified programs align with key investment priorities. These priorities, including Growth and Electrification, Renewing Deteriorating Infrastructure, Grid Modernization, and Enhancing Resilience, guide investment decisions, supported by the focus areas of Managing Rising Costs and Investing in the Workforce.

MIPs are developed for each program to facilitate optimization, detailing financial resources required for implementation and enabling decision-makers to assess feasibility and alignment with priorities. The assessment process rigorously evaluates potential costs, benefits, and contributions to strategic objectives.

Results from the program level investment planning for 2026-2030, detailed in Schedules 2-5-6 through 2-5-9, provide insights into the current program portfolio effectiveness and alignment with strategic investment priorities.

5.3.1.2.1. System Access

Investments under System Access are necessary to support growth and electrification. This investment category includes programs like Customer Connections to facilitate new residential and commercial developments, System Expansion to address major infrastructure projects like new stations, and Generation Connections to enable the connection of customer-owned DERs.

MIP are developed for each Capital Program and included in Schedule 2-5-6 - System Access Investments. Program drivers under this category are mainly impacted by the growing number and complexity of customer connections, reflected in expenditures for the Customer Connections and System Expansion Capital programs. These programs are defined by assessing historical spending, historical connections and projects, and industry trends as well as known upcoming committed projects for the 2026-2030 rate period.

5.3.1.2.2. System Renewal

System Renewal investments are required to support the renewal of deteriorating infrastructure. This investment category includes programs like Station and Buildings Infrastructure Renewal, Overhead Distribution Asset Renewal, Underground Asset Renewal, Corrective Renewal, and Metering Renewal.

MIPs are developed for each Capital Program and included in Schedule 2-5-7 - System Renewal Investments. Hydro Ottawa's System Renewal investment planning uses a strategic, forward-looking approach with levelized spending to mitigate the long-term impacts of asset degradation or failure. While safety, financial, environmental, and compliance risks are considered, reliability is the primary driver of the overall risk value (based on actual data available). System Renewal investments have been scaled to reduce the corresponding risk values and maintain overall system reliability. Hydro Ottawa's asset renewal strategy is to mitigate and manage asset risks, considering long-term impacts, through strategic replacement of deteriorating infrastructure, and therefore not to outright replace all aged or deteriorated assets.

Programs for each asset type are defined through the AMPs, as described in Section 5.2.1 - Asset Management Plans and then evaluated at the asset class level (Stations, Overhead, Underground, and Metering assets) through MIPs. Similar alternatives to the asset-type level are used: cost containment, short-term risk mitigation, and long-term risk mitigation as described in Section 5.2.1.1 Program Planning Approach.

5.3.1.2.3. System Service

System Service investments are required to support growth and electrification and grid modernization to enable the energy transition as well as enhancing resilience. This investment category includes programs like Capacity Upgrades, Distribution Enhancements, Station Enhancements, Grid Technologies, Control and Optimization, and Field Area Network.

The System Service investment category focuses on strategic spending to enhance the overall functionality and capability of the distribution system. Key areas of investment include:

- **Expanding Distribution System Capacity:** This involves upgrading and expanding the existing infrastructure to accommodate increased demand and future growth.
- **Improving System Reliability and Resilience:** Investments are made to minimize outages, reduce downtime, and ensure the system can withstand and recover quickly from disruptions caused by natural events or other unforeseen circumstances.

- **Grid Modernization:** This encompasses the integration of advanced technologies and intelligent systems to optimize grid performance, enable better demand management, and support the integration of renewable energy sources.

The allocation of spending within the System Service category is guided by MIPs. These plans are developed for each Capital Program and are detailed in Schedule 2-5-8 - System Service Investments. They provide a structured framework for prioritizing and implementing projects that align with overall investment priorities.

A key component of the System Service investment strategy is the selection of specific station capacity projects for capacity upgrade programs based on capacity system needs described in Section 9 - System Capacity Assessment. These projects are carefully chosen based on several factors, including recommendations from the IRRP and aligned with supporting distribution and NWSs programs. This ensures that capacity upgrades are implemented strategically and in a way that maximizes benefits for the overall system.

5.3.1.2.4. General Plant

MIPs guide the allocation of spending within the General Plant category. These plans, which are detailed in Schedule 2-5-9 - General Plant Investments, are developed for each Capital Program and provide a structured framework for prioritizing and implementing projects that align with overall investment priorities.

Investments in CCRAs with Hydro One are included in the System Service planning process and are thus evaluated using the same criteria. See Section 5.3.1.2.3 - System Service for more details.

General Plant investments in IT, Fleet, and Facilities follow a similar approach to the distribution asset management processes. These investments are typically large replacement or enhancement initiatives for assets reaching the end of their useful life. As such, they generally span several years. Therefore, they are initiated and justified with detailed business cases.

Information Technology

All new IT requirements must be communicated to the IT team prior to purchase and/or implementation. The IT Engagement model outlines the appropriate contact for IT services when the nature of the request is not obvious or lacks an established communication channel. This process is designed to promote optimal use of technology assets, track and plan project demand, and to ensure objectives align with company priorities and the IT strategy.

Facilities

Hydro Ottawa engages consultants to complete building condition assessments for all its office buildings every five years. The building condition assessments include information about asset age and condition and represent the main component of Hydro Ottawa’s five-year facility renewal plan. Hydro Ottawa performs alternating roofing and building envelope inspections on its substations in five-year cycles as well as monthly field inspections and safety checks to ensure its facilities assets remain in good working condition. Any defects found are catalogued and repaired or replaced as needed. To align with Hydro Ottawa’s sustainability goals and level of organizational growth, the Facilities program will focus on maintaining and upgrading office and operational facilities to support workforce needs, improving energy efficiency, and providing a safe working environment.

Fleet

Every five years, a plan is devised for replacements and additions. Replacement decisions and timing are assessed unit-by-unit using a set of quantitative replacement criteria combined, a physical assessment, and judgement. See Schedule 2-5-9 - General Plant Investments for more details on evaluation criteria. Planned additions are informed by the operational needs of the business and ultimately determined through an iterative process with multiple stakeholders. Operation requirements inform projected staffing levels which are used to create an initial estimate of vehicles with preliminary specifications. The initial estimate is reviewed with operational staff to refine requirements and identify opportunities for efficiencies. Ultimately, the required number of vehicles by category are aligned and agreed between the business and operations.

5.3.2. Project Level Investment Planning

Following the approval of the overall Capital Expenditure Plan, Hydro Ottawa conducts an annual project-level assessment to refine and optimize the selection of individual projects within each program. Using Hydro Ottawa's investment optimization software (Copperleaf Portfolio), projects are prioritized based on their value, and constraints like budget limitations are applied to create a realistic and achievable project list. This process generates preliminary and final project lists, with the latter containing more refined cost estimates. The final project list is then presented for approval, marking the final step before project execution can begin. Essentially, this stage focuses on determining which specific projects will be funded within the already-approved budget allocations, maximizing the return on investment for Hydro Ottawa and its customers.

It is noteworthy that projects under the System Renewal and System Service investment categories only go through the capital investment planning process completed in Hydro Ottawa's investment optimization software (Copperleaf Portfolio) and as detailed in Sections 5.3.2.1 - Project Concept Definition to 5.3.2.4 - Portfolio Optimization below. Projects under the System Access investment category are obligatory in nature and hence not prioritized through Copperleaf Portfolio, but rather based on available resources and in collaboration with the requesting party. Similarly, projects under the General Plant investment category are also not evaluated within the Copperleaf Portfolio. These investments are typically large replacement or enhancement initiatives for assets reaching the end of their useful life. As such, they generally span several years. Therefore, they are initiated and justified with detailed business cases.

5.3.2.1. Project Concept Definition

Two distinct processes drive System Renewal and System Service project creation within Copperleaf Portfolio. These processes differ in their origin, data utilization, and scope definition. System Renewal projects leverage the power of data and PA for proactive asset management. They originate from insights derived from Copperleaf Assets and PA. The process begins with ACA information, which is used to identify assets that need intervention. The focus is on proactively minimizing risk based on predicted asset failure.

System Renewal projects born out of Copperleaf Assets and PA move to Copperleaf Portfolio, where they are reviewed to identify opportunities for synergy. For example, a pole renewal project might be expanded to include capacity upgrades in the same area, maximizing efficiency and minimizing disruption. System Renewal projects are then evaluated based on their contribution to system resilience. This includes comparing alternatives for "like-for-like" replacements with storm hardening upgrades or undergrounding assets, allowing for informed decisions regarding long-term resilience.

System Service projects, in contrast, are created on an individual basis within Copperleaf Portfolio. These projects address specific needs as they arise from capacity assessments detailed in Section 9 - System Capacity Assessment. Information for these projects is gathered on a case-by-case basis, and supporting documentation is manually entered into Copperleaf Portfolio. Value measures are assigned across various risk categories (capacity, reliability, compliance, resilience, etc.) to quantify the project's potential benefits. Where applicable, alternative solutions are identified and documented within Copperleaf Portfolio, enabling a comparative assessment of different approaches to mitigate the identified risk.

These two distinct processes contribute to a well-rounded and optimized project portfolio with System Renewal projects providing a proactive, data-driven approach to long-term asset management, ensuring system reliability and resilience while maximizing efficiency through synergy identification. Conversely, System Service projects address specific needs, ensuring responsiveness to emerging challenges. Their focus on individual project value allows for prioritization based on risk and potential impact.

By integrating both System Renewal and System Service projects within Copperleaf, Hydro Ottawa achieves a balanced portfolio. This approach allows for proactive asset management and timely problem-solving, ultimately leading to improved system performance, reduced risk, and optimized resource allocation. The ability to score projects across consistent metrics, regardless of origin from either Copperleaf Asset or Copperleaf Portfolio, allows for a holistic view and facilitates data-driven decision-making.

5.3.2.2. Project Evaluation

The Project Evaluation phase creates business cases supporting the project alternatives. Each alternative is valued based on Hydro Ottawa's Asset Management Objectives using the Value Framework Model to assess the project's alternatives. The evaluation of project alternatives is completed within the Copperleaf Portfolio.

For System Renewal investments, Copperleaf Assets' predictive asset analytics plays a critical role in investment planning for the system renewal portfolio as it identifies the assets that require intervention in a given year. The process begins with PA that assesses the condition and performance of assets, helping to forecast when they might fail or underperform. When an asset is flagged as requiring intervention, an investment proposal is created within Copperleaf Assets and pushed to Copperleaf Portfolio through the Capture Module in Copperleaf. For more details on Predictive Analytics see Section 5.1.4 - Asset Risk Assessment.

The value of the proposed investment is determined by evaluating the risk that would be mitigated by the intervention. This risk value reflects the potential consequences of asset failure, including financial, safety, and operational impacts. The benefits of the intervention are assessed against the replacement or repair costs. The combination of risk mitigation and benefits realization forms the basis for justifying and prioritizing the investment within the broader asset management strategy. This ensures that resources are allocated efficiently, focusing on projects that offer the most value in terms of risk reduction and cost-effectiveness.

For System Service investments, project concepts and their alternatives are conceptualized. Project alternatives are then scored by identifying their risk and/or benefit value measures as it relates to Hydro Ottawa's Asset Management Objectives through the use of the Copperleaf Value Model. The evaluation Value Model comprises twelve Value Measures grouped into three Value Categories, as shown in the Table 14 below.

Table 14 – Copperleaf Value Model

Asset Management Objective	Value Measure	Value Category
Resource Efficiency	Financial Benefits & Costs	Benefit Value Measures
Levels of Service	Program Effects	
Levels of Service	Distributed Generation	
Asset Value	Technological Innovation	
Levels of Service	Capacity Risk	Risk Value Measures
Compliance	Compliance Risk	
Health, Safety & Environment	Environmental Risk	
Resource Efficiency	Financial Risk	
Levels of Service	Reliability Risk	
Levels of Service	Resilience Risk	
Health, Safety & Environment	Safety Risk	
Resource Efficiency	Total Investment Cost	Cost Value Measure

Benefit Value Measures

- **Financial Benefits & Costs**: measures the financial benefits or costs to the organization in the form of annual Capital and OM&A cost savings/increases, cost avoidance or revenue increase (i.e. would result in a budget decrease/increase).
- **Program Effects**: captures the value of all programs not otherwise tracked in Copperleaf.
- **Distributed Generation**: measures the impact of whether a project enables distributed generation. Projects that enable distributed generation are given an additional 30 value units.
- **Technological Innovation**: measures the impact of whether a project introduces technological innovation to the corporation. Projects that introduce technological innovation are given an additional 10 value units.

Risk Value Measures

- **Capacity Risk**: measures the societal cost associated with an interrupted electrical supply and assigns a positive value to projects that help mitigate a proportion of this risk.
- **Compliance Risk**: measures the mitigation of the risk of non-compliance with federal regulations, namely the risk of annual fines, additional compliance costs, or the subsequent cost of operating restrictions.
- **Environmental Risk**: measures the mitigation of incidents that can lead to environmental damage.
- **Financial Risk**: measures the mitigation of financial risk due to damage to equipment, loss of company assets, financial errors, or other factors resulting in monetary loss.
- **Reliability Risk**: measures the mitigation of risk due to customer outages on the distribution system. The reliability value is based on the maximum of three computations: cost of outage duration, cost of outage frequency, and customer minutes of interruption. This Value Model also differentiates between residential, commercial, industrial, and mixed customers and between redundant & non-redundant equipment.
- **Resilience Risk**: measures the improved ability of distribution assets to resist damage due to inclement weather and the corresponding reduction in customer interruptions. This may be added to investments that move equipment underground or improve weather resistance in any way.
- **Safety Risk**: measures the mitigation of the risk of public safety incidents. This risk is intended for use in a Value Function and the avoided risk is a positive contributor to project value.

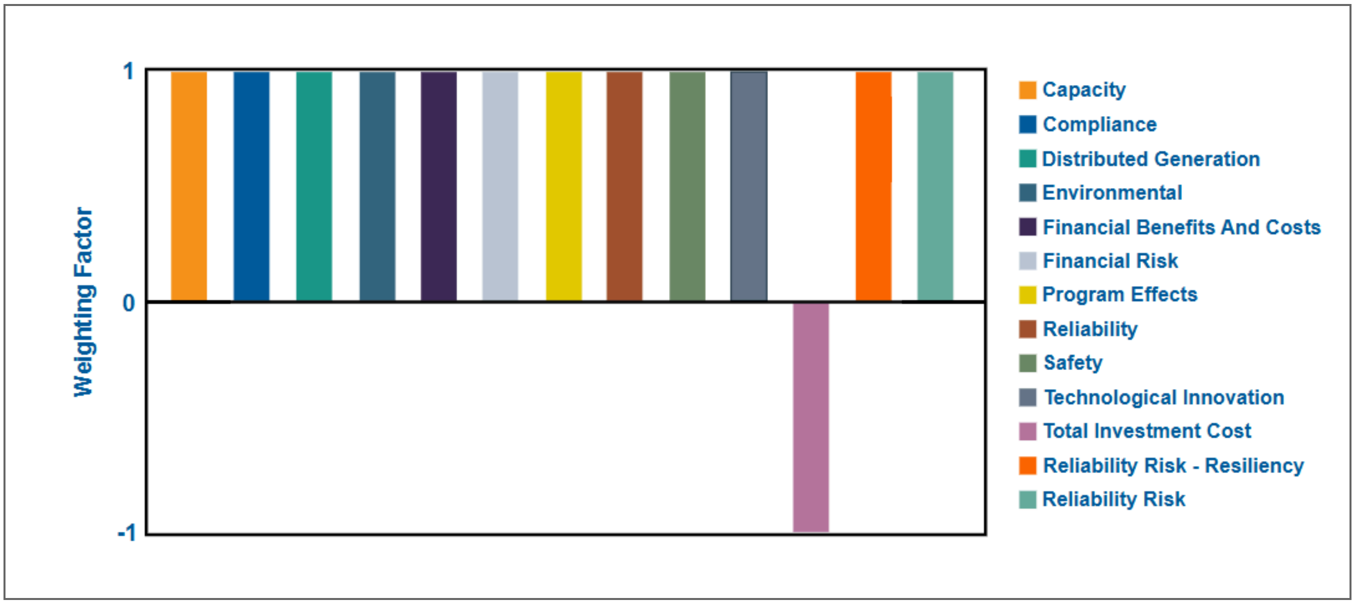
Cost Value Measure

- **Total Investment Cost**: measures the total spending from year to year on proposed projects.

In Figure 18, each Value Measure is normalized to the same scale, where one value point equals approximately $1,000. This means that within the Value Function, each Value Measure (except

Investment Cost) is weighted with the same value of +1. Investment Cost is a negative contributor to the Value Measure and, as such, is weighted with a value of -1.

Figure 18 - Value Category Weighting



The Value Measures for each project are computed for each year (the benefits or risks in one year can be different than the next – for example, the risk of a poor-condition asset failing increases with time). They are then converted into a single number by taking the present value back to the current fiscal year using the system-defined discount rate. This means that if a project has a negative value, the cost of the project outweighs its benefits.

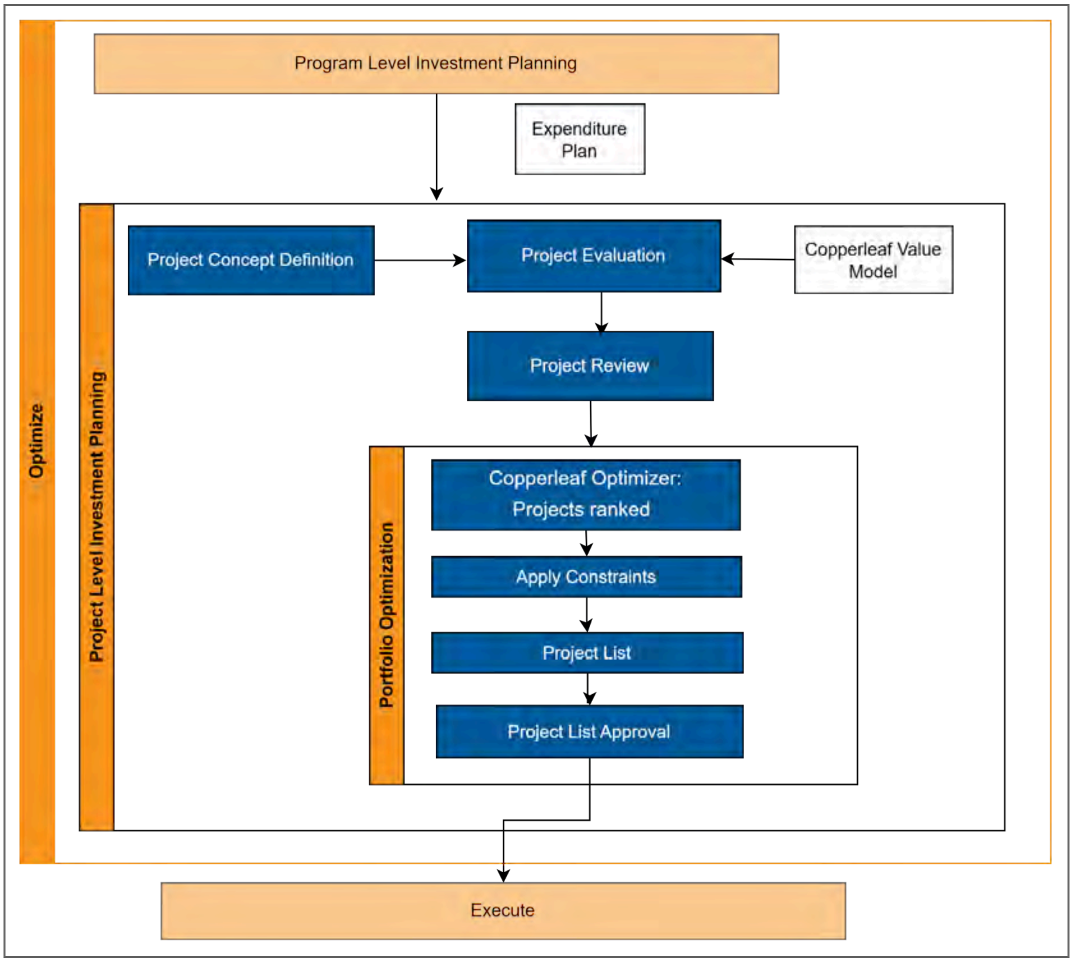
5.3.2.3. Project Review

During the project review phase, the valuation of each project is reviewed and compared to similar projects before the projects are optimized to ensure a consistent approach.

5.3.2.4. Portfolio Optimization

The portfolio optimization phase, depicted in Figure 19, uses Copperleaf to prioritize projects based on their value. Project Prioritization Procedure ensures consistent prioritization of projects to deliver on Asset Management Objectives. This phase utilizes the Copperleaf Portfolio module to rank projects based on their value, calculated through the Project Evaluation phase. The Optimizer algorithm within Copperleaf selects the optimal project portfolio based on value and constraints applied. This leads to the creation of a preliminary project list. Cost estimates are refined for projects in the preliminary list and a second phase of optimization is completed in Copperleaf Portfolio to produce the final project list with refined cost estimates. This final list is presented to Hydro Ottawa's Executive Management Team and Board of Directors for approval before project execution begins.

Figure 19 - Portfolio Optimization



5.4. EXECUTE

5.4.1. Portfolio Implementation and Monitoring

The Execution phase follows Hydro Ottawa's internal project management methodology called "Project Coach," which defines the core lifecycle for projects. Project Coach is based on the internationally accepted standard for project management: Project Management Body of Knowledge (PMBOK) issued by the Project Management Institute.[7] An ongoing effort titled "Project X" is in

[7] Project Management Institute, "PMBOK(R) Guide," https://www.pmi.org/standards/pmbok.

progress, with the goal of updating Hydro Ottawa's project delivery methodology. Further detail regarding "Project X" can be found in Section 3.1.1 of Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement.

Project Coach, and Project X, provide specific guidelines, procedures, work instructions, and industry best practices that allow Hydro Ottawa personnel to perform project work efficiently, effectively, and with high quality. Processes described in Project Coach are intended to be scalable and applicable to all projects, regardless of complexity. By standardizing on a project delivery model, a consistent approach to planning, scheduling, and execution of projects can be implemented.

Project Coach describes six steps in the execution of the project:

1. Planning & Project Initiation (Plan): The project charter, scope, and objectives are created. Key players take steps to initiate the project and engage any needed authorization.
2. Design: The project charter, scope, and objectives are reviewed and approved. Preliminary and detailed project design and estimates are created.
3. Procurement & Circulation (Procure): The project design is approved. Material and services are procured.
4. Scheduling (Schedule): The project is scheduled with key milestones and deliverable dates.
5. Construction (Construct): The project is executed with a continuous review of progress and risk to completion.
6. Closure (Close): The project documentation, financials, and reviewed lessons learned are completed. Feedback and lessons learned are registered and communicated for continuous improvement.

Project X will serve to streamline the six steps in the project delivery methodology. More specifically, Project X aims to improve the Distribution Design team's project management expertise, improve organizational efficiency and capacity, update the delivery model (with enhanced reporting), and ensure smooth adoption of new processes through a change management plan.

Key activities include defining the strategy, establishing a project delivery model with stage gates, standardizing artifacts, reviewing tools and infrastructure, establishing clear roles, responsibilities and organizational structure to support the updated project delivery model, comprehensive reporting, and creating training and change management plans.

5.4.2. Performance Measurement and Continuous Improvement

Hydro Ottawa prioritizes continuous improvement in its asset management practices to ensure reliable and resilient electricity service. Recognizing the challenges posed by deteriorating infrastructure, climate change, and increasing demand, the company utilizes performance measurements to regularly evaluate the effectiveness of its asset management process. A key focus is on mitigating the risks associated with infrastructure nearing or exceeding its TUL. For the 2026-2030 DSP, Hydro Ottawa has implemented a refined set of performance outcomes specifically designed to evaluate plan performance at the MIP level. This targeted approach, combined with strategic investments in data analytics, enables a more precise assessment of network assets and facilitates data-driven decision-making. The performance framework for the 2026-2030 DSP, detailed in Schedule 2-5-3 - Performance Measurement for Continuous Improvement, will drive continuous improvement and ensure alignment with Hydro Ottawa's evolving operational context, ultimately supporting the company's commitment to delivering reliable service to its customers.

6. OVERVIEW OF DISTRIBUTION SYSTEM

Section 6 provides an overview of Hydro Ottawa's distribution system, including information such as characteristics of the service area. The subsections are organized as follows:

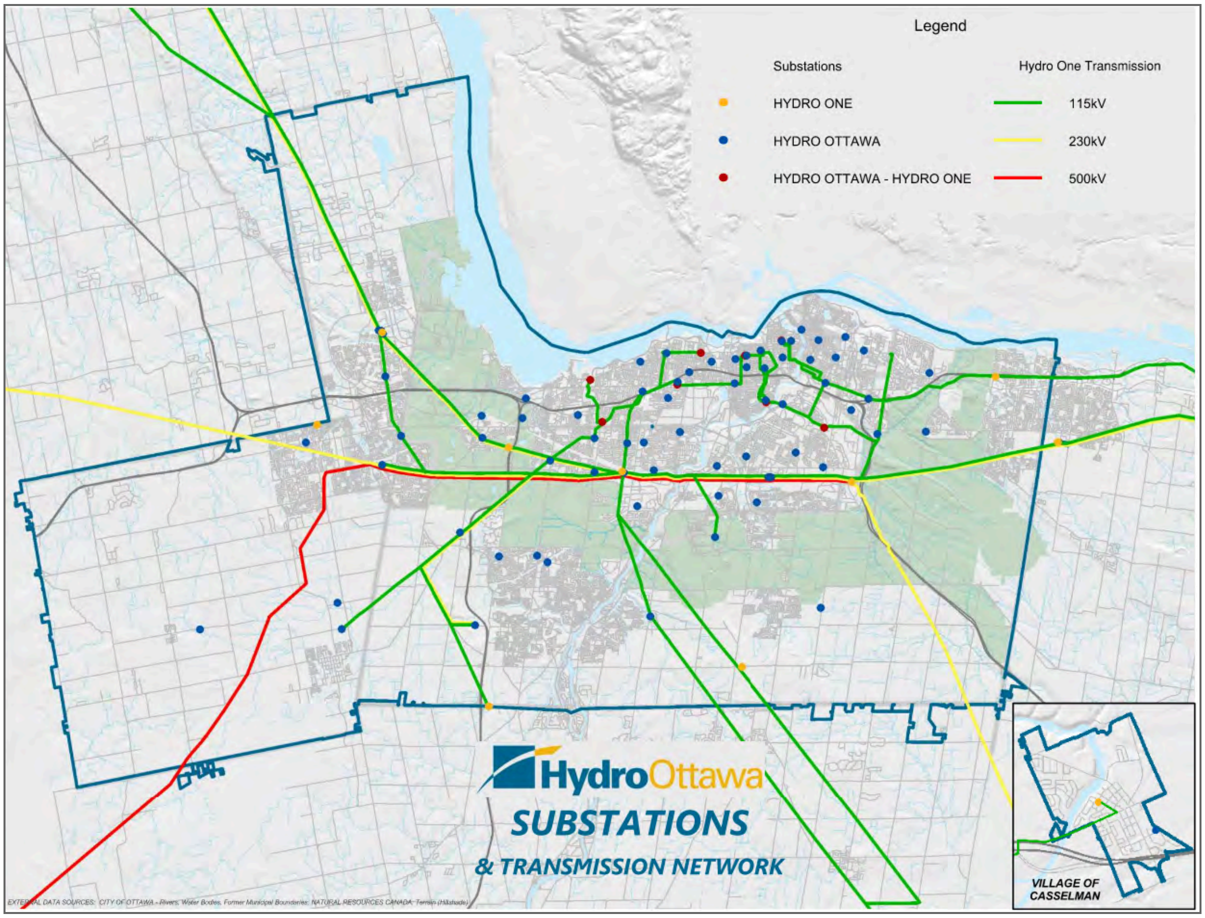
- 6.1 - Overview of Distribution System: provides a high-level description and a map of the Hydro Ottawa service territory.

- 6.2 - System Configuration: describes how the system is configured, including voltages and ownership of stations and transformers.
- 6.3 - Geographic Planning Considerations: looks at the geographic and physical characteristics of the Hydro Ottawa service area.
- 6.4 - Historical and Future Climate: provides historical weather details, including recent extreme weather events, as well as climate change impacts.
- 6.5 - System Demand and Growth Planning Considerations: discusses historical system peaks and details on anticipated customer growth within the service areas.

6.1. OVERVIEW OF DISTRIBUTION SYSTEM

Hydro Ottawa is one of the five largest electric distribution utilities in Ontario and, as of the end of 2023, distributes electricity to approximately 364,000 metered customers within the City of Ottawa and the Municipality of Casselman. The service area covers 1,116 square kilometers and is supplied by an even mix of overhead and underground distribution lines. Figure 20 illustrates Hydro Ottawa's service territory boundaries and its connection to the Hydro One transmission network.

1 **Figure 20 - Hydro Ottawa Service Territory**

2 

6.2. SYSTEM CONFIGURATION

6.2.1. Asset Overview

Hydro Ottawa's formation in 2000 resulted from the amalgamation of five municipally owned electric utilities: Gloucester Hydro, Goulbourn Hydro, Kanata Hydro, Nepean Hydro, and Ottawa Hydro. This consolidation stemmed from the restructuring of Ontario's electricity sector, driven by the *Electricity Act, 1998*. The integration of utilities from the former region of Ottawa-Carleton. Casselman Hydro was subsequently acquired in 2002, further expanding Hydro Ottawa's service area. This amalgamation of six distinct utilities created a diverse distribution system characterized by six different operating voltages and a mix of overhead and underground infrastructure. The underground systems are predominantly located in urban areas. Table 15 details the length of overhead and underground lines within Hydro Ottawa's distribution system.

Table 15 - Length of Underground & Overhead Lines[8]

Orientation	Total Length (km)	Total Length (%)
Underground	3,515	55.9%
Overhead	2,768	44.1%
TOTAL	**6,283**	**100%**

Table 16 presents the number of circuits and length of overhead and underground cables by voltage level in Hydro Ottawa's distribution system.

[8] The km shown in this section pertain to primary circuits only, for information on the calculation of secondary lines, refer to Attachment 1-3-3 (A) - PEG Benchmarking Analysis, the total km including both primary and secondary are approximately 7,900 km of underground cable and 4,800 km of overhead lines

Table 16 - Number & Length of Circuits by Voltage Level

<table>
<tr><th>Orientation</th><th>Number of Circuits</th><th>Total Overhead (km)</th><th>Total Underground (km)</th></tr>
<tr><td>4 kV</td><td>310</td><td>609</td><td>288</td></tr>
<tr><td>8 kV</td><td>119</td><td>672</td><td>565</td></tr>
<tr><td>12 kV</td><td>6</td><td rowspan="2">456</td><td rowspan="2">943</td></tr>
<tr><td>13 kV</td><td>334</td></tr>
<tr><td>28 kV</td><td>66</td><td>838</td><td>1,711</td></tr>
<tr><td>44 kV</td><td>16</td><td>193</td><td>8</td></tr>
<tr><td>TOTAL</td><td>851</td><td>2,768</td><td>3,515</td></tr>
</table>

The service area is supplied by a combination of stations and transformers owned by both Hydro Ottawa and Hydro One. Table 17 details the number of station transformers serving Hydro Ottawa customers, categorized by secondary voltage level and ownership.

Table 17 - Number of Stations and Transformers Owned by Hydro Ottawa and Hydro One

Secondary Voltage	Number of Stations	Number of Hydro Ottawa Owned Transformers	Number of Hydro One Owned Transformers
4 kV	35	95	0
8 kV	23	42	1
12 kV	2	3	0
13 kV	12	2	23
28 kV	17	28	5
44 kV	3	0	6
TOTAL	**92**	**170**	**35**

6.2.2. Embedded Feeders

Embedded feeders within Hydro Ottawa's distribution network are sections of Hydro One infrastructure that, upon entering Hydro Ottawa's service territory, transition to Hydro Ottawa ownership. Table 18 provides details on embedded feeders, including the connecting Hydro One Station, the corresponding Hydro Ottawa feeder name, and their respective voltages. Of the 13 embedded feeders listed, five serve Hydro Ottawa customers under normal operating conditions, while the remaining eight are reserved for abnormal or contingency situations.

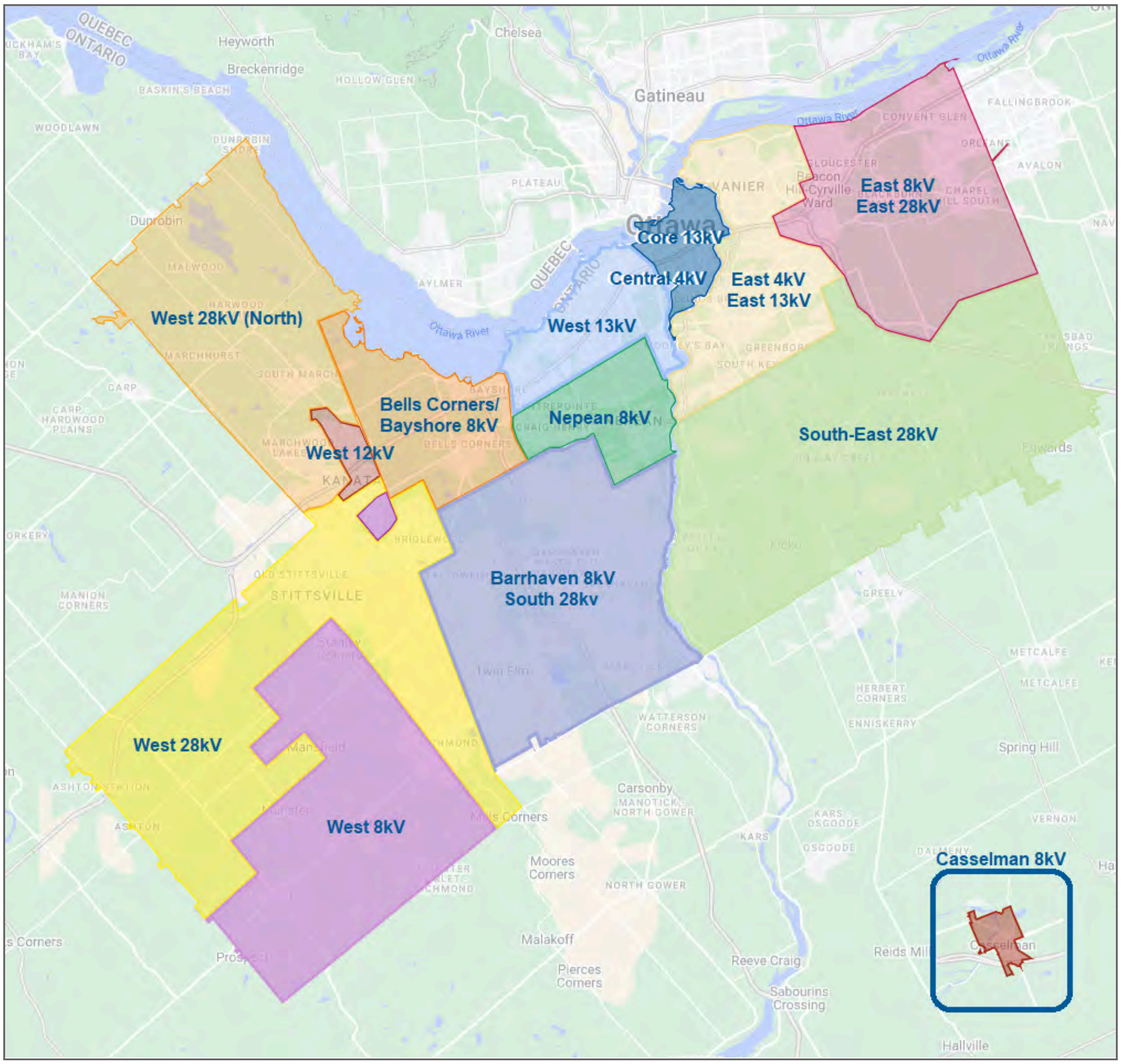
Table 18 - List of Distribution Supply Points

Hydro One Station	Feeder	Voltage	Type
Bilberry TS	77M3	28 kV	Back-up Supply
Bilberry TS	77M4	28 kV	Back-up Supply
South March TS	A9M3	44 kV	Nominal Supply
South March TS	A9M5	44 kV	Nominal Supply
St. Isidore TS	62M2	44 kV	Nominal Supply to Casselman - 62M2
Beckwith DS	BECKF2	28 kV	Nominal Supply
Casselman DS	36F1	8 kV	Back-up Supply
Casselman DS	36F2	8 kV	Back-up Supply
Manotick DS	81F5	8 kV	Back-up Supply
South Gloucester DS	56F3	8 kV	Nominal Supply
South Gloucester DS	56F2	8 kV	Nominal Supply
Alexander DS	ALEXF1	28 kV	Back-up Supply
Alexander DS	ALEXF2	28 kV	Back-up Supply

6.2.3. Planning Regions

Hydro Ottawa's distribution system consists of distinct subsystems, delineated by operating voltage, system interconnections and geographical boundaries, as seen in Figure 21. These subsystem characteristics have informed the definition of planning regions, which are essential for effective infrastructure management, resource allocation, service enhancement, and addressing the diverse needs of customers throughout the service territory. This regional approach facilitates more targeted, efficient, and responsive utility planning and operations.

Figure 21 - Hydro Ottawa Planning Regions



6.3. GEOGRAPHIC PLANNING CONSIDERATIONS

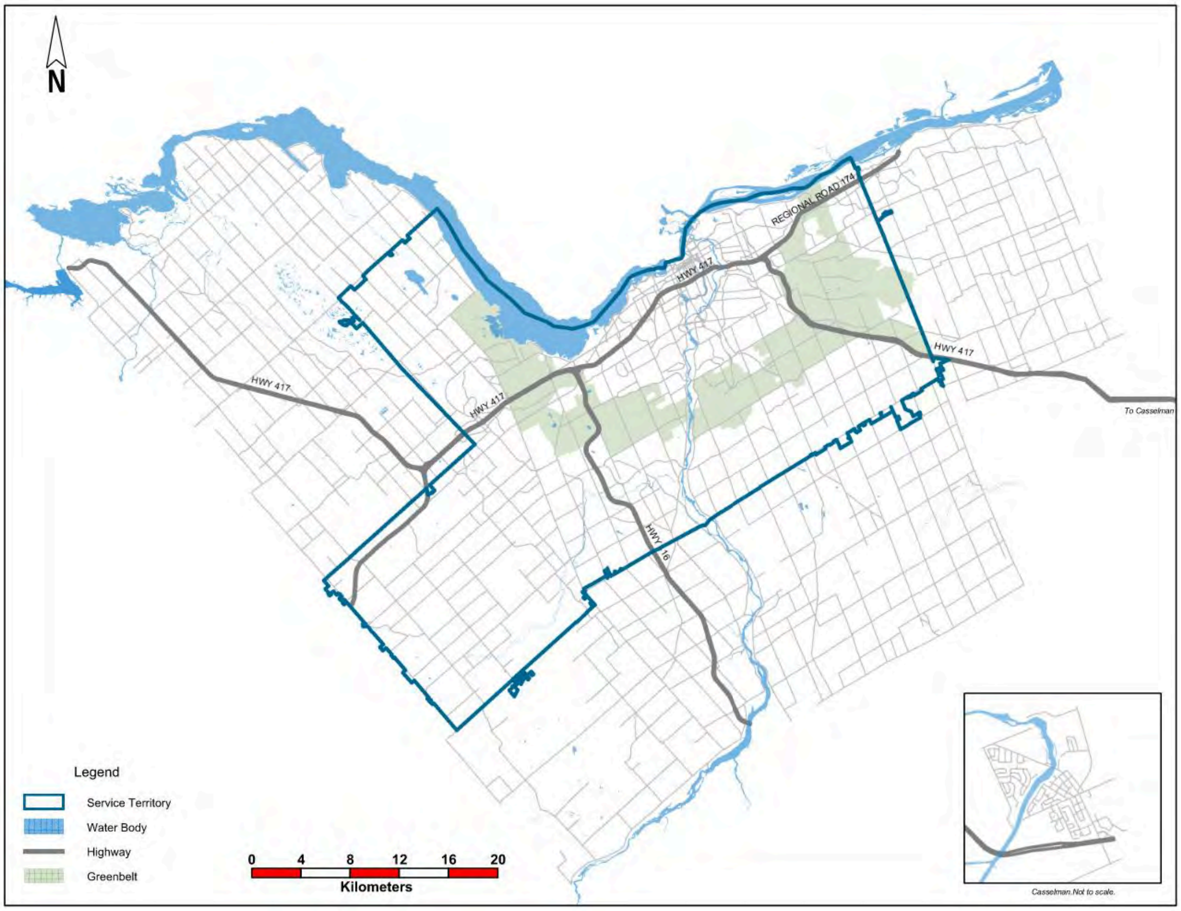
Distribution system planning within Ottawa requires careful consideration of the geographic and physical characteristics of Hydro Ottawa's service territory. The following sections detail key planning considerations and constraints that influence the planning process.

6.3.1. Geographic and Jurisdictional Influences

Hydro Ottawa's service territory encompasses the area surrounding the confluence of the Ottawa and Rideau Rivers. The Ottawa River forms the northern boundary, with the province of Quebec across the river. Hydro One's service territory completely surrounds Hydro Ottawa's remaining boundaries, as illustrated in Figure 22 below. Within the service area, the Rideau River and the Rideau Canal (which bypasses unnavigable sections of the river) traverse the landscape. This creates unique challenges, as certain neighborhoods, such as Old Ottawa, are effectively islanded by both the river and the canal, complicating both service provision and infrastructure maintenance.

The City of Ottawa's main urban area is encircled by a substantial Greenbelt, consisting primarily of forests, farmlands, and marshlands. Beyond the Greenbelt, numerous suburban communities are experiencing rapid growth. Furthermore, constructed barriers such as divided highways (Highways 417, 416, and 174) further segment Hydro Ottawa's service territory.

Figure 22 - Geographic and Jurisdictional Boundaries in Hydro Ottawa's Service Territory



As the Nation's Capital, the service territory also includes numerous federal lands managed by various government agencies. These federal land holdings can create administrative barriers due to the time and effort required to obtain environmental, land access, and encroachment permits, as well as to establish access agreements. These requirements create both technical and administrative challenges for the construction and maintenance of distribution interconnections, often resulting in increased cost and time for creating or augmenting such interconnections within the service territory.

6.3.2. Geotechnical Consideration

Soil Conditions

Hydro Ottawa's service territory faces unique geotechnical challenges due to the prevalence of problematic soil conditions. The dominant soil type, Champlain Sea clay, is inherently unstable, susceptible to liquefaction, and exhibits significant volume changes with varying moisture and temperature. These characteristics create poor foundation conditions and necessitate specialized construction techniques. Furthermore, extensive bog areas with compressible organic soils and the presence of shallow bedrock add complexity and cost to infrastructure development. These challenging conditions impact all aspects of electric distribution planning, from pole installations and underground cabling to station construction. Mitigation strategies, such as engineered fill replacement, specialized foundation designs, and robust pole hole standards, are essential for ensuring the long-term stability and reliability of the electrical grid. Careful geotechnical investigations and tailored engineering solutions are implemented on a project-by-project basis to navigate these challenges and deliver a resilient and dependable power supply to the Ottawa region.

Seismic Zone

Hydro Ottawa's service territory lies within the Western Quebec Seismic Zone,[9] requiring specialized engineering to ensure infrastructure resilience against potential seismic events. Through detailed seismic investigations and project-specific engineering solutions, Hydro Ottawa mitigates these risks. These solutions may include enhanced foundation and footing designs with increased reinforcing steel, concrete, and excavation, along with the incorporation of supplementary steel cross bracing. This approach enables Hydro Ottawa to deliver a dependable power supply to the Ottawa region, even in seismically-active conditions.

[9] Natural Resources Canada. (n.d.). *Earthquakes in Eastern Canada*. Retrieved from https://www.seismescanada.rncan.gc.ca/zones/eastcan-en.php#WQSZ

6.4. HISTORICAL AND FUTURE CLIMATE

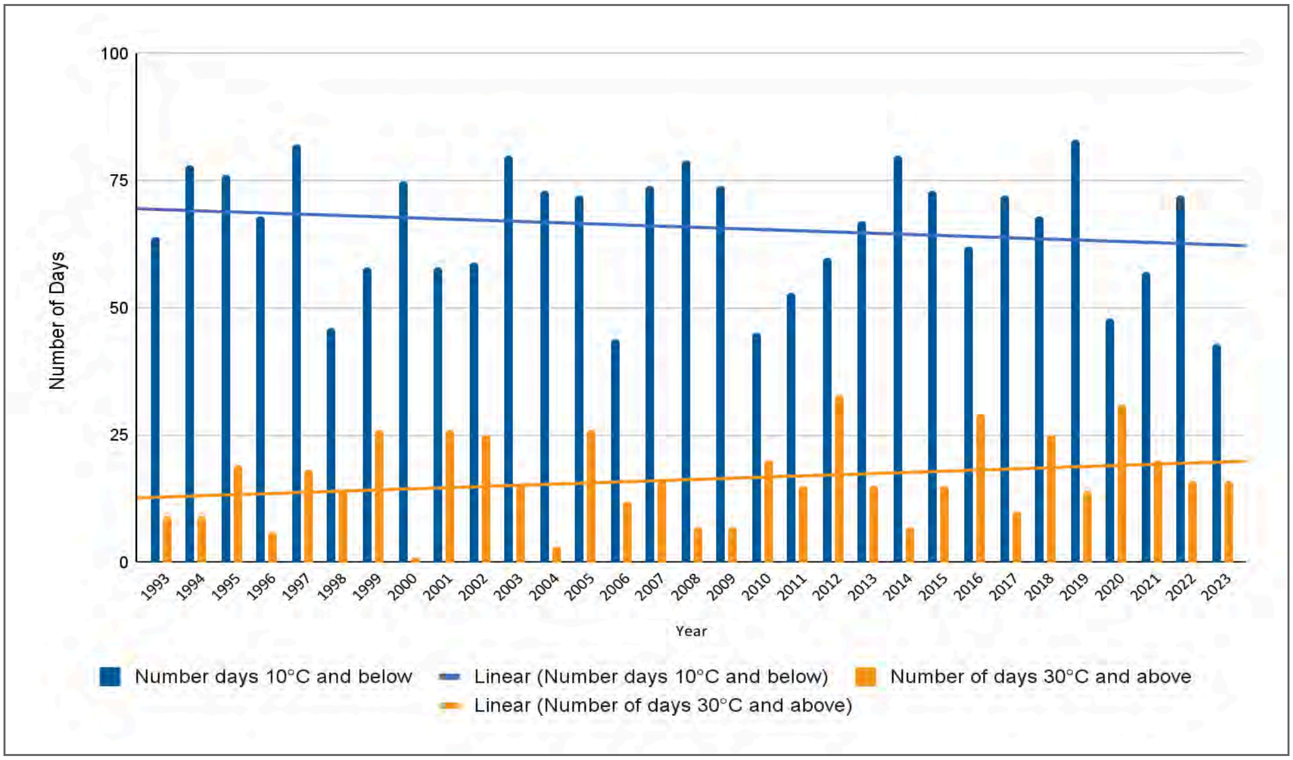
6.4.1. Historical Climate

Climate and weather significantly impact Hydro Ottawa's operations, particularly in planning and managing electricity demand and supply. Temperature variations directly influence consumption, with increased cooling loads in summer and growing heating loads in winter due to electrification trends. Monitoring temperature extremes, such as the increasing frequency of days above 30°C and below -10°C, is crucial for operational planning. Wind speed is another key factor, with high wind events posing challenges to grid stability. Recent severe storms have underscored the vulnerability of the electricity grid to extreme weather. Therefore, Hydro Ottawa's planning process incorporates these climatic considerations to ensure a reliable and resilient electricity supply for its customers.

Temperature

From 1993 to 2023, Hydro Ottawa tracked the annual number of days with temperatures exceeding 30°C and the annual number of days with temperatures falling below -10°C. The data that Hydro Ottawa has tracked is detailed in Figure 23. The near-horizontal slope of the linear trend line indicates a lack of short-term trend in the number of days above 30°C. However, a slight decline is observed in the annual number of days that fall below -10°C.

Figure 23 - Number of Days Below -10° and Below and Number of Days Above 30° and Above



Hydro Ottawa will continue monitoring the frequency of days exceeding 30°C due to the operational challenges that increasing trend presents for electricity distribution systems. Elevated demand from air conditioning usage can strain system capacity, requiring peak load management strategies. Furthermore, equipment is at a higher risk of overloading and reduced efficiency, potentially necessitating increased maintenance and upgrades to transformers, conductors, and substations.

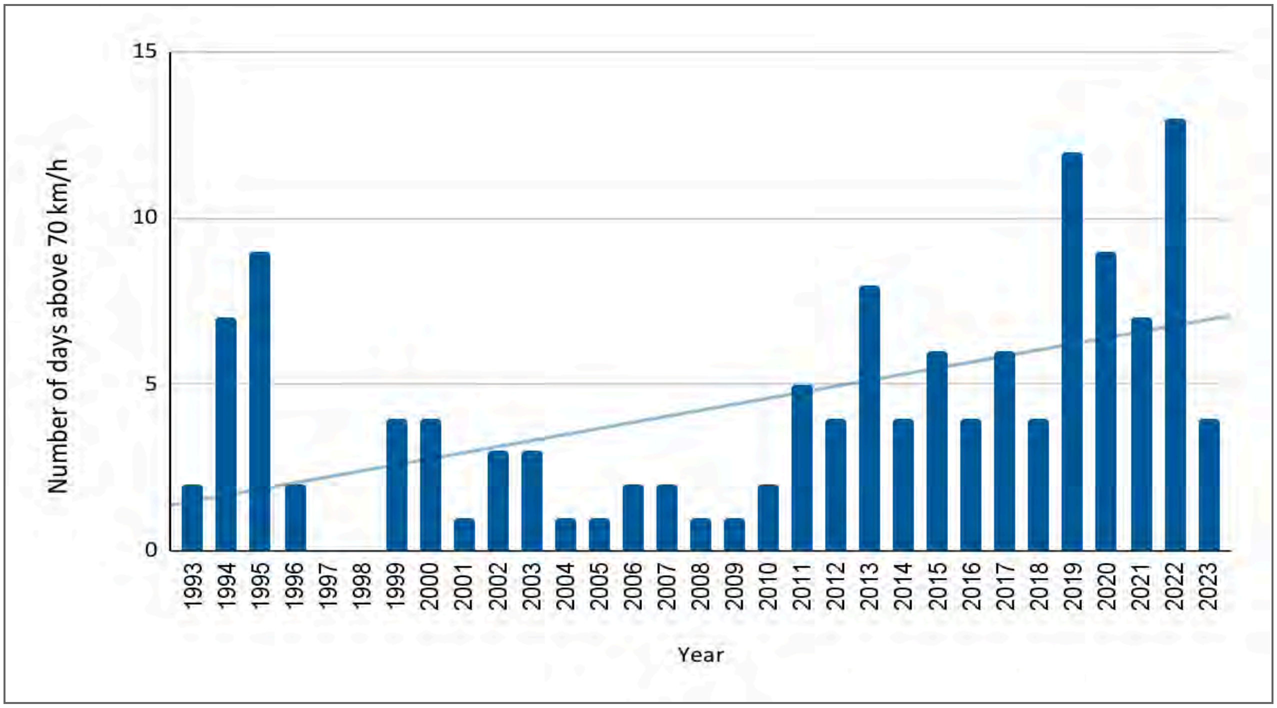
The number of days with temperatures below -10°C is an important metric for Hydro Ottawa, particularly given the increasing adoption of electrified space heating. For example, while heat pumps are efficient, they increase electricity demand significantly during periods of extreme cold, potentially posing operational challenges. Therefore, monitoring days with temperatures below -10°C is essential for accurate demand forecasting and effective system planning. Although no increasing trend in such cold days is currently observed, continued monitoring of this metric remains crucial for adapting to future climate and energy transitions further elaborated in Section 6.4.2 - Future Climate and Section 6.5 - System Demand and Growth Planning Considerations.

Wind Speed

From 1993 to 2023, Hydro Ottawa monitored the number of days when wind gusts exceeded 70 km/h, as illustrated in Figure 24. The graph demonstrates an overall upward trend in the number of days with gusts exceeding 70 km/h since 1993, with 2019 and 2022 in particular showing peaks with more than 10 days.

Figure 24 reveals a notable increase in the frequency of high-wind events, particularly since 2011. This observed trend highlights the need for Hydro Ottawa to maintain a system designed for resilience against such meteorological challenges. The data underscores the importance of ongoing vulnerability assessments and proactive asset hardening in high-risk areas. Given the observed impact of high-wind events on reliability, the data reinforces the need for proactive customer communication regarding outage risks and safety precautions.

Figure 24 - Number of Days Above 70 km/h Winds per Year



Extreme Weather Events

Hydro Ottawa has experienced firsthand the impact of weather events, with a series of severe storms in recent years causing significant damage and disruption to the electricity grid. Between 2017 and 2023, Hydro Ottawa faced multiple major weather events, impacting tens of thousands of customers:

- **2017**: Freezing rain, heavy snow, flooding, and a severe thunderstorm which impacted thousands of customers.
- **2018**: Freezing rain, high winds, and tornadoes caused widespread outages, impacting over 200,000 customers.
- **2019**: A flash storm, flooding, lightning strikes, and high winds which caused repeated disruptions throughout the year.
- **2021**: Lightning strikes caused further outages.

- **2022**: The devastating Derecho, with record-breaking wind speeds, which impacted over 180,000 customers and became the 6th costliest natural disaster in Canada's history. This was followed by a bomb cyclone in December, causing further outages.
- **2023**: An ice storm, freezing rain, and multiple lightning strikes continued the trend of severe weather impacts.

These weather events, excluding the 2019 flood, were categorized as Major Event Days (MEDs). For further information, refer to Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Reliability impacts from weather events classified as MEDs are reported separately from standard reliability metrics. These events highlight the vulnerability of the power distribution network to high wind speeds and emphasize the need for strong adaptation and mitigation strategies to improve resilience.

6.4.2. Future Climate

In 2023, Hydro Ottawa commissioned Stantec to update the 2019 Distribution System Climate Risk and Vulnerability Assessment and the associated 2019 Climate Change Adaptation Plan. The primary objective of this undertaking was to evaluate the continued efficacy of the adaptation and mitigation measures outlined in the 2019 assessment, considering both updated climate projection data and current risk levels.

The 2019 assessment used Coupled Model Intercomparison Project Phase 5 (CMIP5) climate projections, an international project modeling future climate change under different emission scenarios, including temperature, precipitation, sea level, and extreme weather. For the 2023 Climate Reaffirmation report provided in Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan, Stantec incorporated the latest available climate projection data Coupled Model Intercomparison Project Phase 6 (CMIP6) to update the Hydro Ottawa assessment. This update aimed to estimate climate parameter probabilities and determine whether the changes in the projection data significantly impact the risk scores assigned to Hydro Ottawa's infrastructure assets.

The Climate Reaffirmation report included updating the list of climate parameters to consider recent extreme weather events, updating climate parameter probabilities and impact severity based on input from Hydro Ottawa staff, and completing a forensic analysis of the May 2022 Derecho event.

Changes to the climate parameters can be seen in the Climate Reaffirmation report. Specifically, two additional high wind thresholds were established based on updated Environment and Climate Change Canada (ECCC) criteria for severe thunderstorm winds and the damages observed by the Northern Tornadoes Project in surveys following the May 2022 Derecho. The thresholds established included:

- **Wind speeds > 130 km/h**: Based on new ECCC severe thunderstorm winds and a 17% higher loading factor than the 120 km/h gust threshold used in the 2019 study.
- **Wind speeds > 180 km/h** (Derecho event equivalent): based on consistent EF-2 style observed damage in the Ottawa region and Doppler Radar near-surface wind speed recordings.

Climate parameters frequency and probability were updated using downscaled projections for the National Capital Region and CMIP6, where available. Changes were observed in annual and/or 30-year probabilities for several climate parameters in the 2050s. Frequency and probabilities were also established for new high wind thresholds. Increased consequence ratings for higher threshold wind speeds in both current and future climates resulted in increased risk scores. However, most risks did not experience a change in risk level. Table 19 summarizes the changes (highlighted in orange) and additions to consequences and risk scores.

The historical weather trends observed in 6.4.1 Historical Climate provide insight into the past climate patterns and influence future projections by providing baseline climate conditions. The method used in the Climate Reaffirmation report adjusts future climate projections based on similar historical trends presented in Section 6.4.1 - Historical Climate, allowing for shifts in temperature and wind patterns to be incorporated into long-term forecasting. Short-term weather events remain dependent on real-time atmospheric conditions, the approach used in the Climate Reaffirmation ensures that forecasts in temperature extremes and high-wind days reflect both historical variability and projected climate shifts, making the historical trends a factor in shaping the probabilistic forecast over longer timescales.

Table 19 - Summary of Changes and Additions to Consequence and Risk Scores

Climate Parameter: Threshold	Infrastructure Performance Category	Consequence Update	2019 Study		2023 Update	
			Consequence Score	2050s Cumulative Risk Score	Consequence Score	2050s Cumulative Risk Score
High wind: 120 km/hr	Asset Value - Financial score for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Increased consequence scores from 9 to 16 due to recent extreme wind experienced by Hydro Ottawa that led to more operational and capital expenses	9	81	16	102
High wind: 130 km/hr	All categories	Consequence scores mirror those of the 120 km/hr threshold	N/A	N/A	16	102
High wind: 180 km/hr	System accessibility, service quality, and resource efficiency for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Consequence scores assigned a 16 based on UWO's analysis of damage for the 2022 Derecho event	N/A	N/A	16	114
	Financial for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Consequence scores assigned a 25 due to damage experienced by Hydro Ottawa in the 2022 Derecho event	N/A	N/A	25	
Freezing rain: Ice accumulation of 25 mm	Financial for Power Distribution - Overhead (N-S and E-W orientations) Lines	Increased consequence scores for 4 to 9 due to recent freezing rain events experienced by Hydro Ottawa that led to more operational and capital expenses	4	16	9	26

The adaptation and risk mitigation plan was subsequently updated, incorporating input from workshops and addressing any risk scores that had changed to medium-very high under current or future climate scenarios. To ensure consistency, Stantec employed the same methodologies used in the 2019 report for this reassessment. The updated report also reviewed the adaptation measures proposed in the 2019 report. While most of these measures remained relevant, additional recommendations were made for strengthening pole line systems and improving real-time weather monitoring. Hydro Ottawa has made progress in implementing these measures but must continue addressing new and accelerating climate risks. In Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan, Appendix B, "2023 Adaptation Status, Next Steps, and Barriers" details Hydro Ottawa's progress in implementing the 2019 adaptation measures.

Hydro Ottawa made significant strides in implementing the 2019 adaptation plan. Examples of the progress made since 2019 include:

- Strengthening North-South pole lines by installing a composite pole every fifth pole, along with additional guying and anchoring.
- Utilizing satellite imaging to monitor tree trimming growth and maintenance.
- Complete a cost/benefit analysis to convert overhead lines to underground infrastructure.
- Implementing wind restrictions for aerial work platforms during high winds.

Due to the substantial impact of the 2022 Derecho on overhead distribution infrastructure, design standards have been revised. Hydro Ottawa's Overhead Design Guideline now includes recommendations for anti-cascading strategies and infrastructure hardening, including installing composite poles with storm guying every five poles in vulnerable areas.

The updated climate study confirmed that continuous adaptation and mitigation strategies are necessary. This assessment supports planning to improve grid resilience and prioritize system reliability due to increasingly frequent severe weather events and growing reliance on stable power.

Hydro Ottawa's climate assessment aligns with the OEB's VASH - Draft Report[10] by developing climate forecast data derived from climate forecast models developed by Stantec. This data allows for a quantitative analysis comparing asset threshold criteria to the probability of extreme weather events during project evaluation, ensuring investments improve climate resilience within the distribution system.

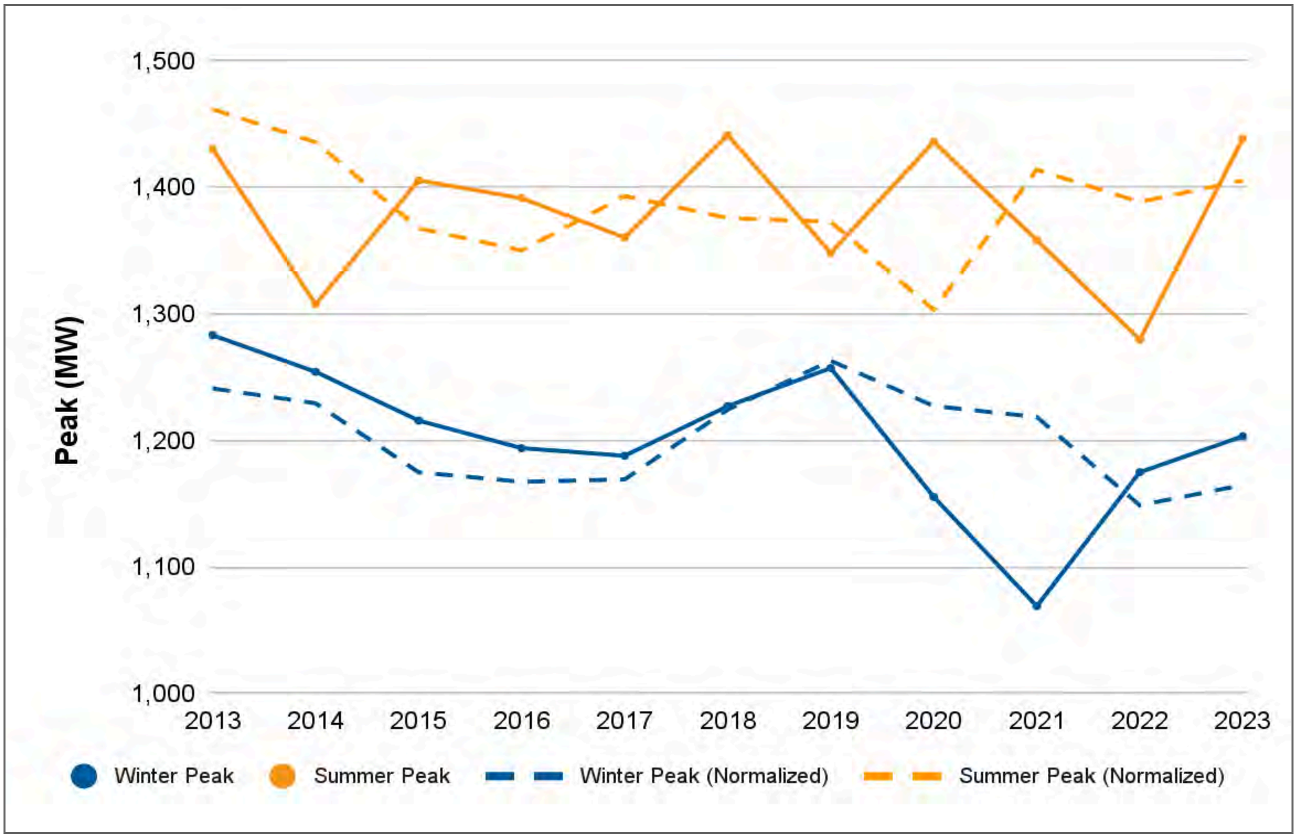
6.5. SYSTEM DEMAND AND GROWTH PLANNING CONSIDERATIONS

6.5.1. System Demand

In 2023, Hydro Ottawa purchased a total of 7,471 gigawatt hours of electricity from the provincial grid to supply customers. Figure 25 illustrates both the summer and winter peak demands from 2013 to 2023. The Hydro Ottawa system has continued to see a higher peak during summer, which has remained relatively stable over the past decade, ranging from a high of 1,441 MW in 2018 to a low of 1,280 MW in 2022.

[10] Ontario Energy Board, *Vulnerability Assessment - Draft Report*, EB-2024-0199 (December 17, 2024).

Figure 25 - Net System Summer & Winter Peak (2013-2023)[11]



To ensure the continued delivery of reliable and resilient electricity services to its expanding customer base, Hydro Ottawa must strategically expand its grid capacity to accommodate unprecedented demand growth. This increased demand is driven by several converging factors, detailed in Table 20, including residential growth, transportation electrification, and the increasing adoption of electrified space heating.

Residential growth, based on the City of Ottawa's population projections, is a primary contributor to increased energy consumption. The ongoing expansion of the City necessitates increased capacity to serve new residential customers. Further detailed in Section 6.5.2 - Residential Growth below.

[11] The values including embedded generation.

The increasing adoption of electric vehicles will also significantly impact electricity demand. Federal legislation mandates a complete transition to electric vehicle sales by 2035. This national shift is mirrored locally by the City of Ottawa's ambitious plan to fully electrify its bus fleet by 2036. Further detailed in Section 6.5.3 - Transportation Electrification below.

Finally, the growing prevalence of electrified space heating, particularly through the use of heat pumps, will further drive electricity consumption. This trend, aligned with broader electrification efforts, represents a substantial increase in demand for electricity. Further detailed in Section 6.5.4 - Electrified Space Heating below.

Table 20 - Ottawa Growth Factors

Factor	Description	Supporting Statistic
Residential Growth	Forecasted increases in housing and population will drive increased energy demand.	Ottawa population Compound Annual Growth Rate (CAGR) of 1.3% and dwelling CAGR of 1.5% between 2026 and 2031 as per the City of Ottawa Official Plan.[12]
Transportation Electrification	Increased adoption of electric vehicles.	Federal Government legislation requires 60%[13] of all light duty vehicles sold in Canada to be electric vehicles by 2030 and 100% by 2035, compared to 9% of vehicles sold in 2021. The City of Ottawa planned to procure 354 electric buses by 2027 and a full transition to electric buses by 2036.[14]
Electrified Space Heating	Increased adoption of electric space heating.	Increase of electric space heating in residential and commercial segments through combination of heat pumps and electric furnaces in Canada's net-zero scenarios, with heat pumps providing more than 50% of residential space heating needs by 2050, up from 6% in 2021.[15]

[12] City of Ottawa, "Growth projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93.
[13] Statistics Canada, "Watt's up? Electric Vehicles and future electricity generation needs," https://www.statcan.gc.ca/o1/en/plus/5497-watts-electric-vehicles-and-future-electricity-generation-needs
[14] Ottawa-Carleton Transportation, "Zero-Emission Bus," https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/
[15] Canada Energy Regulator, "Canada's Energy Future 2023: Energy Supply and Demand Projections to 2050," https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/

6.5.2. Residential Growth

For residential growth planning, Hydro Ottawa utilizes the City of Ottawa's *Growth Projections for Ottawa: 2018-2046* report.[16] This report projects a compound annual growth rate (CAGR) of 1.2% for population and 1.4% for dwellings between 2026 and 2036. Based on these projections, Hydro Ottawa anticipates a 13% population increase within its service area, equivalent to an additional 149,900 residents, between 2026 and 2036. This population growth will fuel a corresponding expansion in housing, with forecasts indicating a 15% increase in the number of dwellings over the same period. This growth is expected to be driven by both intensification and redevelopment initiatives, suggesting a focus on denser housing options within existing urban areas. This combination of population growth and increased housing units will contribute to a rising demand for energy within the residential sector.

As the city grows, formerly rural areas served by long distribution feeders are transitioning into urban centers. These long feeders, originally designed for lower population densities, often experience greater voltage fluctuations and are more susceptible to outages due to their extended length and exposure to environmental factors. This presents a challenge for Hydro Ottawa, as maintaining consistent and reliable service in these newly urbanized areas requires upgrades and potentially redesigning sections of the distribution network to meet the higher service quality expectations of urban customers. These upgrades can be complex and costly, requiring careful planning and execution to minimize disruption to existing customers.

City of Ottawa Growth Projections

The population, household, and employment growth forecasts presented in Table 21 have been obtained from the City of Ottawa Growth Projections for 2021-2036. The City of Ottawa published its New Official Plan as of November 2022, which includes updated growth projects.

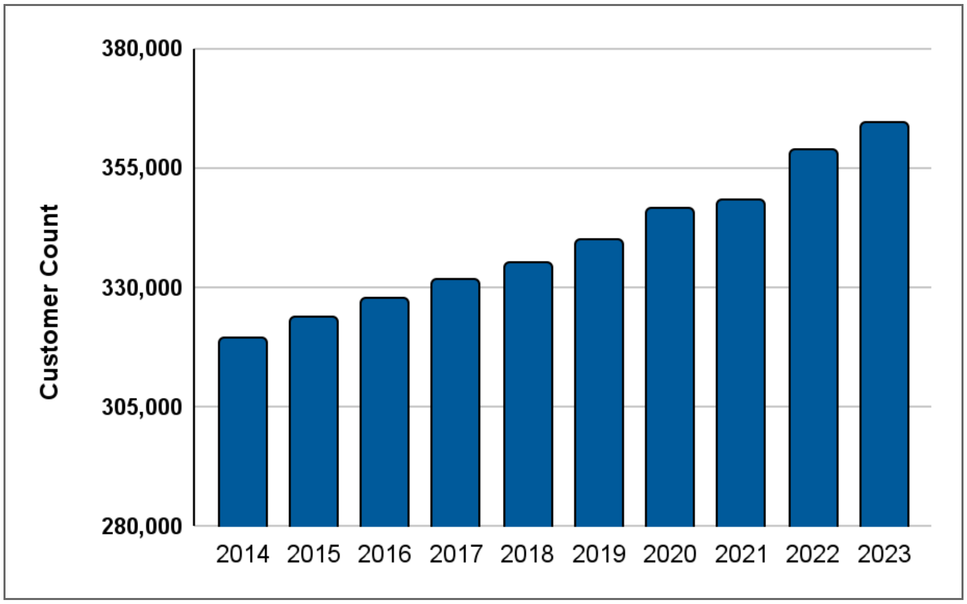
[16] City of Ottawa, "Growth Projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93

Table 21 - Projected Growth in Population, Households & Employment, City of Ottawa, 2021-2036

Population				
Year	**2021**	**2026**	**2031**	**2036**
Total	1,064,100	1,141,800	1,219,200	1,291,700
CAGR		1.4%	1.3%	1.2%
Households				
Year	**2021**	**2026**	**2031**	**2036**
Total	429,800	470,700	509,100	542,900
CAGR		1.8%	1.6%	1.3%
Employment				
Year	**2021**	**2026**	**2031**	**2036**
Total	662,400	698,400	731,500	764,400
CAGR		1.1%	0.9%	0.9%

Hydro Ottawa's customer base has grown at a consistent CAGR of 1.5% between 2014 and 2023, as shown in Figure 26. A comparison of overlapping data from 2018 to 2023 reveals a 1.7% CAGR for both the City of Ottawa's population growth and Hydro Ottawa's customer growth, demonstrating a strong correlation. This alignment with population growth projections supports Hydro Ottawa's expectation of a continuing upward trend in connection requests for residential subdivisions, associated mixed-use centers, and employment centers.

Figure 26 - Historical Customer Count



City of Ottawa Community Design Plans

Hydro Ottawa actively monitors the City of Ottawa's published Community Design Plans (CDPs) to understand projected residential and mixed-use center developments. CDPs are intended to guide change in designated growth areas, as identified in the City of Ottawa's Official Plan. The purpose of CDPs is to translate the City of Ottawa Official Plan's principles and policies to the community level. The City of Ottawa’s Official Plan, which came into effect on November 4, 2022, directs the city's growth over time and establishes policies to guide development. Currently, 36 CDPs, encompassing a variety of development types, are available on the City of Ottawa's website[17]. A summary of these CDPs, linked to Hydro Ottawa Planning Regions, is provided in Table 22. Hydro Ottawa will continue to utilize these CDPs to identify areas anticipated to experience significant load growth due to increased density.

[17] City of Ottawa. "Community Design Plans." City of Ottawa, [Feb 2025], [URL: https://ottawa.ca/en/planning-development-and-construction/community-design/community-plans-and-studies/community-design-plans].

1 **Table 22 - City of Ottawa Community Design Plans Summary**

Study	Hydro Ottawa Planning Area	No. Res. Units	Land Use Type
Barrhaven South CDP	Barrhaven 8kV/South 28kV	6,862	Mixed-Use
Barrhaven South Expansion CDP	Barrhaven 8kV/South 28kV	1,752	Mixed-Use
Bank Street CDP	East 4kV & 13kV	990	Mixed-Use
Bayview Station District CDP	West 13kV & Central 4kV	3,594	Mixed-Use
Beechwood CDP	East 4kV & 13kV	819	Mixed-Use
Cardinal Creek Village Concept Plan	N/A (Hydro One Territory)	3,500	Mixed-Use
Carp Road Corridor CDP	N/A (Hydro One Territory)	-	Commercial
Village of Carp CDP	N/A (Hydro One Territory)	543	Mixed-Use
Village of Constance Bay Community Plan	N/A (Hydro One Territory)	204	Mixed-Use
East Urban Community (Phase 1 Area) CDP	East 8kV & 28kV	3,498	Mixed-Use
East Urban Community (Phase 2 Area) CDP	East 8kV & 28kV	1,726	Mixed-Use
East Urban Community (Phase 3 Area) CDP	East 8kV & 28kV	4,050	Mixed-Use
Fernbank CDP	West 28kV	11,000	Mixed-Use
Former CFB Rockcliffe CDP	East 4kV & 13kV	5,350	Residential
Greely CDP	N/A (Hydro One Territory)	729	Mixed-Use
Leitrim CDP	South-East 28kV	5,300	Mixed-Use
Mer Bleue CDP	N/A (Hydro One Territory)	3,000	Mixed-Use
Kanata North CDP	West 28kV (North)	2,900	Residential
Kanata West Concept Plan	West 28kV	5,000	Mixed-Use
North Gower CDP	N/A (Hydro One Territory)	520	Mixed-Use
Old Ottawa East CDP	Core 13kV & Central 4kV	2,250	Mixed-Use
Orleans Industrial Park Study	East 8kV & 28kV	-	Commercial
Richmond Road/Westboro CDP	West 13kV & Central 4kV	2860	Mixed-Use
Riverside South CDP	South-East 28kV	18,300	Mixed-Use
Scott Street CDP	West 13kV & Central 4kV	1,500	Mixed-Use

Study	Hydro Ottawa Planning Area	No. Res. Units	Land Use Type
South Nepean Town Centre CDP	Barrhaven 8kV & South 28kV	11,000	Mixed-Use
Uptown Rideau CDP	Core 13kV & Central 4kV	2,500	Mixed-Use
Transit-Oriented Development (TOD) Plans	East 4kV & 13kV	16,500	Mixed-Use
Village of Richmond CDP	West 28kV	2,700	Mixed-Use
Wellington Street West CDP	West 13kV & Central 4kV	950	Mixed-Use

City of Ottawa Transportation Master Plan

Hydro Ottawa incorporates the City of Ottawa's Transportation Master Plan (TMP)[18] in its planning process, particularly regarding plant relocation, asset renewal, and line upgrades necessitated by transportation projects. The TMP, a two-decade roadmap for the City of Ottawa's transportation networks, emphasizes affordability and has resulted in the "Affordable Road Network," a prioritized subset of planned road projects focused on fiscal responsibility. Table 23 outlines the City of Ottawa Affordable Road Network projects between 2026 and 2031 that will influence Hydro Ottawa's infrastructure development, ensuring alignment with the City of Ottawa's transportation priorities.

[18] City of Ottawa, "Transportation Master Plan, Exhibit 7.2: 2031 Affordable Road Network- Project By Phase- https://documents.ottawa.ca/sites/default/files/documents/tmp_en.pdf

Table 23 - City of Ottawa Affordable Road Network Projects 2026-2031

Sector	Project	Description
Southeast	Airport Parkway (2)	Widen from two to four lanes between Hunt Club Road and MacDonald-Cartier International Airport
Rural	Bank Street (2)	Widen from two to four lanes between Earl Armstrong Road extension and Rideau Road
Outer Urban	Blair Road	Widen from two to four lanes between Meadowbrook Road and Innes Road
Outer Urban	Coventry Road	Widen from two to four lanes between Belfast Road and St. Laurent Center
Outer Urban	Cyrville Road	Urbanize existing two-lane rural cross-section between Belfast Road and St. Laurent Center
Southwest	Earl Armstrong Road	Widen from two to four lanes between Limebank Road and Bowesville Road
West	Hope Side Road	Widen from two to four lanes between Eagleson Road and Richmond Road
West	Huntmar Drive	Widen from two to four lanes between Campeau drive extension and Cyclone Taylor Boulevard; widen from two to four lanes between Palladium Drive and Maple Grove Road
Southeast	Stitsville Main Street Extension	New two-lane road between Palladium Drive and Maple Grove Road
Inner Urban	Preston Street	Extend existing two-lane urban roadway Albert Street to Vimy Place (at Kichi Zībī Mīkan)
Southwest	Prince of Wales Drive	Widen from two to four lanes between Hunt Club Road and Merivale Road
Outer Urban	Tremblay Road	Widen from two to four lanes between Pickering Place and St. Laurent Boulevard

6.5.3. Transportation Electrification

The electrification of transportation in Canada, driven by federal and municipal climate targets, is poised to significantly reshape the nation's electricity infrastructure. Federal legislation, including the Canadian Net-Zero Emissions Accountability Act and the 2030 Emission Reduction Plan, mandates a rapid transition to electric vehicles, with targets of 20% of new light-duty vehicle sales being zero-emission by 2026, 60%[19] by 2030, and 100% by 2035. Similar targets exist for medium- and heavy-duty vehicles. This surge in EV adoption, fueled by substantial government incentives like the iZEV program and investments in charging infrastructure, will dramatically increase electricity demand.

In Ottawa, these national trends are amplified by the City's own aggressive climate goals, as outlined in its Climate Change Master Plan.[20] The City aims for 100% community emissions reduction by 2050 and 100% corporate emissions reduction by 2040, with transportation electrification playing a key role. Ottawa's plan includes procuring 354 electric buses by 2027, targeting a full transition to electric buses by 2036,[21] and encouraging residential EV adoption. This increased demand for electricity from both private vehicles and public transit will necessitate significant upgrades and expansion of the electrical distribution grid.

6.5.4. Electrified Space Heating

The increasing adoption of electric space heating, driven by Canada's net-zero targets, will necessitate significant growth in electricity infrastructure. This growth will be fueled by the shift from traditional heating methods to heat pumps and electric furnaces in both residential and commercial sectors. Specifically, heat pumps are projected to provide over 50% of residential space heating needs by 2050, a substantial increase from 6% in 2021.[22]

[19] Statistics Canada, “Watt’s up? Electric Vehicles and future electricity generation needs,” https://www.statcan.gc.ca/o1/en/plus/5497-watts-electric-vehicles-and-future-electricity-generation-needs
[20] City of Ottawa, “Climate Change Master Plan” https://ottawa.ca/en/planning-development-and-construction/official-plan-and-master-plans/climate-change-master-plan#section-08062b40-74a0-4521-b619-93451ff489fe
[21] Ottawa-Carleton Transportation, “Zero-Emission Bus,” https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/
[22] Canada Energy Regulator, “Canada’s Energy Future 2023: Energy Supply and Demand Projections to 2050,” https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/

Projections for this increased demand are based on data from Natural Resources Canada (NRCan),[23] the Canada Energy Regulator (CER),[24] Enbridge,[25] and the City of Ottawa.[26] These analyses consider factors such as expected technology adoption rates (heat pumps vs. electric resistance), weather data (particularly in climates like Ottawa), and the diminished efficiency of air-source heat pumps at temperatures below -10°C.

Electrifying space heating, primarily through heat pump adoption, is crucial for Canada's net-zero goals but will dramatically increase electricity demand, especially in colder climates like Ottawa due to reduced heat pump efficiency. This necessitates significant investment in electricity distribution infrastructure to ensure a capable and reliable energy transition.

[23] NRCan, "Residential Sector Energy Use, Ontario," Residential Sector – Ontario | Natural Resources Canada
[24] Canada Energy Regulator, "Canada's Energy Future 2023: Energy Supply and Demand Projections to 2050," https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/
[25] Enbridge, "Pathways to Net-Zero Emissions in Ontario," Pathways to Net-Zero Emissions In Ontario | Enbridge Gas
[26] City of Ottawa, "Climate Change Master Plan" https://ottawa.ca/en/planning-development-and-construction/official-plan-and-master-plans/climate-change-master-plan#section-08062b40-74a0-4521-b619-93451ff489fe

7. OVERVIEW OF ASSETS MANAGED

This section provides a comprehensive overview of the assets managed by Hydro Ottawa, diving into the asset demographics and conditions, asset failures and performance, asset risk profiles, and system utilization.

The detailed demographics and condition profile of each asset class are presented in the following sections: Station Assets (transformers, switchgear, batteries, and P&C equipment), Overhead Assets (distribution poles, overhead transformers, and switches), and Underground Assets (distribution cables, underground transformers, switchgear, vault transformers, and civil structures).

Asset failures and performance are reviewed further through performance measurement for continuous improvement, observing equipment failure trends to implement risk mitigation strategies.

Asset risk profiles, considering reliability, safety, environmental, financial, and compliance risks, were analyzed through PA modules. Reliability risk was the most significant factor due to its broad applicability and data availability.

Finally, system utilization is monitored through KPIs like the SLI and FLI, demonstrating capacity limitations, and in turn employs strategies such as Load Forecasting, Renewable Energy Integration, and Grid Modernization.

7.1. ASSET DEMOGRAPHICS AND CONDITION

This Section summarizes the demographics and condition profile for the major assets classes within Hydro Ottawa’s distribution system. ACA is based upon health index calculations that are unique to each asset class. Hydro Ottawa categorizes and manages assets under four main systems: Stations, Overhead, Underground, and Metering. Each system has distinct types of assets that are specific to the system and are subject to different types of risks.

System Renewal Program investments, as outlined in Schedule 2-5-7 - System Renewal Investments, are focused on managing and mitigating the risk of asset failure within Hydro Ottawa's distribution network by renewing deteriorating asset infrastructure. The underlying asset demographics (in terms of TUL and condition) are a key consideration for system renewal investment planning in addition to the risk at each individual asset level. TUL refers to the expected duration an asset can reliably operate before it requires replacement or refurbishment. As a part of its asset renewal planning, Hydro Ottawa has grouped the asset age demographics into three categories:

1. **More than 10 Years of TUL Remaining:** Assets with a remaining TUL of over 10 years are considered to be in a stable condition and do not require immediate intervention. These assets are typically monitored through routine maintenance and inspections.
2. **Less than 10 Years of TUL Remaining:** Assets with a remaining TUL of less than 10 years are flagged for future intervention. These assets are not yet at the end of their TUL but will require attention and potential replacement or refurbishment within the 10-year timeframe.
3. **Reached or Exceeded TUL:** Assets that have reached or exceeded their TUL require immediate or short-term intervention. These assets are at the highest risk of failure and are prioritized for replacement or refurbishment in the short-term.

In addition to the TUL categorization, Hydro Ottawa also considers the Health Index value ranging from 0-100% to further assess the condition of each asset and the urgency of any required intervention. The Health Index provides a nuanced evaluation of asset health, allowing for more targeted and efficient maintenance and replacement strategies. The Health Index categories are as follows:

- **0-30% (Very Poor):** Assets falling within this range are considered to be in critical condition and pose an immediate risk of failure. These assets require immediate risk assessment and are prioritized for replacement or refurbishment to prevent service disruptions and safety hazards.

- **30-50% (Poor):** Assets within this range are in poor condition and require short-term attention. While not as critical as those in the 0-30% range, these assets are still at risk of failure and are scheduled for replacement or refurbishment based on the specific risk they pose and the potential consequences of failure.
- **50-70% (Fair):** Assets in this range are showing signs of degradation but are not yet at a critical stage. These assets require increased diagnostic testing and monitoring to assess their condition and rate of deterioration. Depending on the criticality of the asset and the nature of the degradation, remedial work or replacement may be necessary.
- **70-85% (Good):** Assets within this range are in good condition and do not require intervention beyond normal maintenance and inspections.
- **85-100% (Very Good):** Assets in this range are in a very good condition and require no intervention beyond normal maintenance and inspections.

Age and condition are among the parameters that drive Hydro Ottawa's overall risk-based asset management framework outlined in Section 5.1.4 - Asset Risk Assessment. The overall extent of investment required under each distribution asset renewal program is primarily driven by the extent of risk mitigated in the short term/long term and the ability for Hydro Ottawa to maintain system reliability through 2026-2030. This is discussed in the corresponding Alternatives Evaluation sections for each distribution asset renewal program in Schedule 2-5-7 - System Renewal Investments.

Hydro Ottawa's condition assessment process has evolved over the years (since 2014). Some key improvements implemented currently (in 2024) as compared to previous years include:

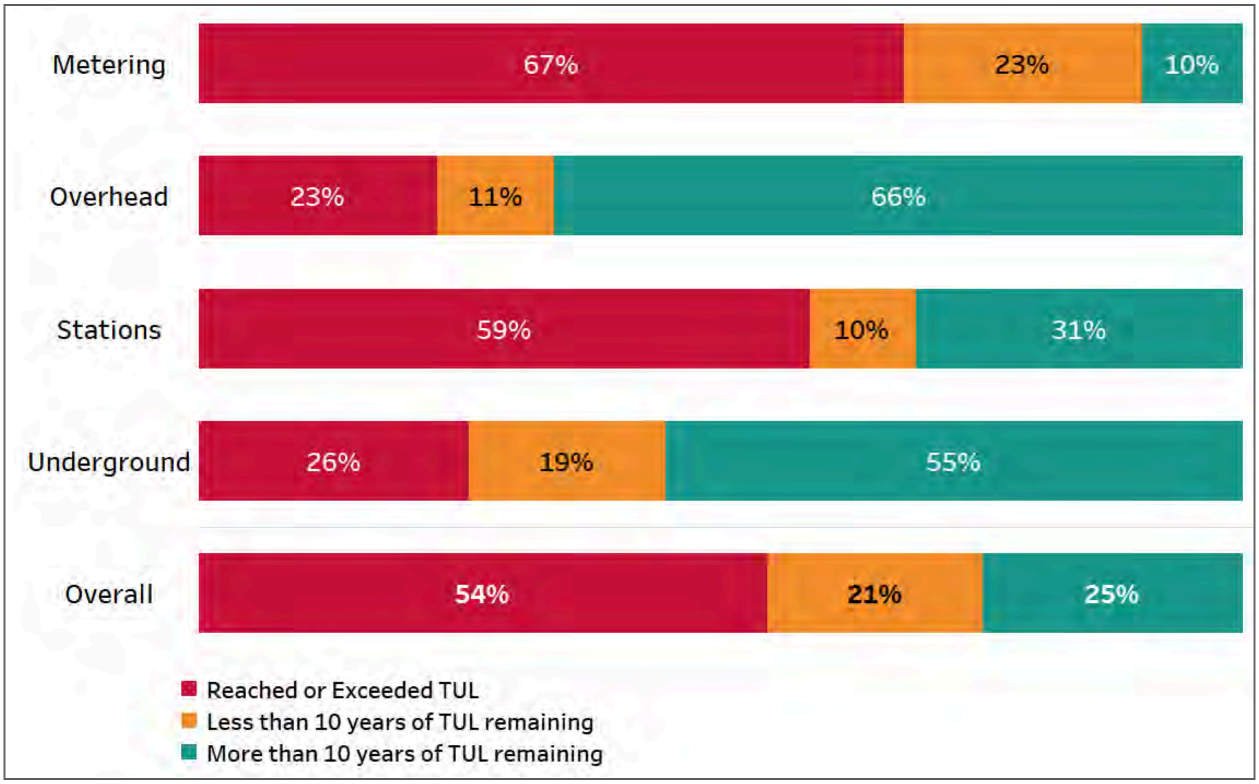
- Updating the health indexing framework to incorporate additional condition parameters gathered through inspection and maintenance programs.
- Reducing the heavy reliance on age as a major contributor to health index. Hydro Ottawa has accomplished this through two ways:
  - Decreasing the weighting assigned to age as a part of the health indexing process.

    - Translating age to condition based on the linear piecewise/linear relationship established between age and condition through the failure curve development exercise outlined in Section 4.4.4 - Failure Curves and Typical Useful Life Update. This approach was used to determine the equivalent condition value for assets that had a known age, but lacked a valid health index.
- Implementing validity to the health index process to ensure that at least 70% of the condition information is available to define a health index value.

These continuous improvement measures have made it difficult to compare Hydro Ottawa's current asset condition state to previous rate periods, as the asset condition profiles have changed since then. A key measure utilized in system renewal planning for 2026-2030 was the ability to forecast asset degradation patterns and risk projections into 2030 through Copperleaf PA, for Hydro Ottawa to intervene on the most impactful and deteriorated assets. The 2030 projections (in terms of age, condition and risk) have been instrumental in deciding on the preferred investment alternative/strategy as outlined in the corresponding Alternatives Evaluation sections for each distribution asset renewal program in Schedule 2-5-7 - System Renewal Investments.

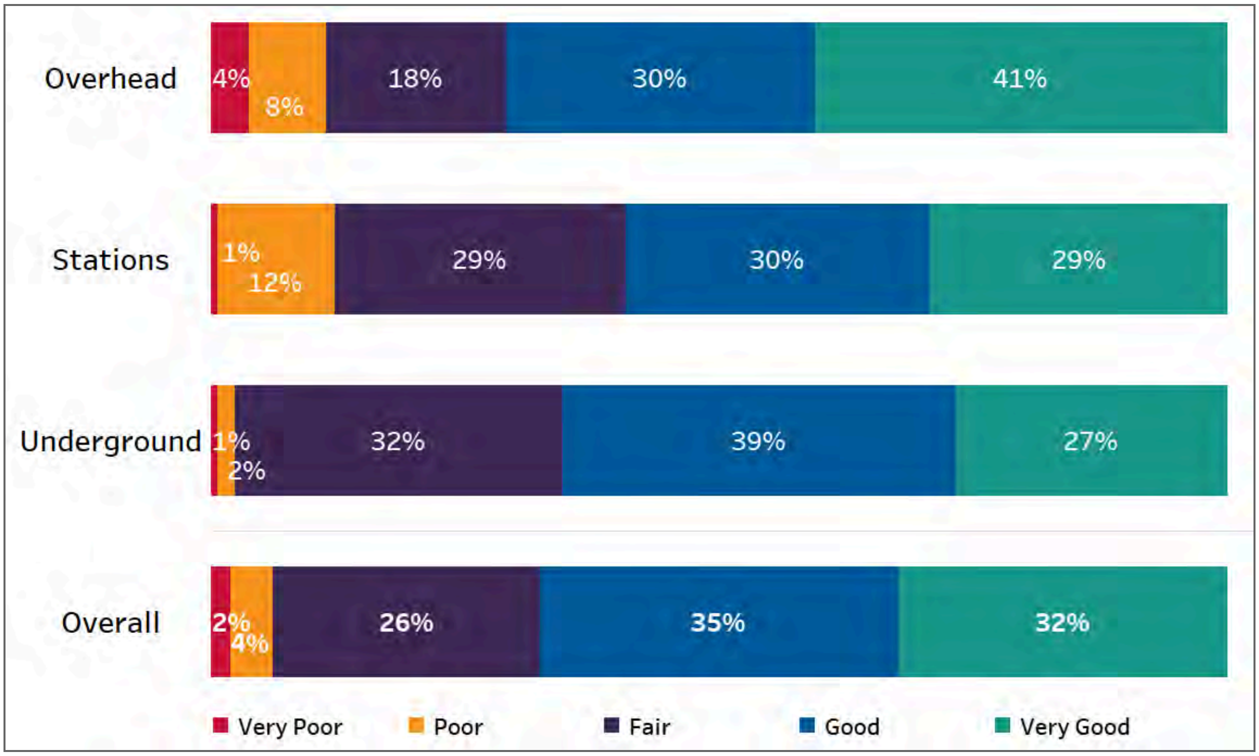
Hydro Ottawa's overall asset demographics, as seen in Figure 27, shows that a large portion (approximately 54%) of the asset population has reached its TUL, posing a higher risk of failure. An additional 21% of assets are within 10 years of reaching their TUL.

Figure 27 - Overall Asset Age Demographics



Hydro Ottawa's overall asset condition ratings are summarized in Figure 28 below. Based on the overall condition profile, approximately 6% of assets are in Poor or Very Poor condition. This presents an immediate and growing risk of asset failure and subsequent reliability impact to the system.

Figure 28 - Overall Asset Condition



The detailed demographics and condition profile of each asset class are presented in the following sections.

7.1.1. Station Assets

Hydro Ottawa station assets are an important part of delivering power to its customers. These assets are located within the fence of an electrical station. Out of the 92 stations that service Hydro Ottawa's customers, Hydro Ottawa fully owns 74. Hydro Ottawa and Hydro One jointly own 12 stations. These stations consist of various assets, some owned by Hydro One, and others owned by Hydro Ottawa. Hydro One wholly owns six stations that supply Hydro Ottawa customers. A list of these stations and their ownership is provided in Attachment 2-5-4(G) - Hydro Ottawa Station Table.

Figure 29 and Figure 30 show the age and condition demographic projections into 2040, without any intervention, as obtained through Copperleaf PA. It can be seen that approximately 65% of the station assets will reach the TUL by 2030, with the proportion increasing to 75% by 2040. On the condition front, approximately one-fourth of the asset population will reach a Very Poor/Poor condition by 2035 and increase to about 35% by 2040. Station renewal projects are complex and require extensive planning, procurement of long-lead equipment and execution over several years (for major station asset renewals).

Figure 29 - Station Asset Age Demographic Projections

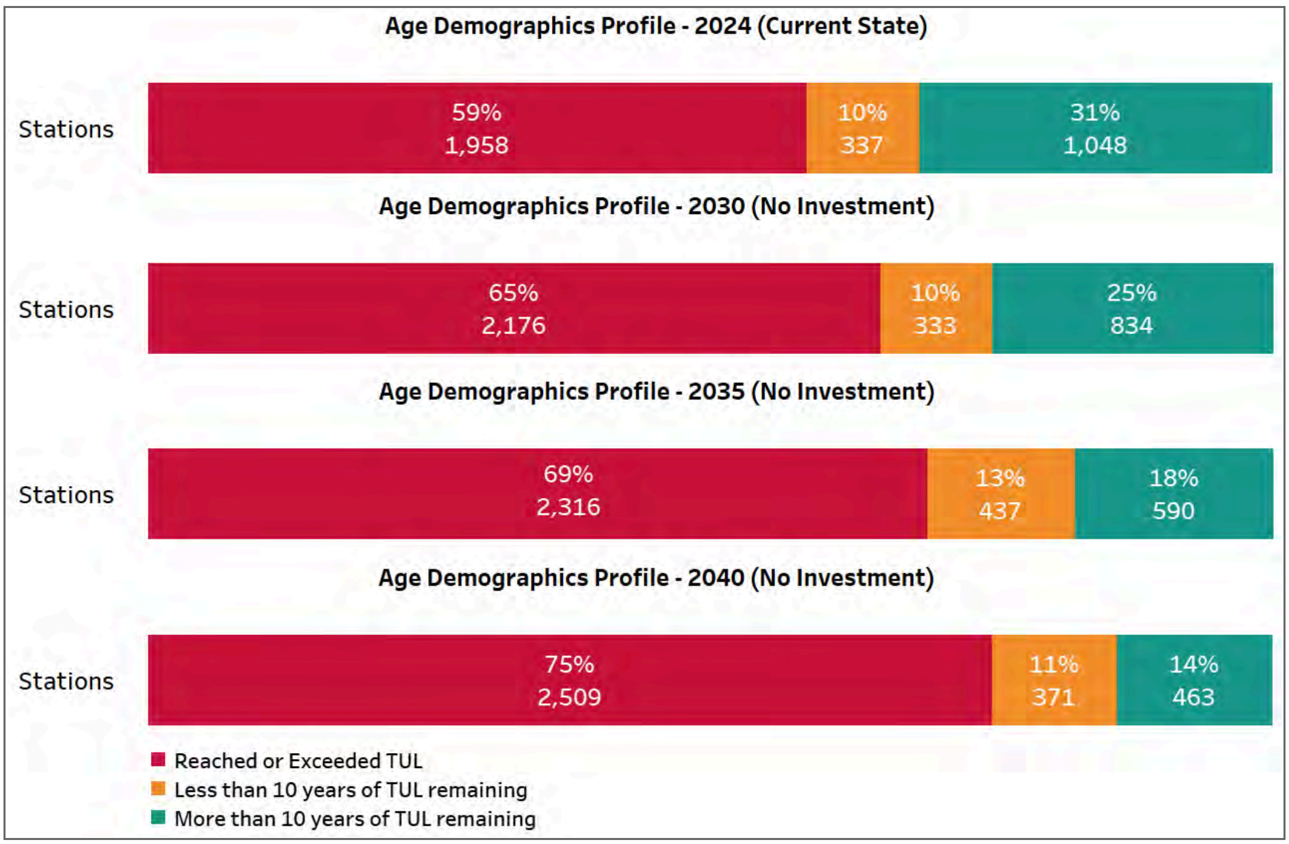
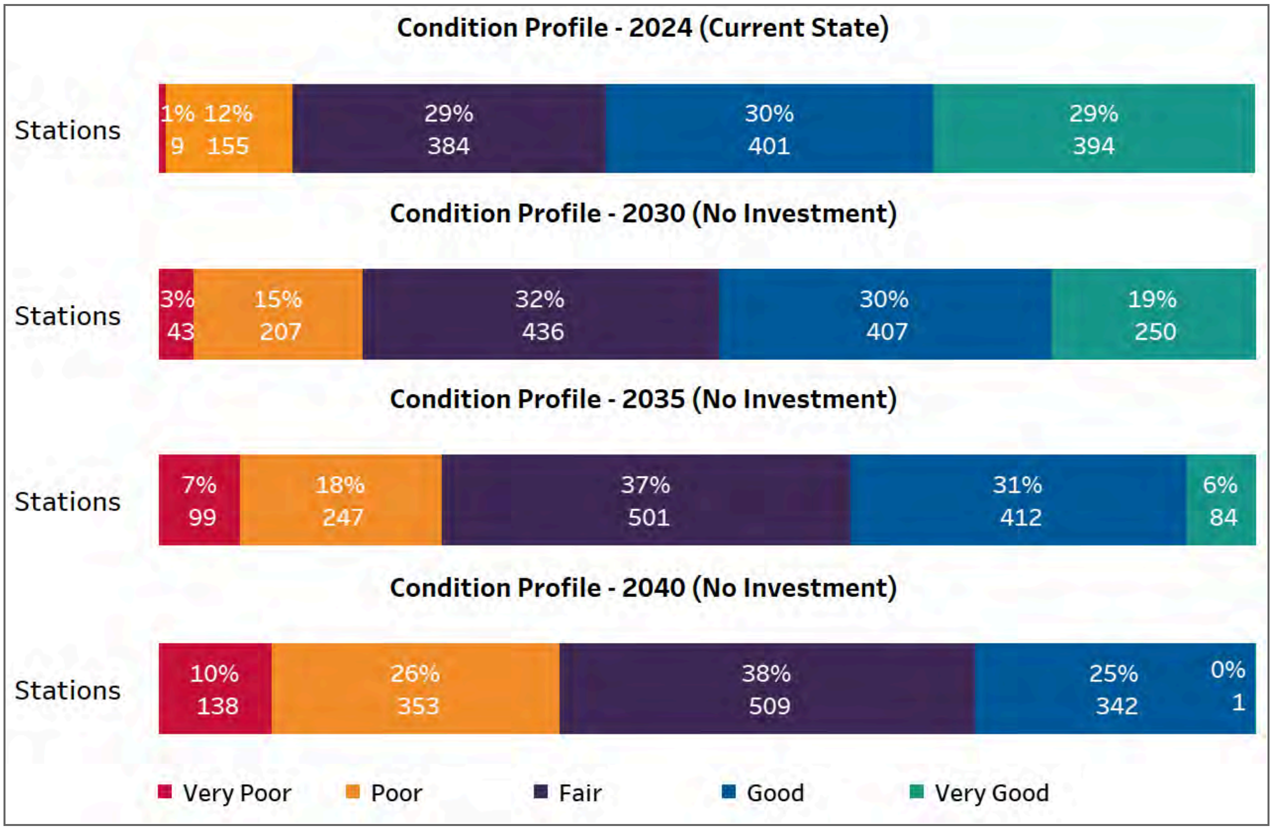


Figure 30 - Station Asset Condition Demographic Projections

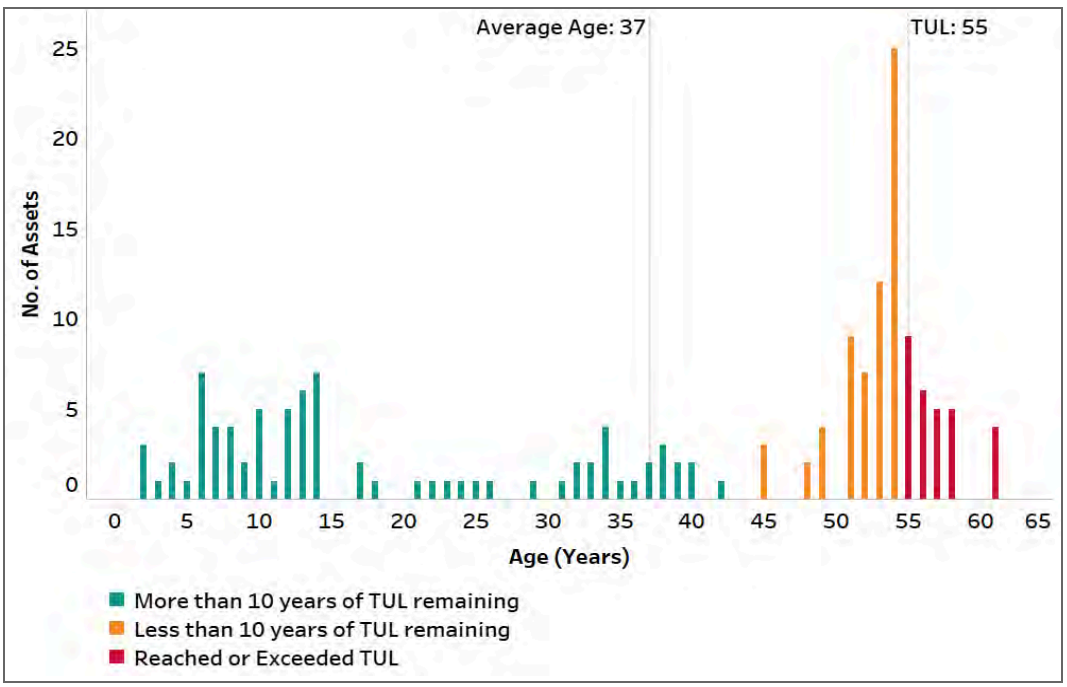


Hydro Ottawa utilized Copperleaf PA to gain a deeper understanding of potential future degradation patterns. This information was used to develop an appropriate, balanced asset renewal investment plan for 2026-2030. Based on these findings, Hydro Ottawa has proposed an increase in station asset renewal spending from the 2021-2025 period. This increase aims to manage long-term asset performance while maintaining affordability for customers. More details regarding Hydro Ottawa's system renewal plan for station assets are outlined in Section 2 of Schedule 2-5-7 - System Renewal Investments.

7.1.1.1. Station Transformers

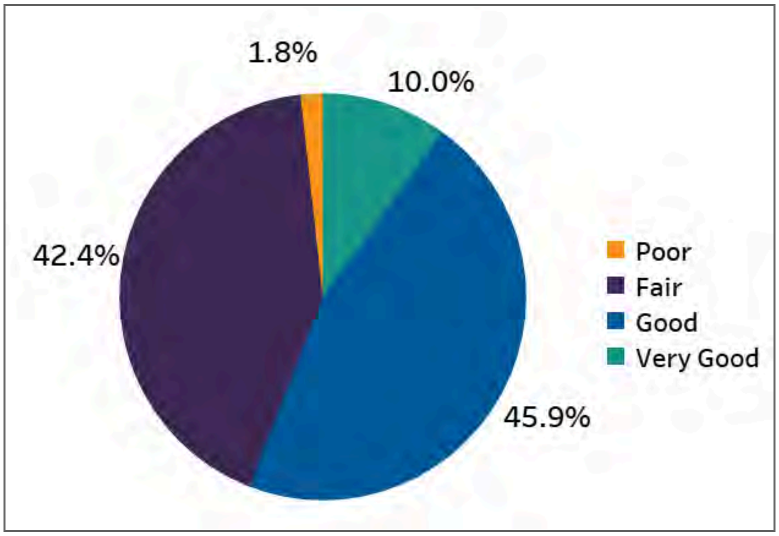
Station transformers are one of Hydro Ottawa's most critical asset classes due to the ability to affect thousands of customers. Hydro Ottawa owns 170 station transformers that operate at various voltages, connected to either Ontario's electric transmission grid or connected to the local sub-transmission system. Hydro Ottawa also supplies distribution stations and customers through 35 station transformers owned and maintained by Hydro One. Hydro Ottawa does not manage Hydro One-owned station transformers. The average age of Hydro Ottawa's station transformers is 37 years, with a TUL of 55 years; Figure 31 illustrates the population demographics.

Figure 31 - Station Transformer Age Demographics



The health index of a transformer is determined through various criteria such as visual inspections, power factor tests, load history, infrared scanning, oil analysis (dissolved gas analysis and degree of polymerization), as well as additional criteria for on-load tap changers, if applicable. The resultant health index is a condition rating from Very Good to Very Poor. This rating is an accurate representation of the current condition of the transformer and is used to drive maintenance and renewal programs. Hydro Ottawa has an active maintenance and monitoring program for its station transformers given their criticality in the system. A summary of Hydro Ottawa's station transformer condition is shown in Figure 32.

Figure 32 - Station Transformer Condition Demographics



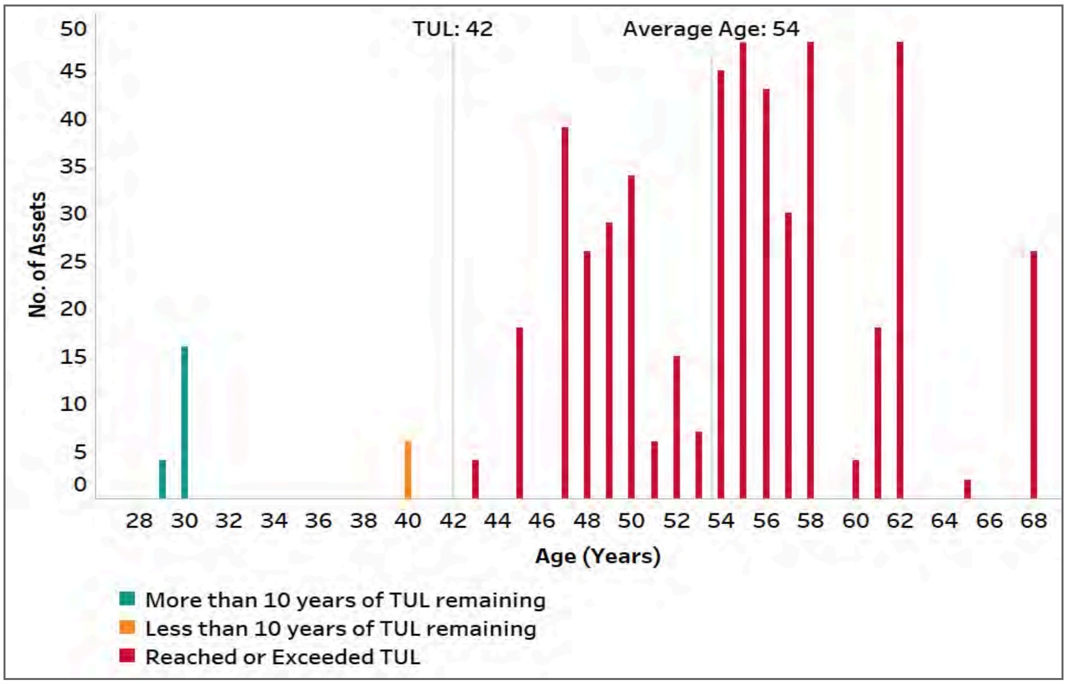
7.1.1.2. Station Switchgear

The station switchgear asset class consists of breakers, switches, bus insulation, support structures, protection and control systems, arrestors, control wiring, ventilation, and fuses. Hydro Ottawa owns and maintains approximately 1,057 station breakers, which form the major part of the station switchgear asset class.

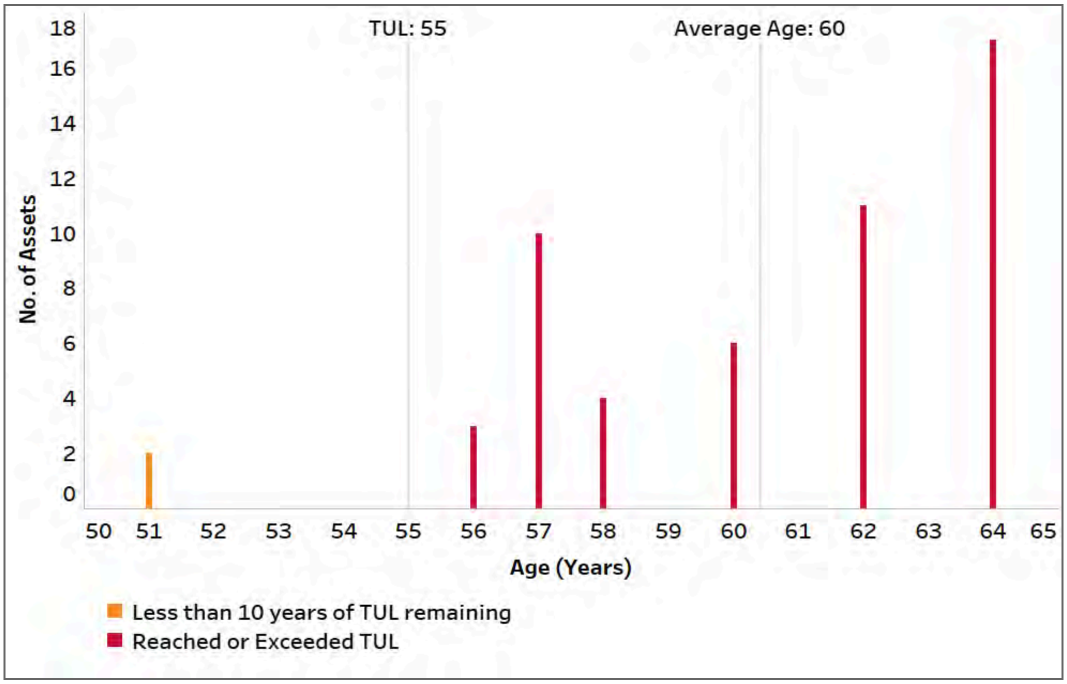
Due to the different TUL of each breaker type, it is more appropriate to break out station breakers per type, rather than as one asset group under station switchgear. Figures 33 to 36 illustrate the population demographics of each type. The TUL of air breakers is 42 years, and the average age is 54 years. The TUL of oil breakers is 55 years, and the average age is 60 years. The TUL of gas

(SF_6) breakers is 51 years, and the average age is 28 years. The TUL of vacuum breakers is 46 years, and the average age is 10 years.

Figure 33 - Station Air Breaker Age Demographics



1 **Figure 34 - Station Oil Breaker Age Demographics**



2

3 **Figure 35 - Station SF6 (Metalclad and HV) Breaker Age Demographics**

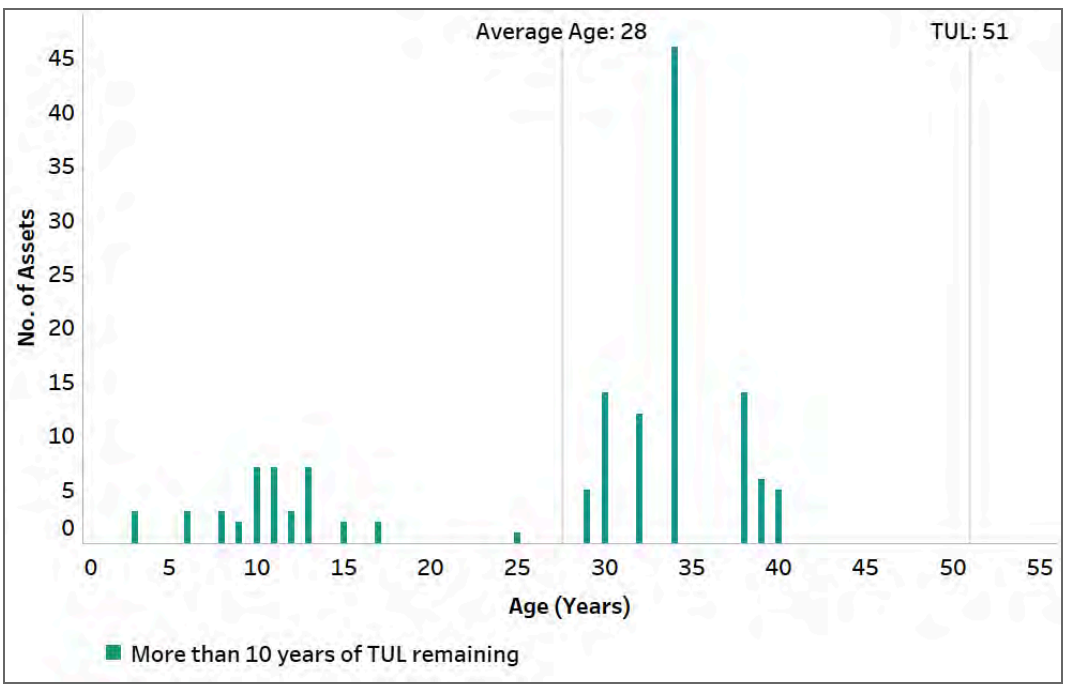


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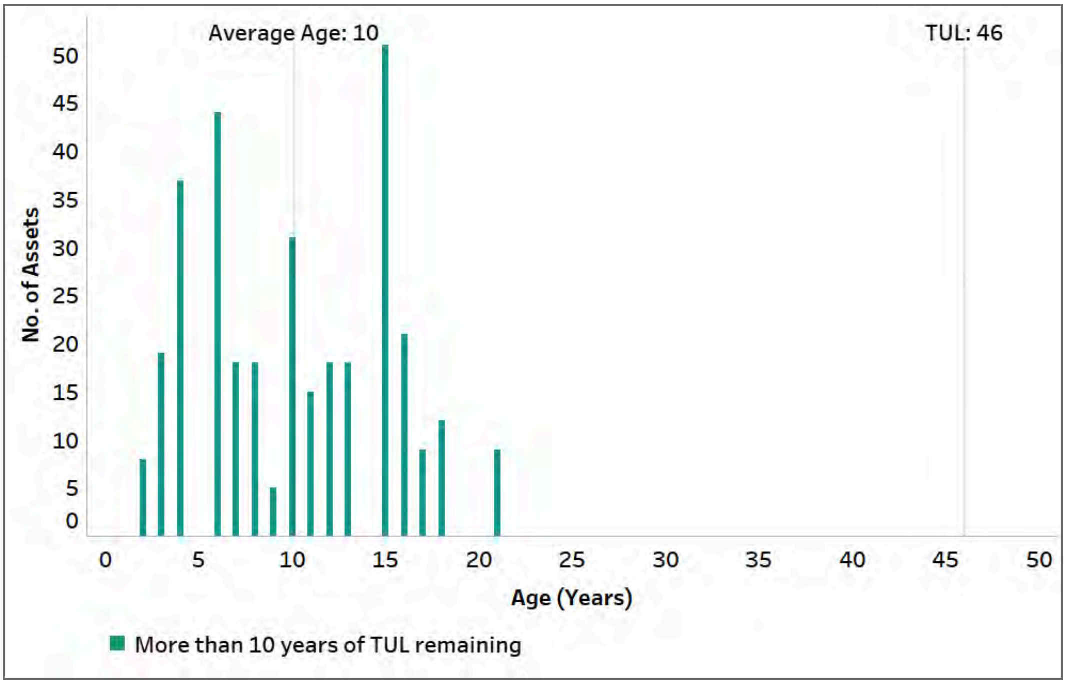
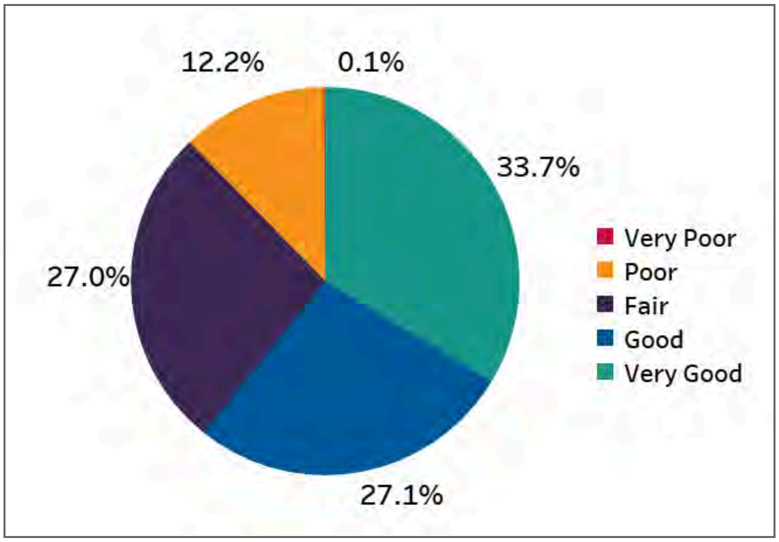
Figure 36 - Station Vacuum Breaker Age Demographics



The health index for station switchgear takes into account the many functional and supporting parts of the equipment. A qualitative assessment of the equipment condition, based on subject matter experience, is done on the switches, breakers, bus, insulation, and supporting structures. The equipment is then reviewed for functional obsolescence and the availability of spare parts. The health index is calculated using this information and the age of the equipment. A summary of Hydro Ottawa's station switchgear condition is shown in Figure 37.

Figure 37 - Station Switchgear Condition Demographics



7.1.1.3. Station Batteries

Hydro Ottawa's station batteries and chargers asset class provide power for operating station breakers and closing coils, DC lights, and relays when the station service power is lost. Hydro Ottawa owns 63 station battery banks and chargers within its stations. Due to the different expected operating life of each battery type, it is more appropriate to break out batteries per type, rather than one asset group. Figure 38 and Figure 39 illustrate the population demographics for each battery type. Vented lead-acid (VLA) batteries have a TUL of 17 years, with an average age of 12 years. Valve-regulated lead-acid (VRLA) batteries have a TUL of 15 years, with an average age of 8 years.

Figure 38 - Station VLA Battery Bank Age Demographics

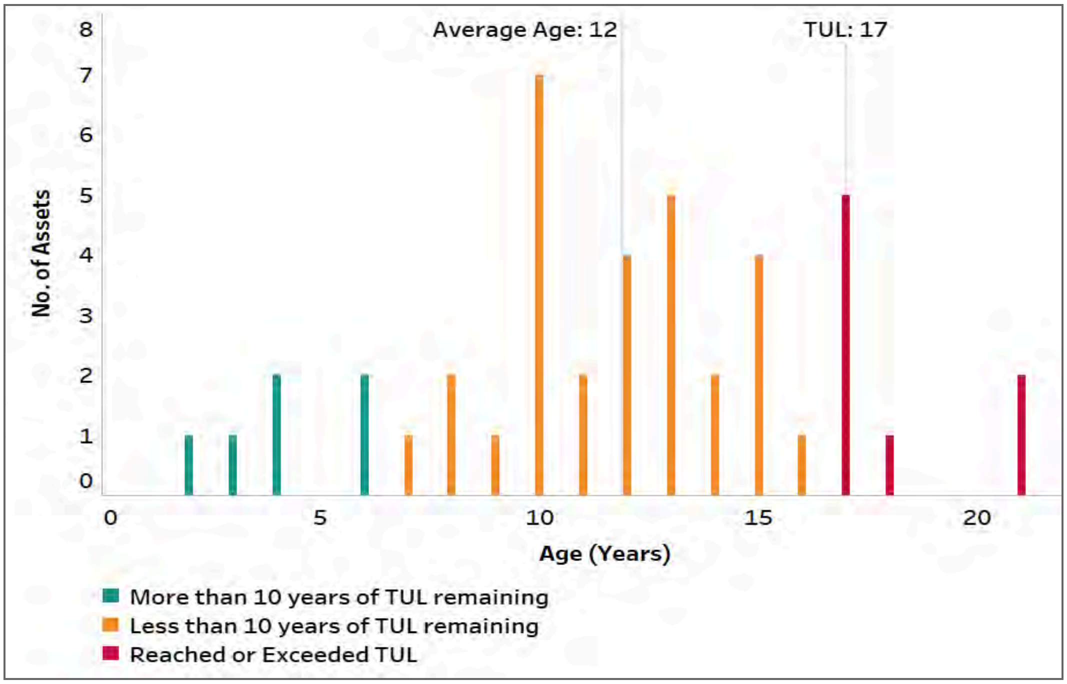
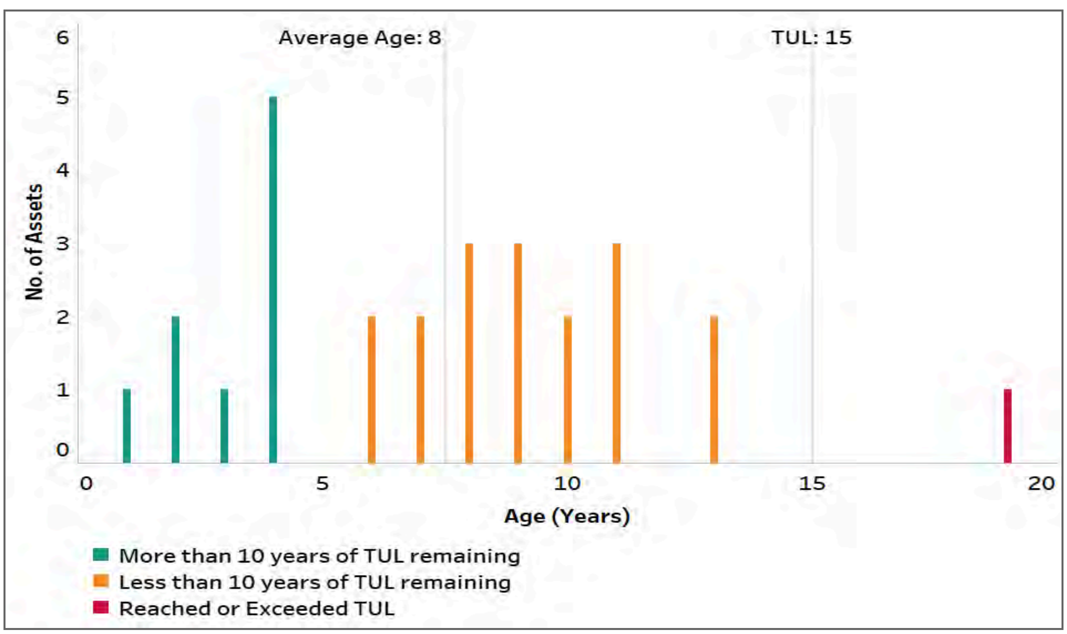


Figure 39 - Station VRLA Battery Bank Age Demographics



7.1.1.4. Station Protection & Control (P&C)

Hydro Ottawa P&C equipment facilitates the control and monitoring of the distribution system. Of the components contained within the P&C asset class, protective relays have a proactive testing and maintenance program. Figures 40 through 42 illustrate the population demographics of protective relay sets and show their average age. The TUL of protective relays is dependent on the relay type, and as such is 40 years for electromechanical, 30 years for electronic, and 25 years for microprocessor based relays.

Figure 40 - Station Electromechanical Relay Age Demographics

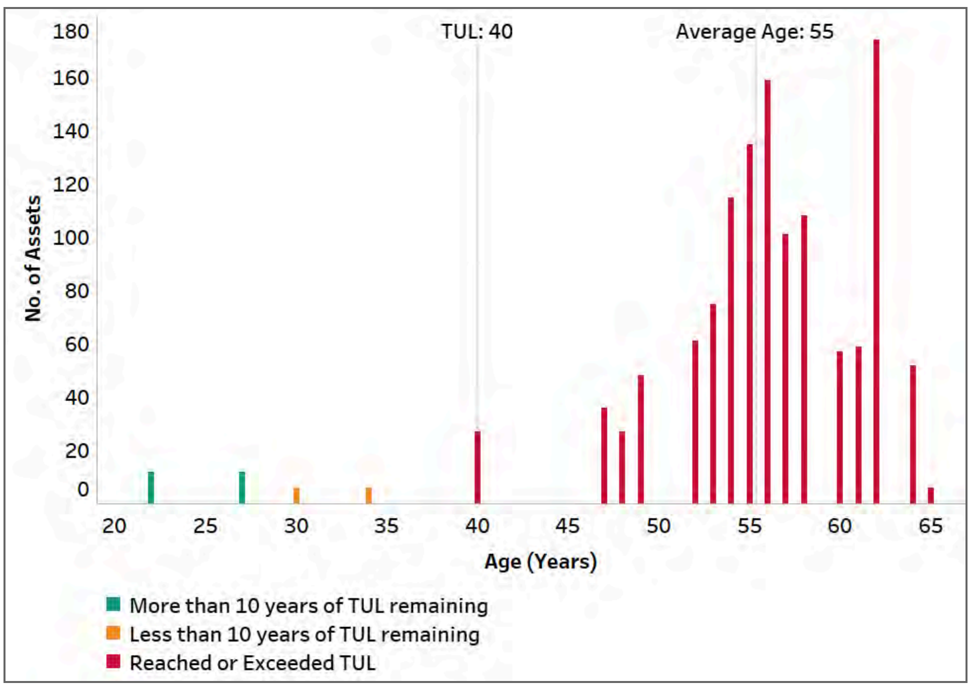


Figure 41 - Station Electronic Relay Age Demographics

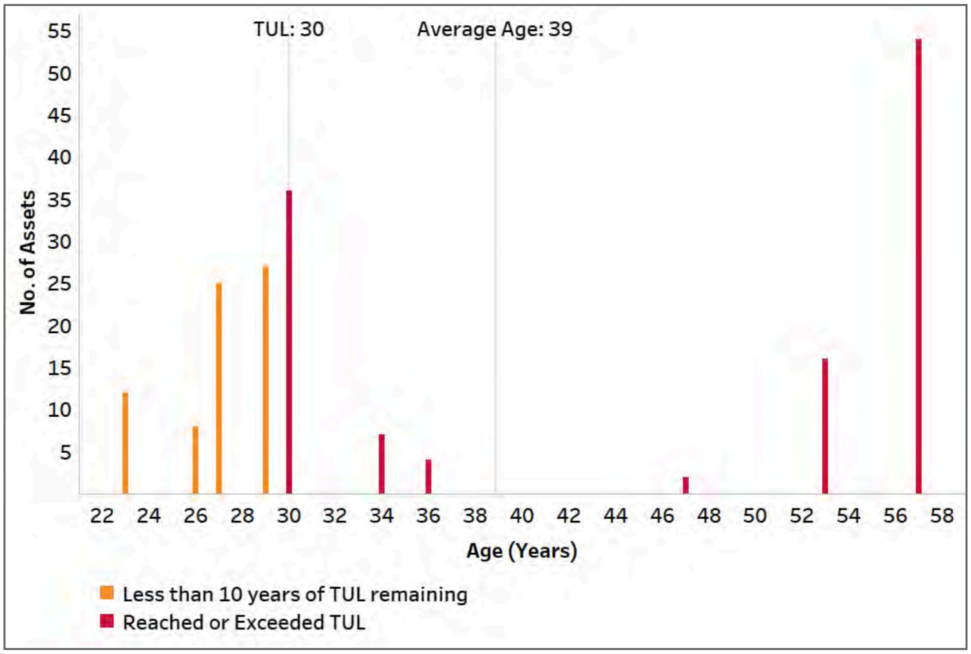
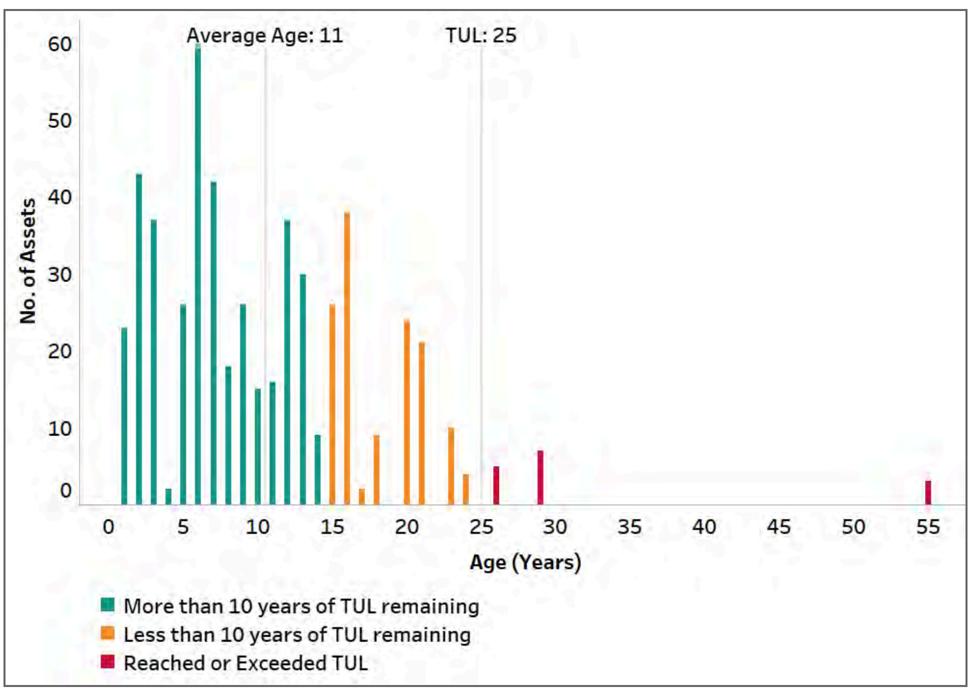


Figure 42 - Station Microprocessor Relay Age Demographics



7.1.2. Overhead Assets

Hydro Ottawa overhead assets are integral for the distribution of electricity. The overhead system, Hydro Ottawa's standard design for delivering power, is built in a range of locations. Overhead assets are broken into the following main asset classes:

- Distribution poles and fixtures
- Overhead distribution transformers
- Overhead distribution switches

Figure 43 and Figure 44 show the age and condition demographic projections of overhead distribution assets into 2040, without any intervention, as obtained through Copperleaf PA. It can be seen that approximately 30% of the overhead assets will reach the TUL by 2030, with the proportion increasing to 46% by 2040. On the condition front, approximately 19% of the asset population will reach a Very Poor/Poor condition by 2035 and increase to about 23% by 2040. Overhead distribution assets are also exposed to and impacted by extreme weather events, thereby impacting reliability and resulting in customer interruptions.

Figure 43 - Overhead Asset Age Demographic Projections

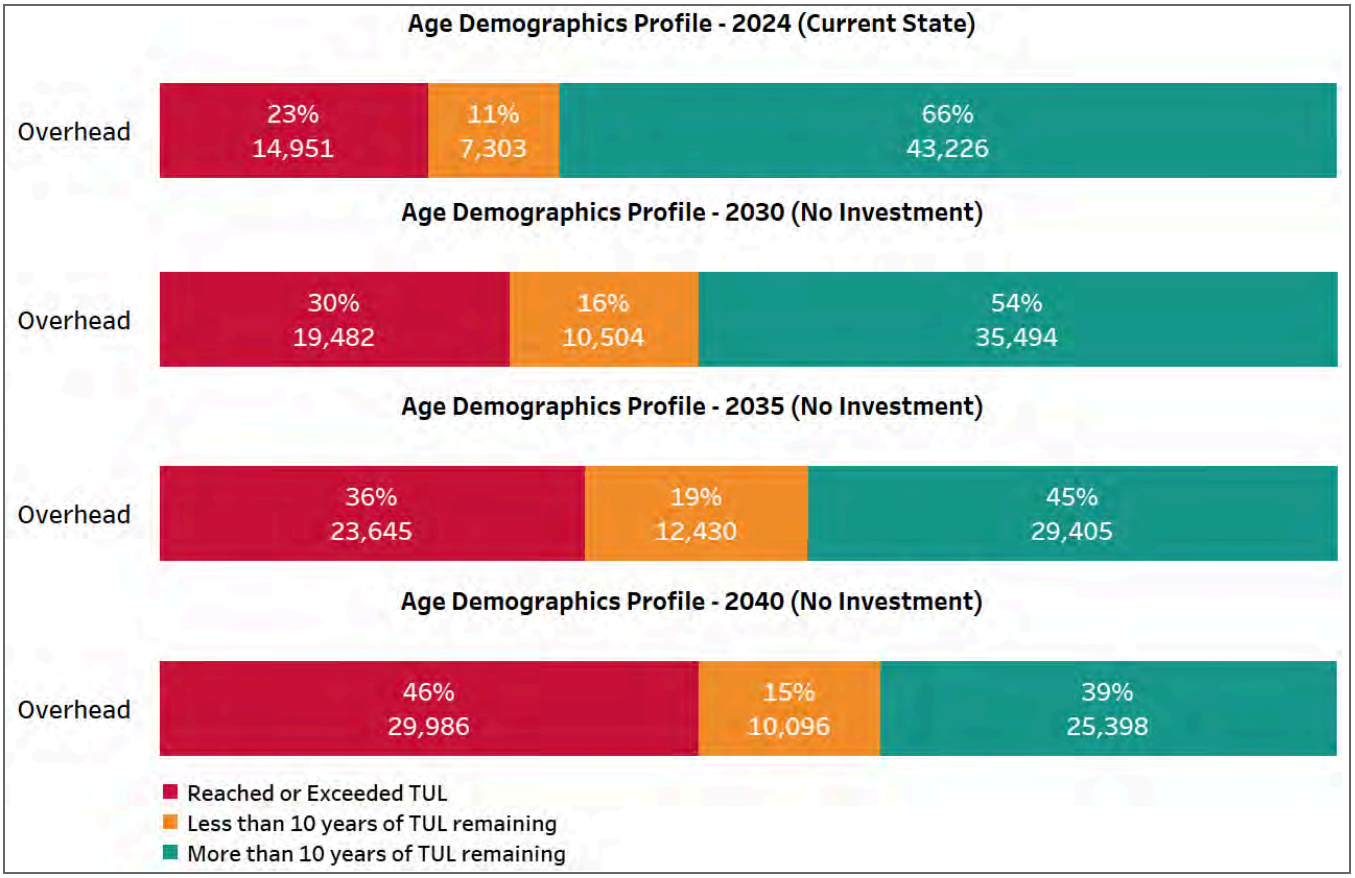
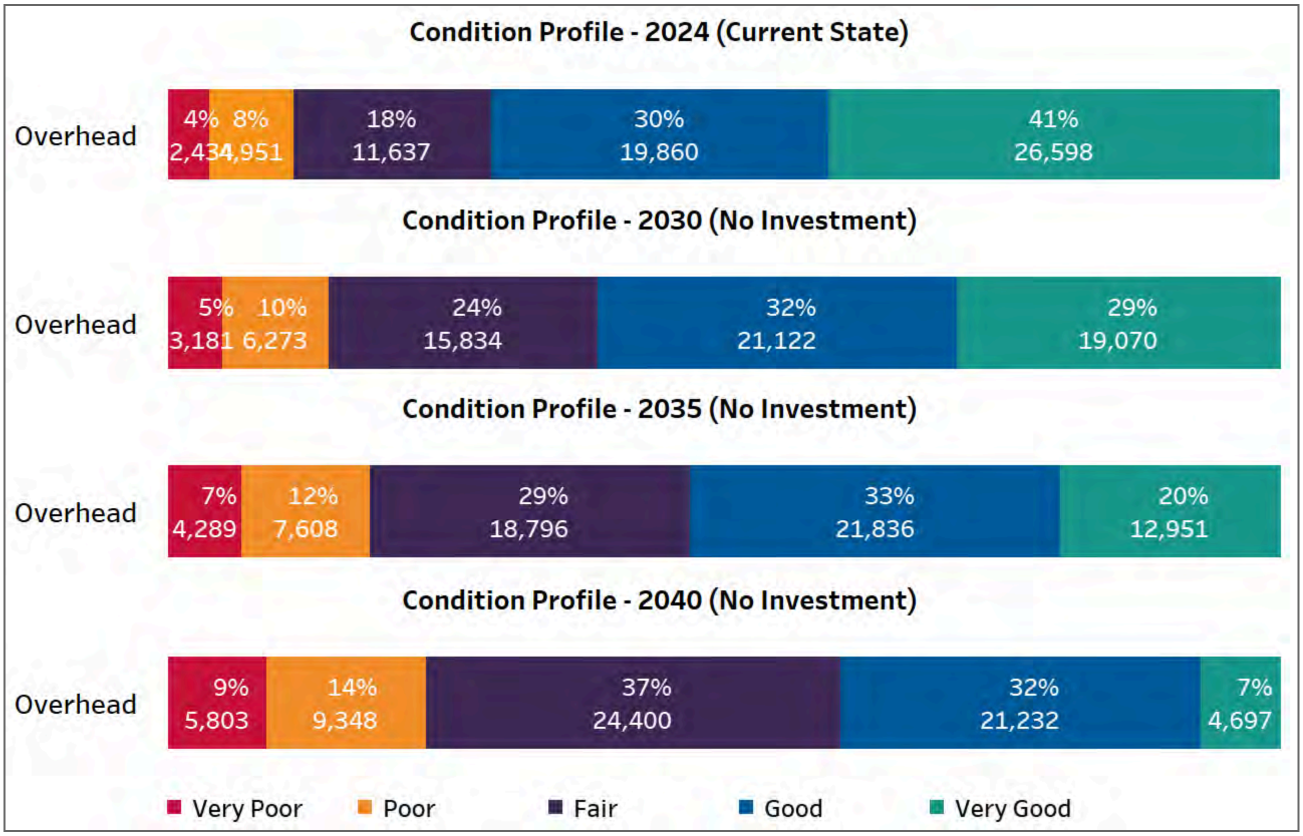


Figure 44 - Overhead Asset Condition Demographic Projections

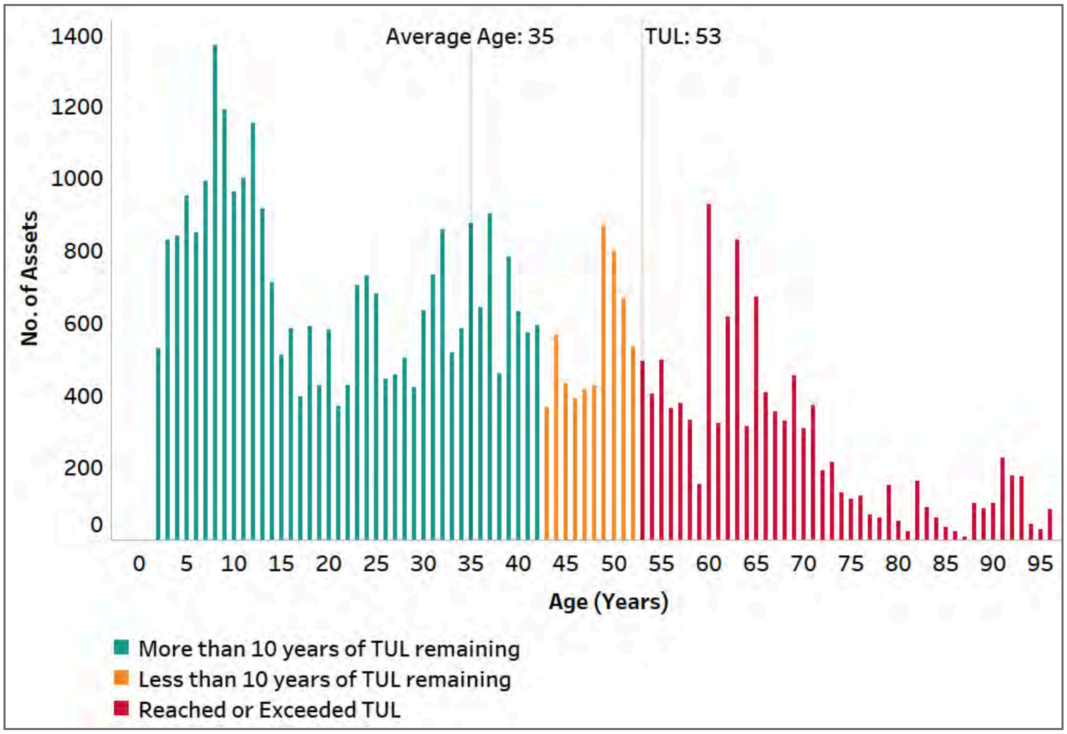


Hydro Ottawa utilized Copperleaf PA to gain a deeper understanding of potential future degradation patterns. This information was used to develop an appropriate, balanced asset renewal investment plan for 2026-2030. Based on these findings and the need for grid resilience (related to the increase in extreme weather events), Hydro Ottawa has proposed an increase in overhead asset renewal spending from the 2021-2025 period. This increase aims to manage asset performance while maintaining affordability for customers. More details regarding Hydro Ottawa's system renewal plan for overhead distribution assets are outlined in Section 3 of Schedule 2-5-7 - System Renewal Investments.

7.1.2.1. Distribution Poles

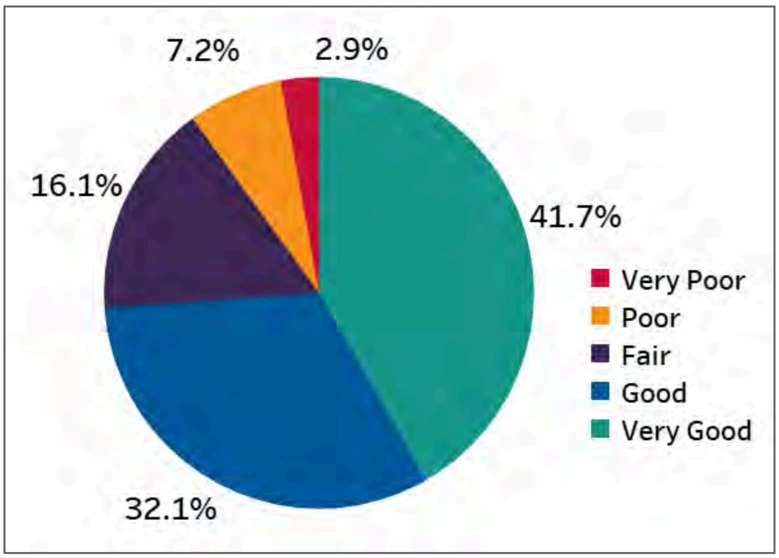
Hydro Ottawa owns approximately 46,636 wood poles in its service territory. The average age of this asset class is 35 years and the TUL is 53 years, with the age demographics shown in Figure 45.

Figure 45 - Distribution Wood Pole Age Demographics



The health index for wood poles is largely based on the estimated remaining mechanical strength in the pole's butt determined using resistograph measurements. Assessment of the pole's condition, and the condition of the ancillary equipment attached to it, are included as part of the process to identify candidate assets for corrective actions. A summary of known Hydro Ottawa's distribution pole conditions is shown in Figure 46.

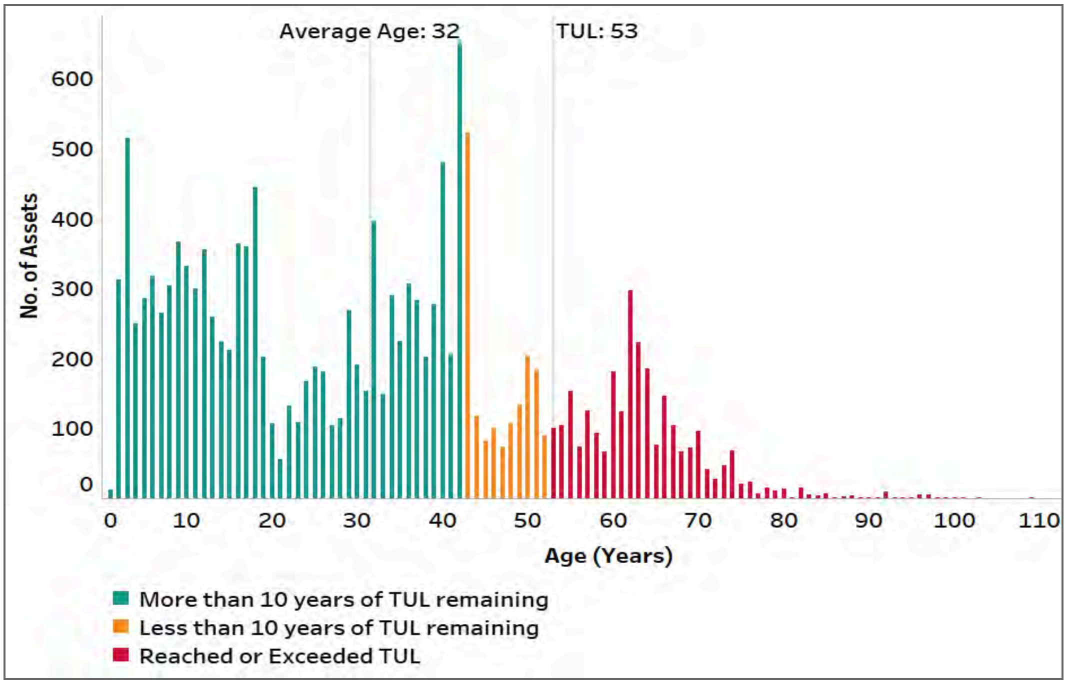
Figure 46 - Distribution Wood Pole Condition Demographics



7.1.2.2. Overhead Transformers

Hydro Ottawa owns and operates 15,218 overhead transformers. These are installed in both the front and rear lot to service Hydro Ottawa customers. The average age of this asset class is 32 years. Figure 47 illustrates the population age demographics. The TUL of overhead transformers is 53 years.

1 **Figure 47 - Overhead Transformers Age Demographics**

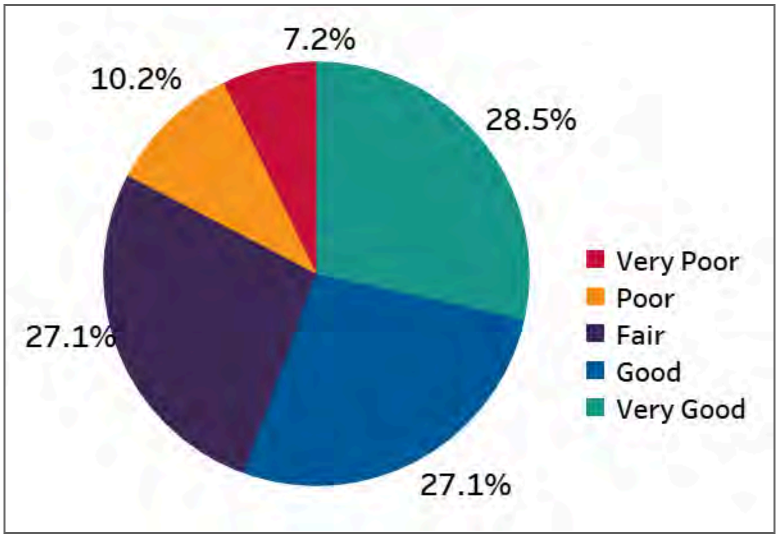


2

3

4 The health index for overhead transformers is based on age and asset condition data collected from
5 planned programs of inspection that use both visual and IR inspection techniques. A summary of
6 known Hydro Ottawa's overhead transformer conditions is shown in Figure 48.

Figure 48 - Overhead Transformer Condition Demographics



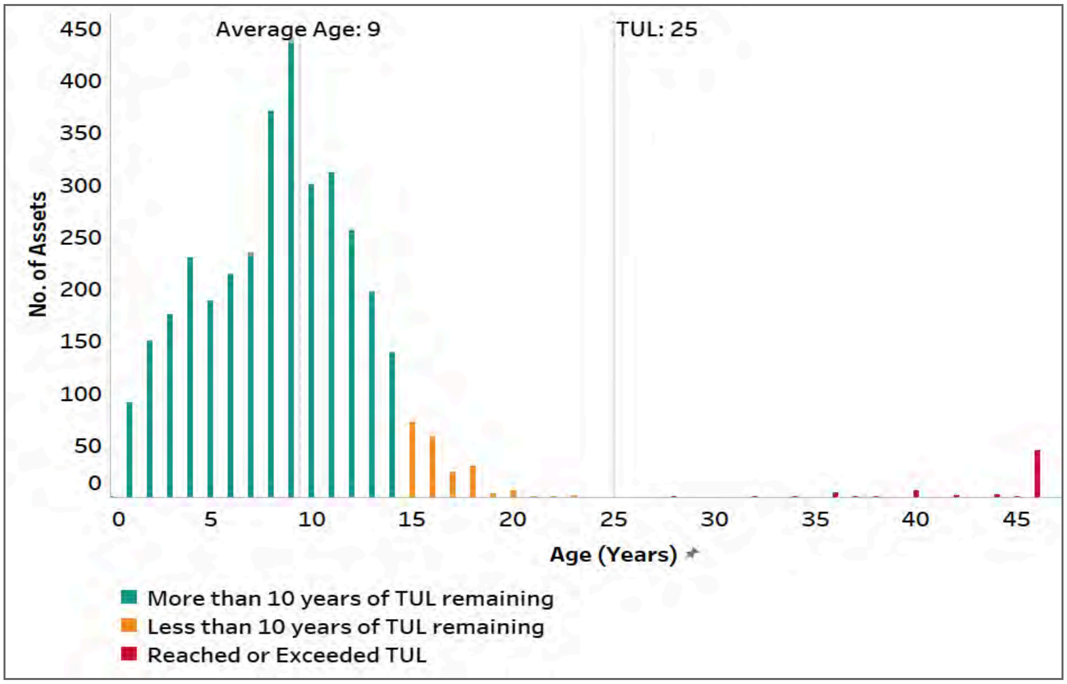
7.1.2.3. Overhead Distribution Switches and Reclosers

Hydro Ottawa's distribution overhead switch and recloser asset class consists of all overhead load break switches, reclosers, fuse cut-outs and inline switches, with a primary voltage rating up to and including 44kV. In general, the purpose of this asset class is to isolate faulted sections of Hydro Ottawa's distribution system, minimize the impact to customers, isolate sections of Hydro Ottawa's distribution system to enable work to proceed while affecting the smallest part of the distribution system possible, isolate customers through requests, and provides backup supply from other feeder(s).

Hydro Ottawa has numerous types of overhead switches with different functionality dependent on the required application. Hydro Ottawa owns 3,583 distribution overhead switches throughout the service territory.

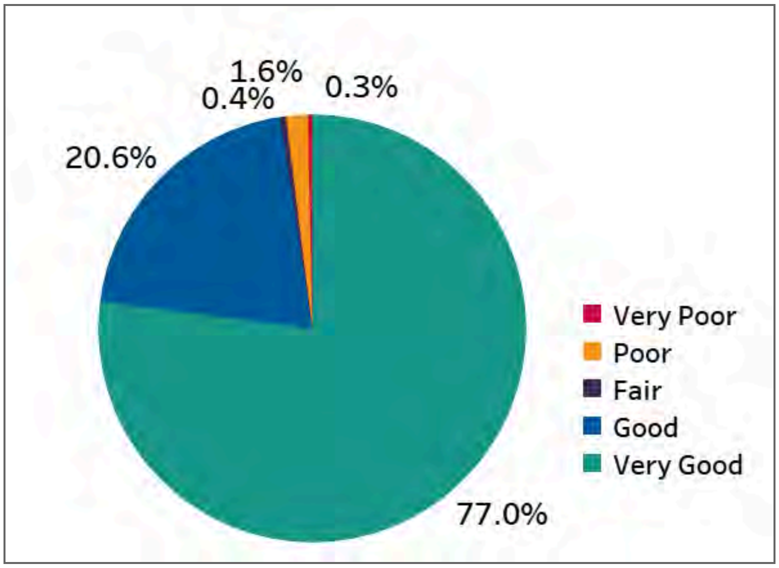
The average age of Hydro Ottawa's overhead load break/gang operated switches with a known age is 9 years; Figure 49 illustrates the population demographics for this asset class. The TUL of overhead load break/gang operated switches is 25 years.

Figure 49 - Overhead Switch Age Demographics



The health index for overhead complex switches is largely based on age and the results from thermographic scans. A complex switch is typically a 3-phase gang-operated device that is capable of interrupting load. Other criteria include the condition of insulators, solid blades, and operating mechanism. A summary of known Hydro Ottawa's overhead switch conditions is shown in Figure 50.

Figure 50 - Overhead Switch Condition Demographics



7.1.3. Underground Assets

Hydro Ottawa underground assets are integral for the distribution of electricity. The underground system consists of distribution assets and their respective supporting civil structures that enable delivery of energy to areas where the feasibility of the overhead system is reduced or where it is preferential to have improved aesthetics. Underground assets are broken into the following categories:

- Distribution cables (PILC, polymer)
- Underground transformers
- Underground switchgear
- Vault transformers
- Underground civil structures

Figure 51 and Figure 52 show the age and condition demographic projections of underground distribution assets into 2040, without any intervention, as obtained through Copperleaf PA. It can be seen that approximately 37% of the underground assets will reach the TUL by 2030, with the proportion increasing to slightly more than half (52%) by 2040. On the condition front, approximately 14% of the asset population will reach a Very Poor/Poor condition by 2035 and increase to slightly more than one-fourth (27%) by 2040.

Figure 51 - Underground Asset Age Demographic Projections

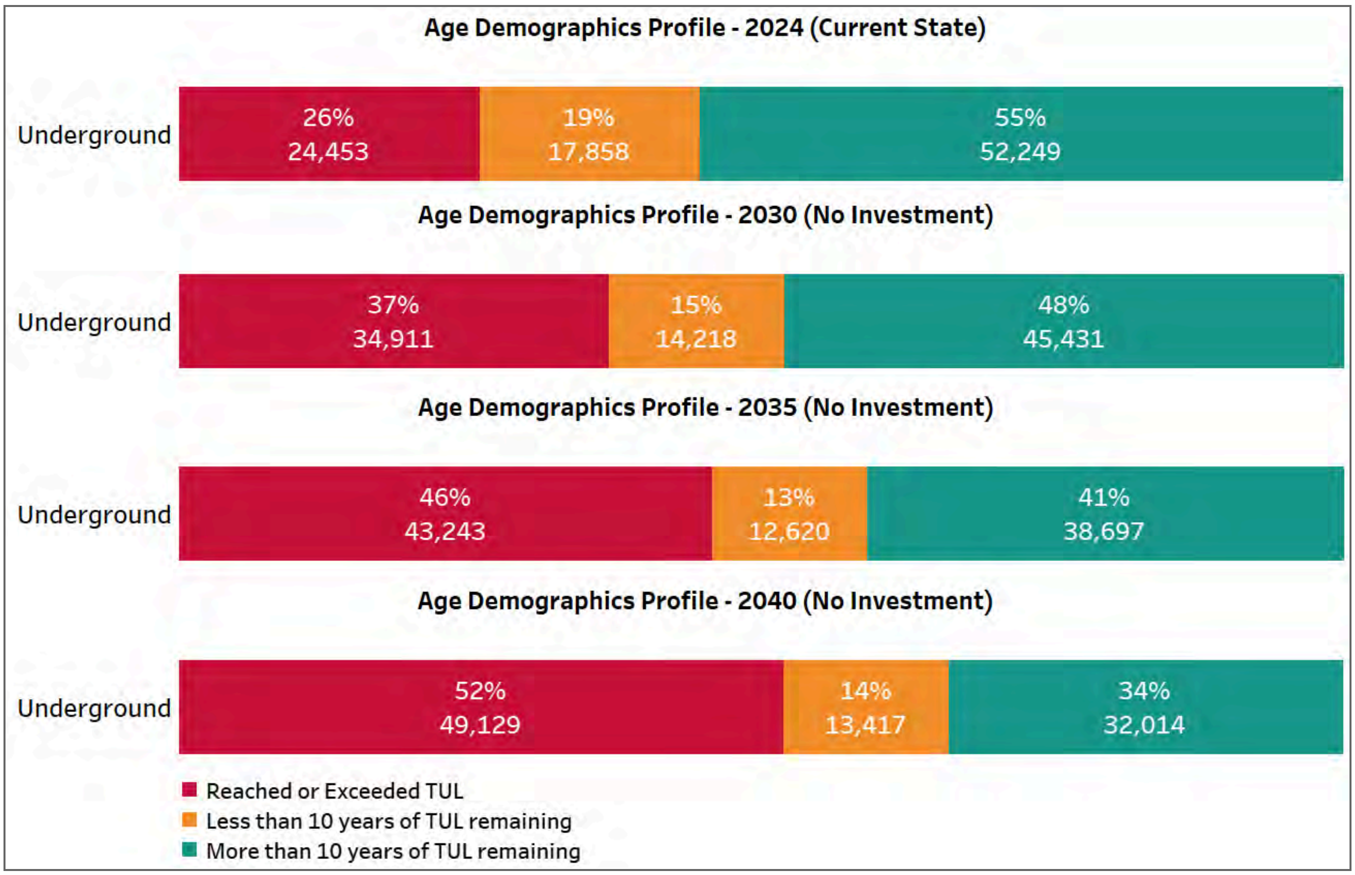
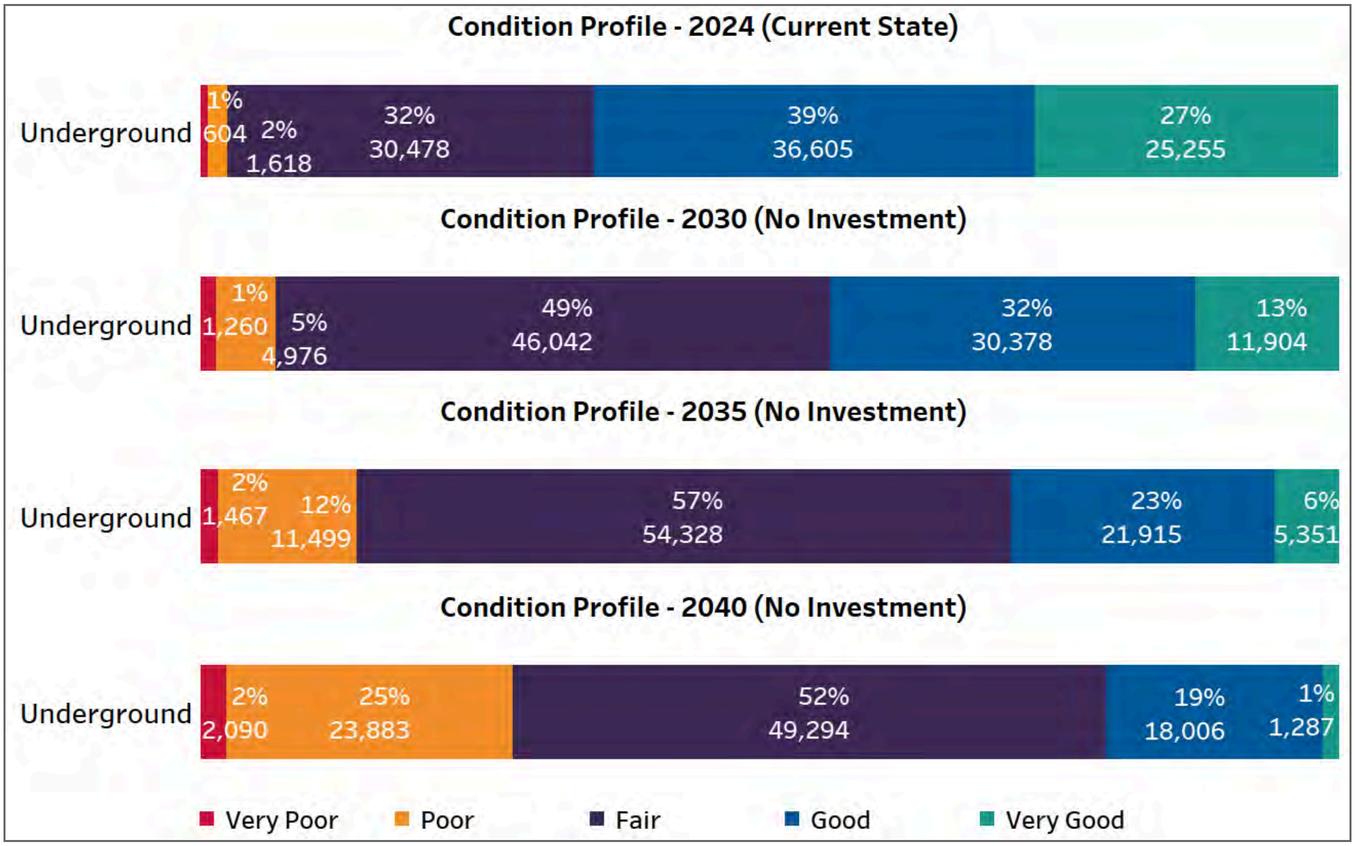


Figure 52 - Underground Asset Condition Demographic Projections



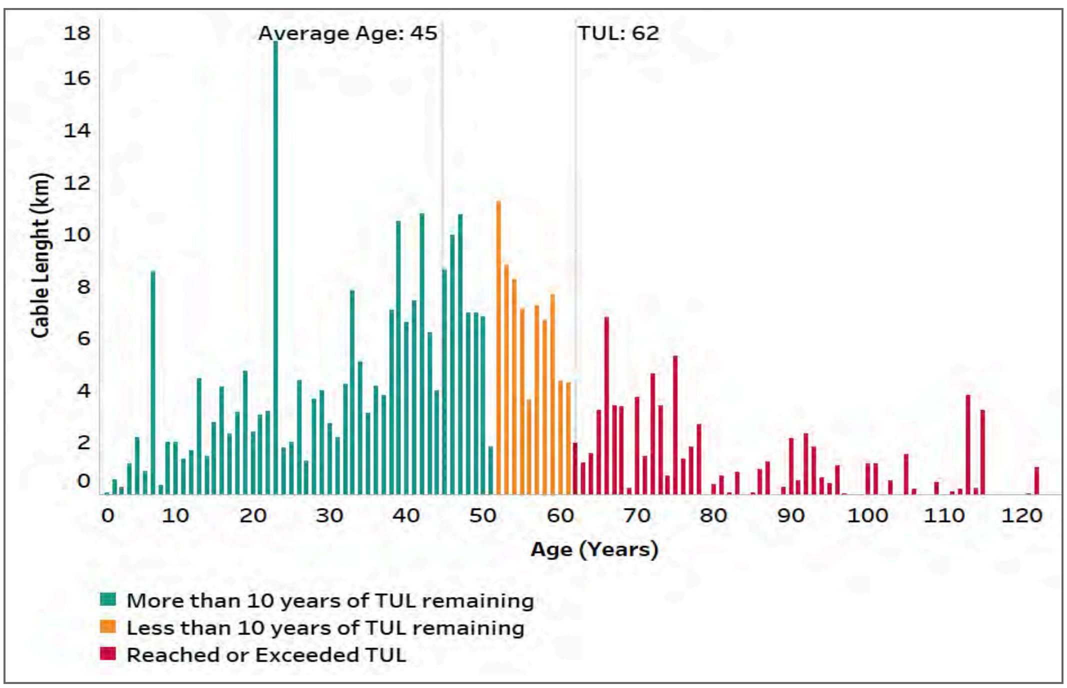
Hydro Ottawa utilized Copperleaf PA to gain a deeper understanding of potential future degradation patterns. This information was used to develop an appropriate, balanced asset renewal investment plan for 2026-2030. Based on these findings, Hydro Ottawa has proposed an increase in underground asset renewal spending from the 2021-2025 period. This increase aims to manage asset performance while maintaining affordability for customers. More details regarding Hydro Ottawa's system renewal plan for underground distribution assets are outlined in Section 4 of Schedule 2-5-7 - System Renewal Investments.

7.1.3.1. Distribution Cables (PILC)

Hydro Ottawa owns and operates 7,419 segments of triple conductor Paper Insulated Lead Cable (PILC). It was primarily installed in the Core of Ottawa on the 13kV system and is some of the oldest cables in the service territory. Due to higher material costs, increasing procurement lead times, and the need for specialized trades, Hydro Ottawa is moving to phase out this type of cable with polymer insulated cable.

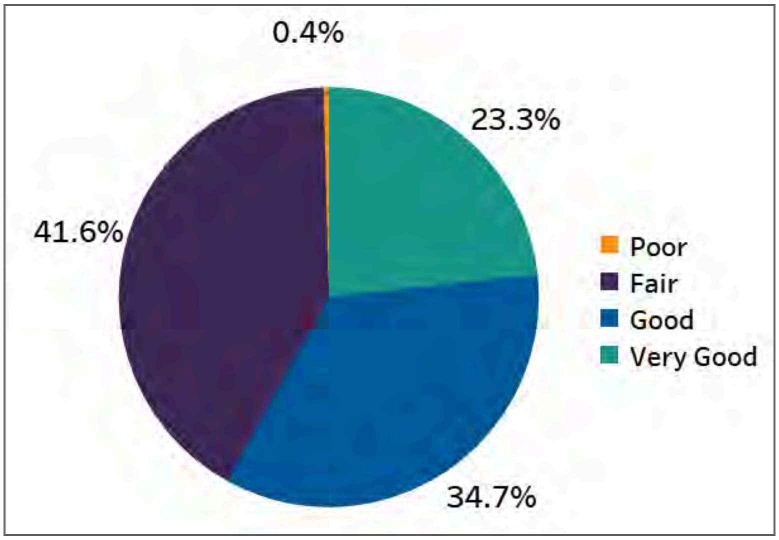
The average age of Hydro Ottawa's PILC cable is 45 years; Figure 53 illustrates the population demographics. The TUL of PILC cables is 62 years.

Figure 53 - PILC Cable Age Demographics



The health index for PILC cables is based on a combination of age, loading history and failure rate. A summary of Hydro Ottawa's distribution PILC cable conditions is shown in Figure 54.

Figure 54 - Distribution Cable (PILC) Condition Demographics



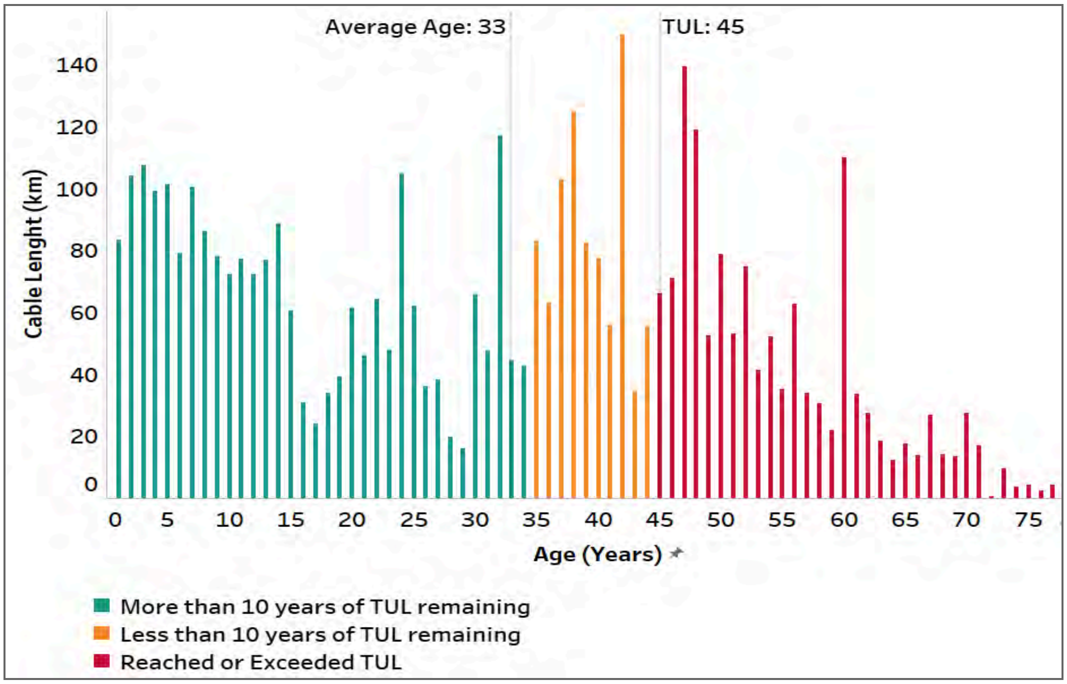
7.1.3.2. Distribution Cables (Polymer)

Hydro Ottawa owns and operates 59,101 segments of single conductor polymer cable (Cross-Linked Polyethylene (XLPE), Ethylene Propylene Rubber (EPR) and Butyl Rubber). The installation of this cable uses a mix of concrete-encased duct, direct-buried duct, and direct-buried cable that can add to the cost and labour requirements when replacing under planned and unplanned events.

The vast majority of the underground polymer cable is XLPE. EPR makes up a small portion of underground cables and has only recently been introduced as a replacement for PILC as it is phased out. For this reason, the condition assessment of underground polymer cable is focused on testing of XLPE cable.

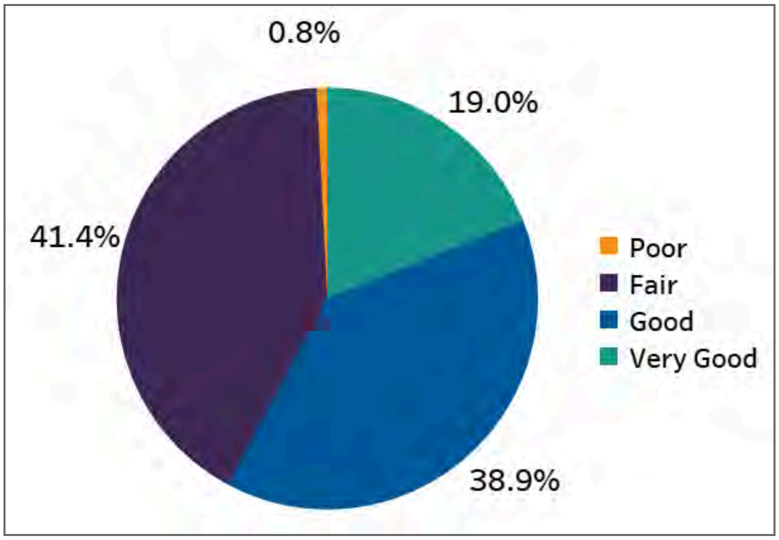
The average age of this asset class is 33 years; Figure 55 illustrates the population demographics. The TUL of XLPE cables is 45 years.

Figure 55 - Distribution Cable (XLPE) Age Demographics



The health index for XLPE cables is based on a combination of age, loading history and failure rate. A summary of Hydro Ottawa's distribution XLPE cable condition is shown in Figure 56.

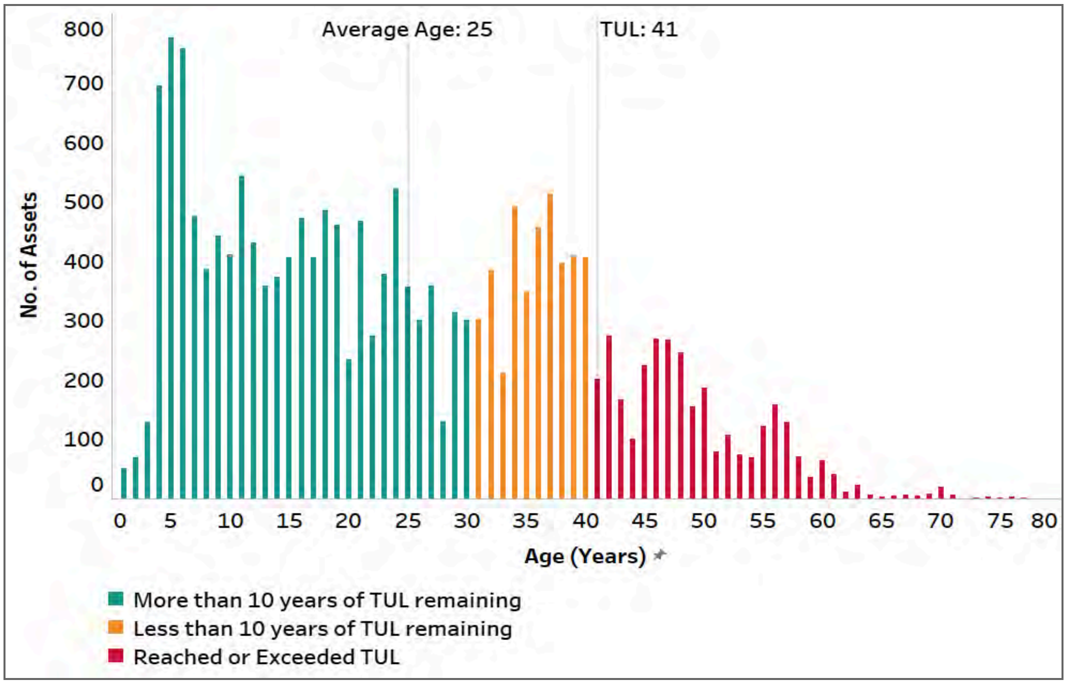
Figure 56 - Distribution XLPE Cable Condition Demographics



7.1.3.3. Underground Transformers

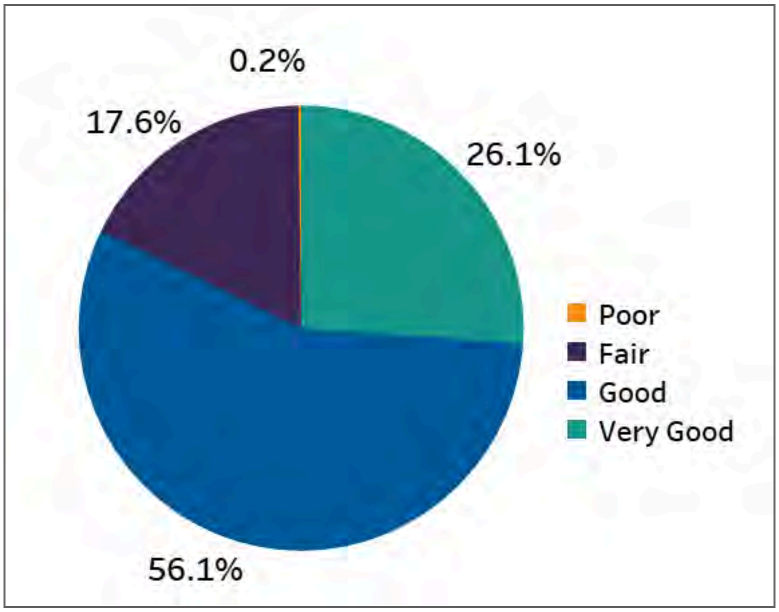
Hydro Ottawa owns and operates 18,875 underground transformers. These are installed in both the front and rear lot to service Hydro Ottawa customers. The average age of this asset class is 25 years. Figure 57 illustrates the population demographics. The TUL of underground transformers is 41 years.

Figure 57 - Distribution Underground Transformers Age Demographics



The health index for underground transformers is largely based on the visual and thermographic inspections. Other factors that influence the health index are the age, loading, and condition of the civil structure. A summary of known Hydro Ottawa's underground transformer conditions is shown in Figure 58.

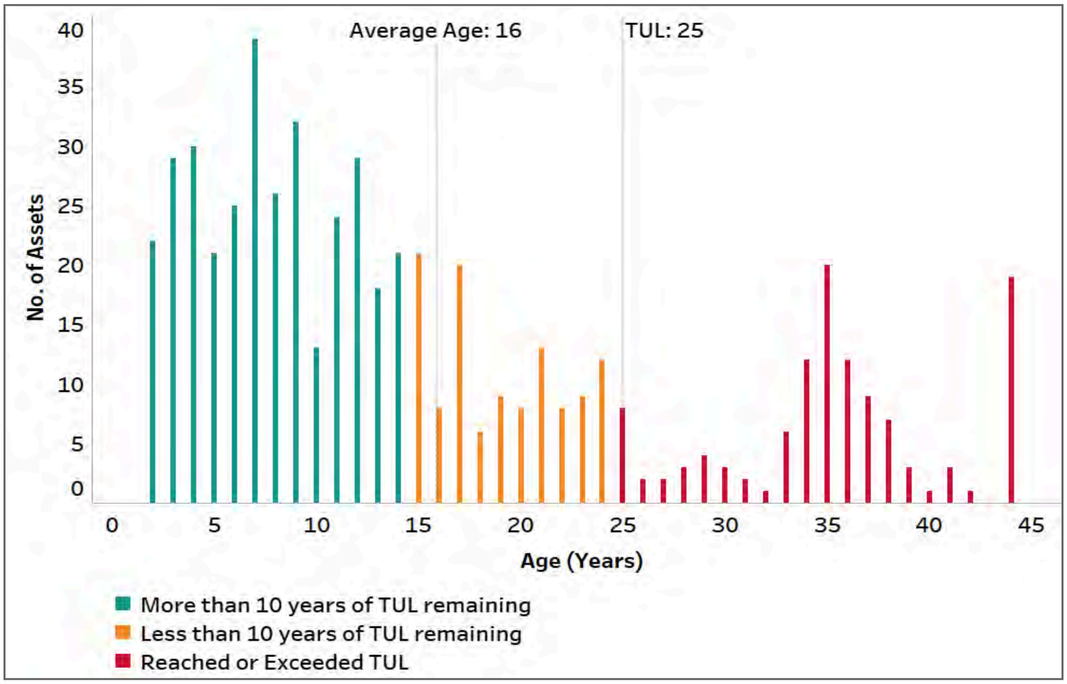
Figure 58 - Underground Transformer Condition Demographics



7.1.3.4. Underground Switchgear

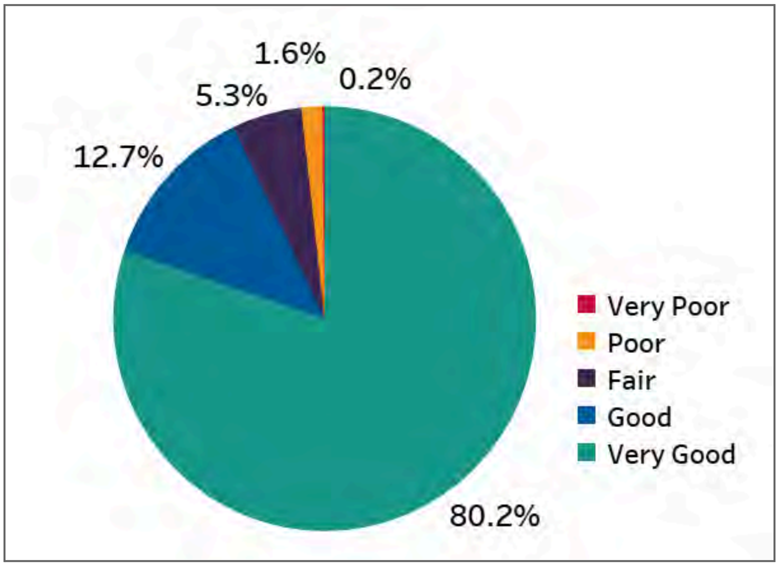
Hydro Ottawa owns and operates 561 underground switchgear units. There are many different configurations and types of switchgear in service due to the amalgamation of the former utilities and their varying policies for servicing customers. The average age of this asset class is 16 years. Figure 59 illustrates the population demographics. The TUL of underground switchgear is 25 years.

Figure 59 - Underground Switchgear Age Demographics



The health index for underground switchgear is largely based on age and the results from visual and thermographic inspections. A summary of known Hydro Ottawa's underground switchgear conditions is shown in Figure 60.

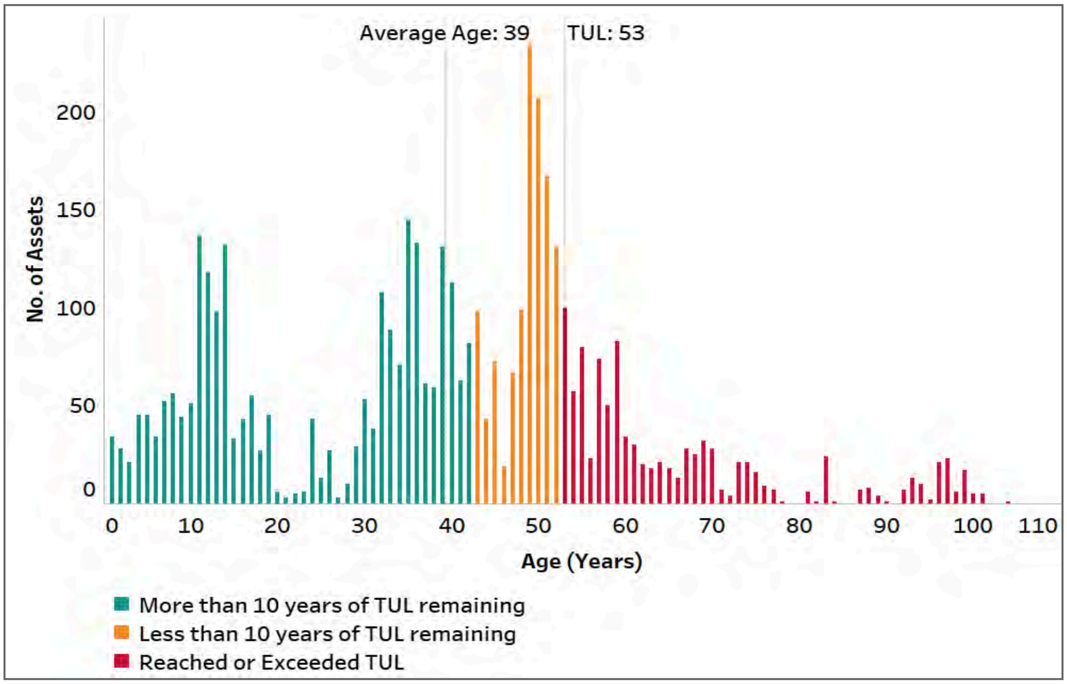
Figure 60 - Underground Switchgear Condition Demographics



7.1.3.5. Vault Transformers

Hydro Ottawa's vault transformers are located in building vaults and typically service a single large customer. Currently Hydro Ottawa owns 4,511 vault transformers. The average age of this asset class is 39 years. Figure 61 illustrates the population demographics. The TUL of vault transformers is 53 years.

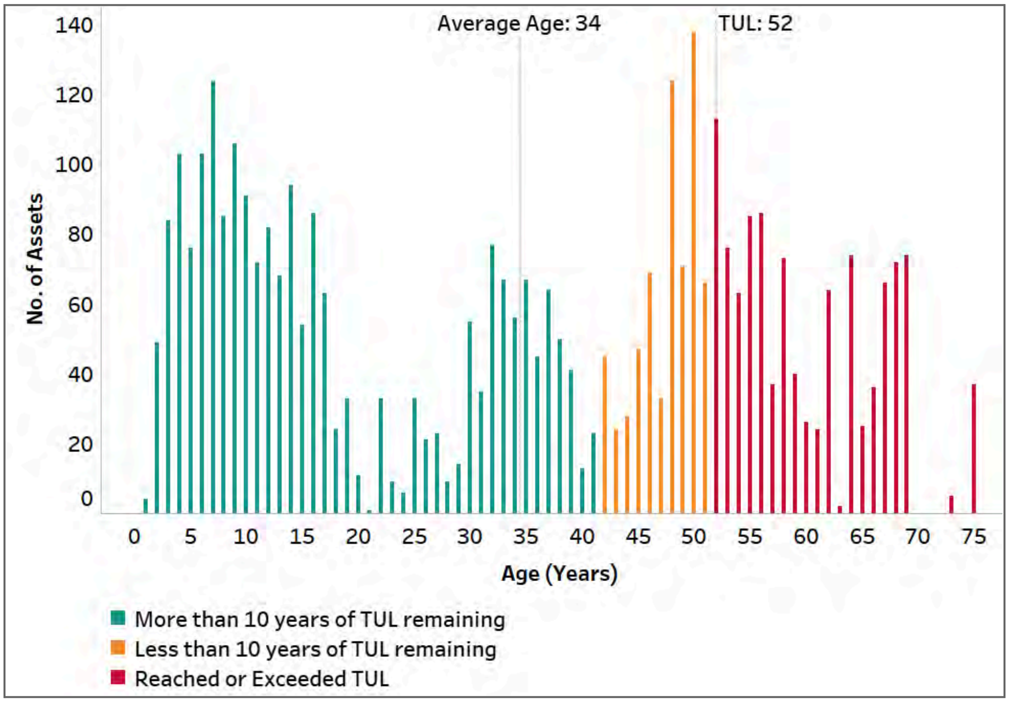
Figure 61 - Vault Transformer Age Demographics



7.1.3.6. Underground Civil Structures

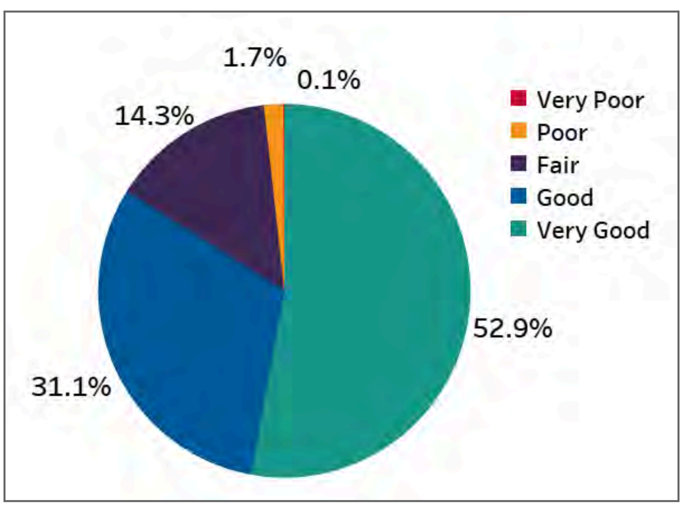
Hydro Ottawa's Underground Civil Structure asset class consists of duct banks, hand holes, and cable chambers forming a network through which cables may be installed. Distribution underground civil structures are used in areas where underground wiring is required, which allows for ease of access and protection of electrical equipment. Currently, Hydro Ottawa owns 3,904 cable chambers. The average age of this asset class is 34 years. Figure 62 illustrates the population demographics. The TUL of cable chambers is 52 years.

Figure 62 - Cable Chamber Age Demographics



The health index for cable chambers is primarily based on visual inspections. A summary of known Hydro Ottawa's cable chamber conditions is shown in Figure 63.

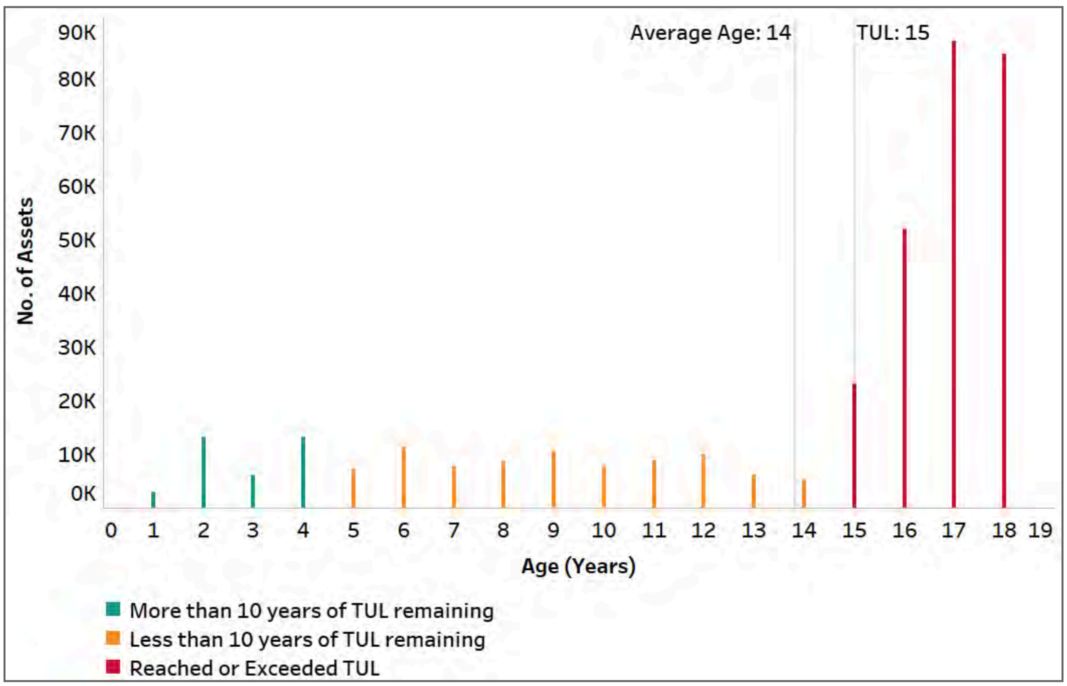
Figure 63 - Cable Chamber Condition Demographics



7.1.4. Metering Assets

Hydro Ottawa's metering asset class consists of residential meters, small commercial meters, and interval meters, all of which are essential for accurate customer billing, settlement with the IESO, and effective grid operations. Currently, Hydro Ottawa owns 366,212 meters. The average age of this asset class is 14 years; Figure 64 illustrates the population demographics. The TUL of a meter is 15 years.

Figure 64 - Current Age Demographics Profile of Residential and Small Commercial Meters



7.2. ASSET FAILURES AND PERFORMANCE

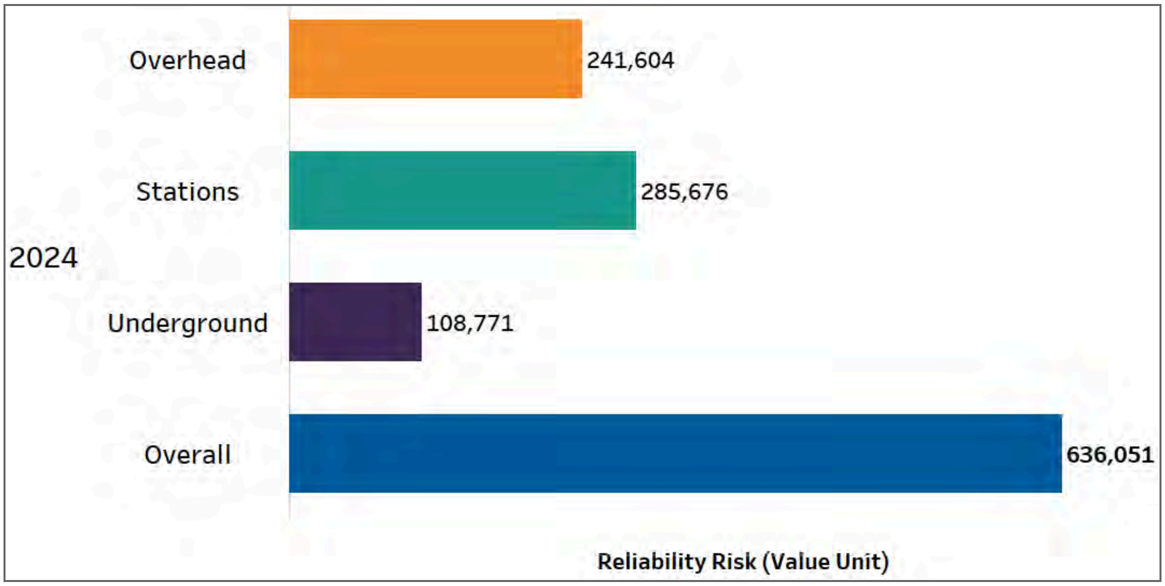
Asset performance metrics can be found in Section 3.3 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Schedule 2-5-3 also contains a summary of asset failures that caused customer interruptions as outlined in Section 4.5.6 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement.

7.3. ASSET RISK PROFILES

Hydro Ottawa utilized the PA module as the primary means for establishing risk at an individual asset level, rolled up to the asset class/system level. Key risk measures tied to reliability impact, safety implications, environmental considerations, financial aspect, and compliance have been considered in determining individual asset risk profiles. While all risk measures have been weighted equally in the PA model, reliability risk was found to be the major contributor, given its wide applicability across all asset types and data availability around asset failure modes and the related customer impact. More information regarding Hydro Ottawa's risk assessment process is outlined in Section 5.1.4 - Asset Risk Assessment.

Figure 65 shows the overall baseline reliability risk profile carried by Hydro Ottawa's asset systems in 2024, with the breakdown of the reliability risks associated with individual assets considered in the PA model shown in Figure 66.

1 **Figure 65 - 2024 Baseline Reliability Risk Profile by Asset System**



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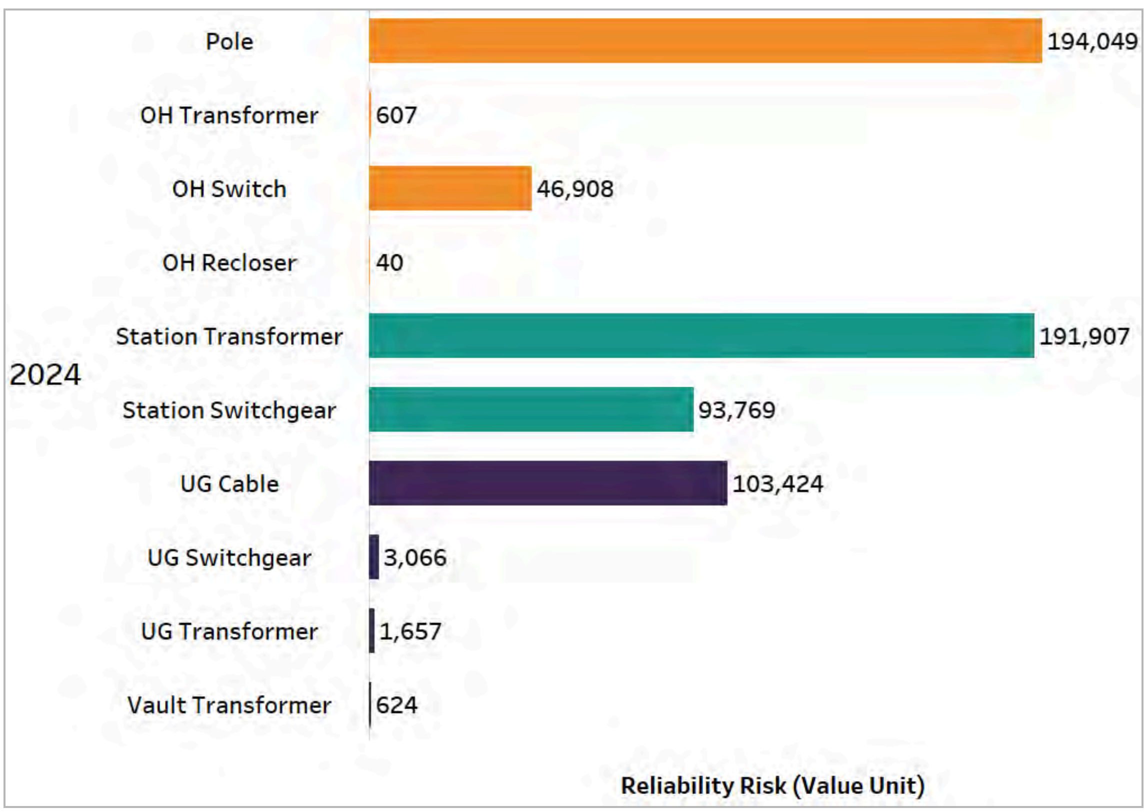
3 **Figure 66 - 2024 Baseline Reliability Risk Profile by Individual Assets**



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7.4. SYSTEM UTILIZATION

Hydro Ottawa is facing a challenge in maintaining reliable power distribution while accommodating future load growth in some supply regions in its service territory. The current infrastructure is under strain, with eight stations already operating beyond their planned capacity limits (100%+ category in Figure 67) and an additional three stations approaching those thresholds (95%-100% category), as illustrated in Figure 67 and listed by planning region in Table 24. This situation highlights critical capacity constraints within the power distribution system.

Figure 67 - Stations by Planning Rating Thresholds

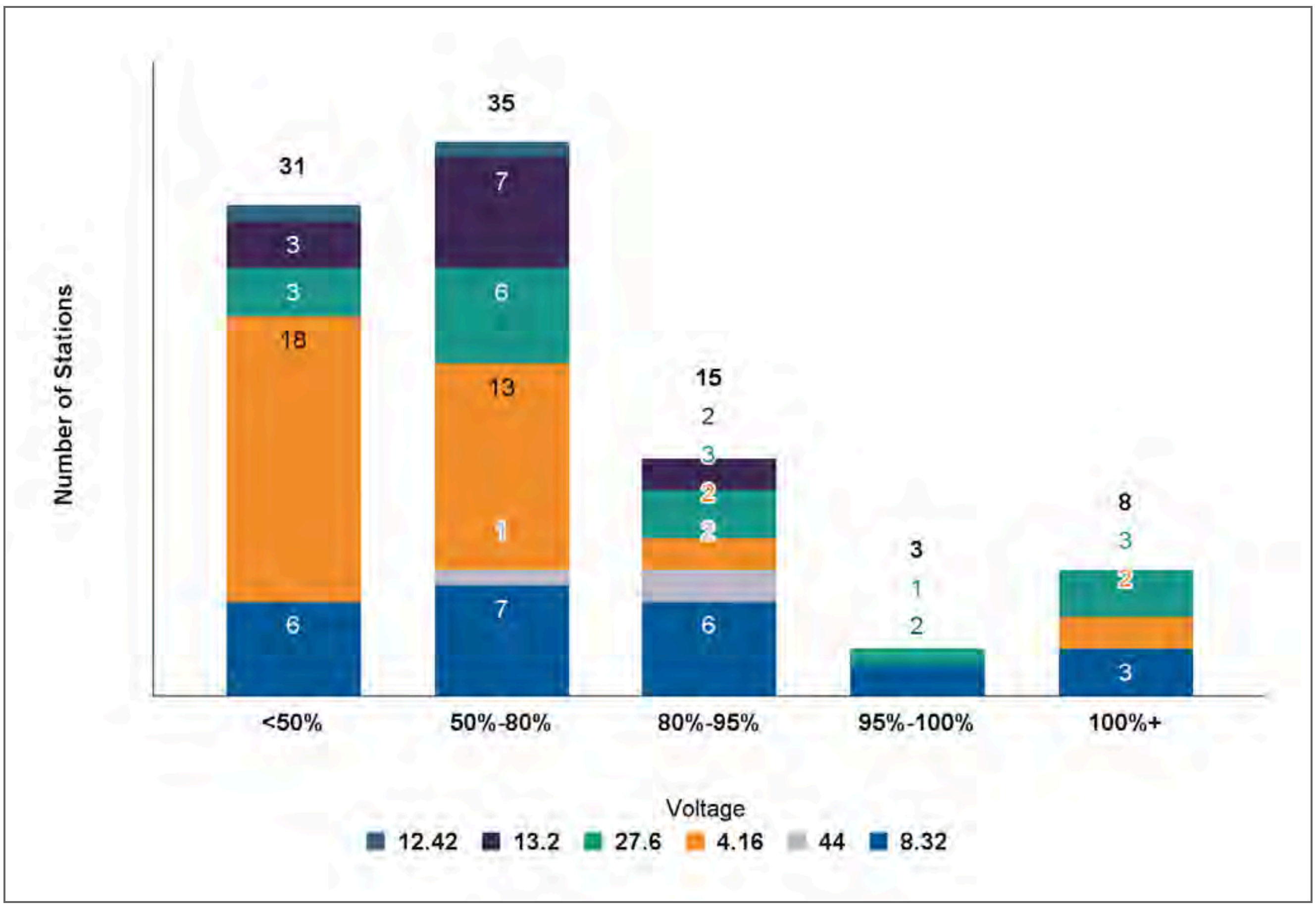


Table 24 - Stations Approaching or Above Planning Thresholds

Planning Threshold	Station	Planning Region
95%-100%	Stafford Road DS	Bells Corners/Bayshore 8 kV
95%-100%	Jockvale DS	Barrhaven 8 kV
95%-100%	Kanata MTS	West 28 kV (North)
100%+	Centrepointe MTS	Nepean 8 kV
100%+	Manordale MTS	Nepean 8 kV
100%+	Leitrim DS	South East 28 kV
100%+	Church DS	East 4 kV
100%+	Richmond North DS	West 8 kV
100%+	Vaughan DS	East 4 kV
100%+	Fallowfield MTS	South 28 kV
100%+	Marchwood MTS	West 28 kV (North)

Operating stations above their planning rating capacity has several detrimental effects on the overall system. Primarily, it significantly reduces the system's flexibility to effectively manage both planned maintenance and operational activities, as well as respond to unforeseen disruptions or abnormal system states, such as equipment failures, power surges, or extreme weather events.

This lack of flexibility can lead to cascading failures, where a problem at one station can quickly propagate to others due to the limited capacity to reroute power or isolate affected areas. This can result in widespread power outages, service disruptions, and potential damage to equipment.

Furthermore, operating stations beyond their intended capacity can accelerate equipment wear and tear, leading to more frequent maintenance requirements and a shorter overall lifespan. This can increase operational costs and further strain the system's ability to meet future load demands.

Hydro Ottawa must take proactive measures to address these capacity issues and ensure the long-term reliability and resilience of the power distribution system. This may involve a combination of strategies, such as upgrading existing stations, building new infrastructure, implementing demand-side management programs, and exploring innovative technologies to optimize system performance and accommodate future load growth.

Hydro Ottawa monitors utilization of assets through KPIs such as SLI and FLI detailed in Section 8.4 - Asset Utilization Policies and Practices.

Hydro Ottawa aims to ensure the stability, efficiency, and sustainability of Hydro Ottawa's distribution system by relying on several key strategies focused on system utilization, such as Load Forecasting and Capacity Planning, Renewable Energy Integration, NWSs, Demand Side Management and Energy Efficiency Programs, see more details in Section 9 - System Capacity Assessment and Grid Modernization Technologies as described in Section 3.4.2 - Grid Modernization Strategy.

8. ASSET LIFECYCLE OPTIMIZATION POLICIES AND PRACTICES

Hydro Ottawa is committed to providing a sustainable and dependable electricity service by optimizing asset lifecycles and ensuring reliability and cost-effectiveness through informed asset management practices. This is achieved by balancing maintenance, renewal, and replacement strategies and includes establishing TUL values; implementing asset replacement and refurbishment policies; conducting testing, inspection, and maintenance programs; and monitoring asset utilization.

The TUL of assets is determined through a robust process involving failure curve analyses and industry benchmarking. This ensures informed decisions about asset renewal and replacement, preventing premature retirement or extended use beyond safe operational lifespans. Corrective actions for assets include repair, refurbishment, or replacement, based on a case-by-case analysis considering factors like age, condition, maintenance history, new standards, and spare parts availability. Hydro Ottawa proactively replaces end-of-life assets and those posing immediate risks through the System Renewal program, while also evaluating opportunities for efficiencies during replacements.

Hydro Ottawa also employs various inspection techniques, including non-destructive testing and preventative maintenance, to assess asset performance and condition. The frequency and nature of these activities vary based on the asset type and are important to ensure the continued reliable operation of low-risk assets in a deteriorated condition (through relevant corrective maintenance). Corrective maintenance addresses minor issues and unforeseen failures to ensure grid reliability.

KPIs such as the SLI and FLI, are monitored to ensure efficient asset utilization and identify areas for improvement. This involves tracking station capacity and feeder capacity to prevent overloads, minimize downtime, and optimize resource allocation.

The following sub-sections highlight Hydro Ottawa's asset lifecycle optimization policies and practices in detail.

8.1. ASSET TYPICAL USEFUL LIFE

Hydro Ottawa partnered with Hatch to enhance asset failure curve knowledge and insights, aiming to refine the utility’s risk- and value-based asset management framework. In addition to the primary goal of enhancing Hydro Ottawa's understanding of asset failure and degradation patterns (failure curve intelligence), this project also yielded crucial insights into the typical lifespans of various asset types. These recommended TUL values were not determined arbitrarily, but rather through a rigorous process that involved aligning the results from the failure curve simulation model with the maturity and reliability of the input data used, as well as drawing upon extensive industry experience and established benchmarks. Refer to Section 4.4.4 - Failure Curves and Update for details on this process.

The ability to establish these updated and empirically-grounded TUL values for the diverse range of asset types within Hydro Ottawa's infrastructure represents a significant achievement. These values provide a solid and defensible basis for making informed asset renewal and replacement decisions, ensuring that assets are not prematurely retired, leading to unnecessary capital expenditure, nor kept in service beyond their safe and reliable operational lifespan, which could increase the risk of failures and service disruptions.

Hydro Ottawa has categorized its assets into three groups based on their remaining TUL to facilitate asset renewal planning:

- **Assets with over 10 years of TUL remaining:** These assets are stable and don't need immediate action. They are routinely monitored through maintenance and inspections.
- **Assets with less than 10 years of TUL remaining:** These assets are not at the end of their lifespan but will need attention and possible replacement or refurbishment within 10 years.
- **Assets that have reached or exceeded their TUL:** These assets pose the highest risk of failure and are prioritized for immediate or short-term replacement or refurbishment.

A detailed report on the asset failure curve analysis and TUL determination is available in Attachment 2-5-4(D) - Failure Curves Review.

Table 25 shows a summary between the old and new TUL values for the various asset types considered as a part of the study. The suitability of the new TUL values were confirmed through a workshop between Hydro Ottawa and Hatch Subject Matter Experts. Factors such as the convergence of the failure curve simulation model, maturity of input data and industry experience were considered in finalizing the new TUL values, thereby making the new proposed changes more robust.

1 **Table 25 - Summary of Typical Useful Life Values**

Asset Type	Old Typical Useful Life (in years)	New Typical Useful Life (in years)
Station Transformers	55	55
Station Switchgear	42 (Air), 55 (Oil), 46 (Vacuum) and 51 (SF_6)	42 (Air), 55 (Oil), 46 (Vacuum) and 51 (SF6), 45 (HV SF_6)[27]
UG Switchgear	25 (Air) and 25 (SF_6)	25 (Air) and 25 (SF_6)
UG Transformers	53	41
OH Transformers	53	53
Vault Transformers	53	53
Vault Switchgear	25 (Air) and 25 (SF_6)	25 (Air) and 25 (SF_6)
OH Switches	25 (Manual) and 25 (SCADAmate)	25 (Manual) and 25 (SCADAmate)
Poles, Towers, Fixtures (Wood)	53	53
UG Polymer Cable	45 (XLPE and EPR)	45 (XLPE and EPR)
UG PILC Cable	62	62
Cable Chambers	52	54
Station Batteries	15 (VRLA batteries) and 25 (VLA batteries)	15 (VRLA batteries),17 (VLA batteries)
SCADA RTU, Relays and Communication Equipment	40 (Electromechanical relays), 15 (Electronic relays) and 25 (Microprocessor relays)	40 (Electromechanical relays), 30 (Electronic relays), 25 (Microprocessor relays)

2

3 ## 8.2. ASSET REPLACEMENT & REFURBISHMENT POLICIES

4 Assets identified as needing corrective action (through periodic maintenance, field inspections,
5 patrols, etc.) are evaluated to determine whether the asset should be repaired, refurbished, or
6 replaced. Factors such as the age, condition, maintenance history, new standards, and availability of
7 spare parts all influence the decision of whether or not to refurbish, repair, or replace the asset.

[27] Historically, HV SF6 was grouped within “SF6” with a TUL of 51.

Specific to asset replacements, Hydro Ottawa proactively replaces end-of-life assets in a deteriorated condition, as a part of the system renewal program outlined in Schedule 2-5-7 - System Renewal Investments. To determine the asset renewal needs, Hydro Ottawa uses PA to calculate the risk posed by individual assets. PA is also capable of predicting the degradation pattern, probability of failure, and progression of risk over time for each individual asset in Hydro Ottawa's service territory. This allows Hydro Ottawa to follow a risk-based asset replacement/intervention strategy. More details on Hydro Ottawa's asset risk assessment framework that drives system renewal investment planning can be found in Section 5.1.4 - Asset Risk Assessment.

Apart from this, assets which pose an immediate or imminent risk to the asset management objectives are repaired under maintenance or replaced under corrective renewal. These assets are identified immediately based on visual inspections or periodic maintenance and also based on recommendations by PA on low-risk assets in a deteriorated condition. Hydro Ottawa has a budget allocated for corrective renewal, outlined in Section 6 of Schedule 2-5-7 - System Renewal Investments. Repair and refurbishment activities are covered under the reactive maintenance budget and typically undertaken on asset sub-components, which if unaddressed may lead to a catastrophic failure.

Hydro Ottawa has also defined the criteria which determine corrective renewal for each individual asset class in order to determine the relevant budget program and timeline. An example for station transformers is provided in Table 26. Specifics on the emergency and critical renewal criteria for all asset classes are provided in Section 6 of Schedule 2-5-7 - System Renewal Investments.

Table 26 - Station Transformer Corrective Renewal Criteria

Emergency Renewal (Immediate Risk)	Critical Renewal (Imminent Risk)
Internal fault	Tap-changer failure
Bushing failure	Heavy gassing
Tank rupture (loss of oil)	Overheated bushing (found with IR scan)
Major issue found during maintenance	High furan level
Health index of 0%	Significant issues found in testing
	Insufficient health index (very poor / < 30%)

In addition to individual intervention assessments, each asset identified for replacement is evaluated for opportunities for efficiencies by assessing the condition of the other assets in proximity that may need to be replaced concurrently, evaluating future growth and demand, and determining if decommissioning is an option.

Repair actions are corrective interventions that involve the replacement of a minor component which can be obtained from stock materials or through manufacturer sourcing.

Refurbishment is expected to renew the asset and extend the TUL. These actions are also used to defer the need for replacement to a time where efficiencies can be found by replacing other assets at the same time. Typically, station assets, such as transformers and breakers, have been more economical to refurbish than overhead and underground assets. The refurbishment/repair actions are undertaken through targeted maintenance programs as detailed in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

To maintain overall system reliability and mitigate the related risks (safety, reliability, environmental, financial, and compliance), Hydro Ottawa uses a strategic, forward-looking approach that includes levelized spending and data-driven system renewal investment planning. The asset renewal strategy is designed to manage and mitigate asset risks by strategically replacing deteriorating infrastructure, not simply replacing all aged or deteriorated assets. Hydro Ottawa's proposed 2026-2030 System

Renewal investment plan does not aim to replace all degraded assets. Instead, it prioritizes replacement based on PA assessments, while balancing cost, resourcing and material availability, and short- and long-term risk. This comprehensive assessment emphasizes that Hydro Ottawa is making strategic choices about which assets to replace and at what rate, rather than simply replacing everything that is degraded. Specific details of each renewal program are outlined in Schedule 2-5-7 - System Renewal Investments.

8.3. TESTING, INSPECTION & MAINTENANCE PROGRAMS

To optimize the asset lifecycle and manage risk, Hydro Ottawa uses various programs and activities to evaluate the performance and condition of its assets. The practices used to assess risk include non-destructive testing and predictive and preventative maintenance, which help to drive corrective maintenance and capital investments.

Most of Hydro Ottawa's asset maintenance activities are performed on a predetermined periodic schedule. The cycle period is selected based on various factors such as asset age, equipment usage, equipment type, and typical operating life, to address manufacturers' recommendations, regulatory requirements in the DSC, and/or internal experience and standards. Table 27 outlines the inspection and maintenance cycles of each program.

Table 27 - Hydro Ottawa's Maintenance Programs

Asset	Activity Type	Cycle	Type
Stations	Station Inspections	Monthly	Predictive
	Thermographic Scans	Annually	Predictive
	Transformer Inspection	Annually	Predictive
	Transformer Oil Analysis	Annually	Predictive
	Transformer Maintenance	Every 3-5 Years	Preventative
	Transformer Tap Changer Maintenance	Every 1-8 Years	Preventative
	Switchgear and Breaker Inspection	Annually	Predictive
	Switchgear and Breaker Maintenance	Every 4-6 Years	Preventative
	Battery Testing	Annually	Predictive
	Relay Maintenance	Every 4-6 Years	Preventative
Underground	Underground Switchgear Thermographic and Visual	Every 3 Years	Predictive
	Underground Distribution Transformer Thermographic and Visual	Every 3 Years	Predictive
	Vault Inspections	Every 3 to 6 Years	Predictive
	Underground Switchgear CO2 Washing	Every 3 Years	Preventative
	XLPE/TRXLPE Cable Testing	200 Segments Annually	Predictive
	Cable Chamber Inspections	Every 10 Years	Predictive
Overhead	Overhead Visual and Thermographic Inspection	Every 3 Years	Predictive
	Vegetation Management	Every 2 to 3 Years	Preventative
	Pole Inspection	Every 10 Years	Predictive
	Critical Switch Inspection	Every 8 Years	Preventative
	Insulator Washing	Bi-Annual	Preventative

Aside from the preventative and predictive maintenance programs, Hydro Ottawa also tackles any repairs to the asset population through corrective maintenance. The repairs are performed to address minor issues that do not indicate that an asset has reached its TUL. This determination is made through a thorough inspection process, which includes both visual and detailed assessments/electrical testing, as shown in Table 27. The corrective maintenance activities might include tasks such as repairing, replacing, or refurbishing underlying asset components. Hydro Ottawa also carries out corrective maintenance to address unforeseen issues and failures in electrical assets, ensuring the continued reliability of the electrical grid.

Hydro Ottawa's electrical assets (especially in stations) require significant capital investments through 2026-2030 in renewals to maintain reliability (from a condition and risk perspective), based on the risk assessment process outlined in Section 5.1.4 - Asset Risk Assessment using Copperleaf PA. A significant level of investment is necessary to intervene on all deteriorated station and distribution assets, as outlined in Section 2.3.2 of Schedule 2-5-1 - Distribution System Plan Overview, Table 3. Hydro Ottawa selected the proposed alternatives to ensure that resourcing, material availability, customer affordability, and risk mitigation were properly considered and balanced in the decision, however in some cases, Hydro Ottawa is only able to balance short-term risk as a result of the selected alternative.

In response, Hydro Ottawa has planned increases in the frequency of testing, inspection, and maintenance activities for some asset classes where the planned replacement rate is not high enough to keep up with the pace that assets reach their TUL. Hydro Ottawa has also expanded the data collected through the inspection and maintenance programs to collect more comprehensive condition information. This approach allows Hydro Ottawa to gather additional condition information on deteriorating asset infrastructure and manage it accordingly. To this end, Hydro Ottawa proposes to increase investments in maintenance programs through 2026-2030 to mitigate failure risk of assets not immediately slated for replacement. Further details are outlined in Schedule 4-1-2 - Operation, Maintenance and Administration Program Costs. This strategic investment in maintenance programs supports a balanced approach to long-term asset performance.

Updates to the station maintenance program will include support for voltage conversion of 4kV station assets, and improved transformer maintenance (through targeted insulator washing, advanced diagnostic testing and ensuring the operational performance of online dissolved gas analysis (DGA) monitors). In addition, Hydro Ottawa will introduce advanced inspection technologies, such as drones, to gather more precise data on OH distribution assets. This will enable targeted maintenance and improve asset health assessments. Finally, Hydro Ottawa will focus on spending in its UG distribution asset maintenance programs. This includes leveraging advanced techniques to identify vulnerabilities and optimize capital investments.

By increasing the investment in maintenance activities, Hydro Ottawa can sustain asset performance while minimizing customer interruptions. These updates are intended to ensure that Hydro Ottawa's asset population remains functional and safe through 2026-2030. More information regarding the proposed O&M costs can be found in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

The following sections detail the testing, inspection, and maintenance practices for each asset type.

8.3.1. Station Assets

8.3.1.1. Station Transformers

Hydro Ottawa performs monthly station inspections where a visual inspection checks for any deficiencies and initiates corrective actions. Annually, Hydro Ottawa performs predictive maintenance on every station transformer, which includes a detailed visual inspection, oil analysis, and infrared scans. The oil analysis includes a dissolved gas and oil quality analysis. Every five years, a furan analysis is performed to assess the degradation of the transformer's paper insulation.

Several major station transformers are also continuously monitored through the SCADA system to provide operational and asset condition-related information. Various monitoring technologies have been added to station transformers due to the consequences associated with a failure. These include online DGA monitors, winding and oil temperature monitors and monitors to track tap changer status, cooling fan status, and loading information. Warnings and alarms from these monitoring units allow Hydro Ottawa to identify the need for corrective actions with real-time data. It also ensures that the transformers are not overloaded or overheating, which causes the insulation to degrade and reduces transformer lifespans. Figure 68 shows an example of the visual inspection of a station transformer.

Figure 68 - Visual Inspection of a Station Transformer

Every three to five years, station transformers are isolated for preventative maintenance, which includes electrical testing and mechanical maintenance. Transformer tap changer maintenance intervals vary with the type: oil-filled tap changers with no oil filter are maintained every one to two years, oil-filled tap changers with an oil filter are maintained every two to four years, and vacuum tap changers are maintained every six to eight years.

8.3.1.2. Station Switchgear

Hydro Ottawa performs monthly station inspections where a visual inspection is performed to check for any deficiencies and initiate corrective actions. Predictive maintenance is undertaken annually on station switchgear, which includes a detailed visual inspection and infrared scan. Every five years, preventative maintenance is performed on individual breakers. The breaker maintenance includes electrical, mechanical, and type-specific maintenance tasks to ensure the proper functioning of the breaker.

Every 10 years, detailed preventative maintenance is performed on the entire switchgear assembly. Switchgear maintenance includes detailed internal visual inspections; insulation resistance tests; and ensuring that there are no structural deficiencies, such as cracks, leaks or warped metal, in the switchgear.

8.3.1.3. Station Batteries

Batteries are visually inspected as part of the monthly station inspections to check for any deficiencies and initiate corrective actions. Annually, detailed predictive maintenance is performed on station battery banks; this includes a detailed visual inspection, infrared scan, and electrical and mechanical tests. Battery charger predictive maintenance consists of an annual visual inspection, electrical tests, and functional and alarm tests.

8.3.2. Overhead Assets

8.3.2.1. Distribution Poles

Hydro Ottawa inspects all of its distribution poles as part of multiple planned programs of inspection for overhead assets. This planned program of inspection subjects all of its distribution poles and associated attachments to both a visual and thermographic inspection on a rotating three-year cycle, identifying candidate assets for corrective actions.

Hydro Ottawa also conducts a predictive maintenance program of detailed inspection of all poles on a 10-year cycle. The data collected from this program is used to assess the pole's condition and estimate remaining strength using the results of non-destructive resistograph drill tests. Hydro Ottawa is also working on a drone inspection pilot program to gather more accurate condition information on pole mounted hardware.

8.3.2.2. Overhead Transformers

Hydro Ottawa inspects overhead transformers as part of multiple planned predictive maintenance programs. Transformers are inspected visually as part of the 10-year pole line inspection program and every three years as part of the infrared inspection program. Hydro Ottawa is also working on a drone inspection pilot program to gather more accurate condition information on overhead transformers.

8.3.2.3. Overhead Switches

Hydro Ottawa inspects all of its overhead switches as part of multiple planned programs of inspection for overhead assets. This planned program of inspection subjects all of its overhead switches to both a visual and thermographic inspection on a rotating three-year cycle identifying candidate assets for corrective actions. Hydro Ottawa is also working on a drone inspection pilot program to gather more accurate condition information on overhead switches.

Hydro Ottawa also conducts a separate planned program of detailed inspection and maintenance, based on a rotating eight-year cycle, on overhead load break gang-operated switches. The detailed inspection is to address switches that have a higher reliability consequence. Inspections are performed in the air, in closer proximity to the switch’s components, allowing for a more detailed inspection that could not be performed from the ground. Simultaneously, preventative maintenance is performed on the switch to ensure that it continues to operate as intended.

8.3.3. Underground Assets

8.3.3.1. Distribution Cables

Hydro Ottawa annually tests a portion of its polymer cables using non-destructive test methods to determine the cable’s probability of failure resulting from water tree migration, neutral corrosion, and partial discharge. Hydro Ottawa also combines this information with feedback from utility staff (such as the condition of related UG transformers/UG switchgear, physical condition, operational experience/failure trend based on similar installations, etc.), outage information, and the cable segment's age to determine if the cable would be a candidate for replacement.

PILC are not subjected to a dedicated planned program of inspection or maintenance and are instead included as part of the inspection of underground civil structures. A visual inspection is performed on a 10-year cycle, by qualified outdoor field staff, which includes reviewing the cable condition, racking within the cable chamber, and duct allocation.

8.3.3.2. Underground Transformers

Hydro Ottawa inspects its underground distribution transformers annually on a three-year cycle. The inspection process uses a visual inspection to identify transformers with broken components or leaking oil. A thermographic inspection is also performed to identify defective transformer components including elbows, bushings, and fuses. This process identifies candidate transformers for corrective actions including mechanical repair and component replacement. When repair isn't economical, the transformer is scheduled for replacement.

8.3.3.3. Underground Switchgear

Hydro Ottawa inspects and maintains all of its underground distribution switchgear on a planned basis. This planned program subjects all of its underground distribution switchgear to a visual and thermographic inspection based on a rotating three-year cycle. The maintenance of air-insulated switchgear also includes cleaning of its internal mechanism. The visual inspection records demographic information and the current condition, including the enclosure and civil base.

8.3.3.4. Vault Transformers

Hydro Ottawa inspects all of its vault transformers on a planned three-year cycle. This planned program subjects its vault transformers to a visual and thermographic inspection in addition to minor cleaning. The visual inspection records demographic information and the current condition.

Hydro Ottawa does not own the electrical supply room within customer-owned buildings. Deficiencies found that would affect the ongoing operations or identified safety risks are identified to the building owner to take corrective actions.

8.3.3.5. Underground Civil

Hydro Ottawa performs an inspection of its cable chambers on a 10-year cycle. The cable chamber inspection process involves a visual inspection and sounding test to assess the cable chamber's condition. The inspection includes reviewing the condition of the collar and lid, the roof, and the walls. Cable chamber components that pose an immediate risk to the public, workers, or reliability of the distribution system are identified for immediate corrective actions; if they pose a reduced risk, they are identified for planned corrective actions at a later date.

Through the use of experienced underground field workers, the electrical components installed within the cable chambers can be inspected and minor corrective actions addressed immediately. The visual inspection includes capturing information about the cable demographics, location of splices, and identification of duct allocation.

Other civil assets, including hand holes, ducts, and duct banks, are not subject to a planned program of inspection. Unforeseen failure of these assets poses a reduced risk to the public and workers.

8.4. ASSET UTILIZATION POLICIES AND PRACTICES

Hydro Ottawa monitors the operational performance of the distribution system by tracking annual levels of station capacity, feeder capacity, and system losses. Monitoring and managing the capacity and performance of these distribution systems are critical to prevent overloads, minimize downtime, and optimize resource allocation.

Two key metrics used in this context are the SLI and FLI.
The SLI and FLI are discussed in greater detail in Sections 8.3.1 - Station Assets and 8.3.2 - Overhead Assets. The importance and application of these measures are:

- **Capacity Planning:** Hydro Ottawa monitors these indices to identify which substations or feeders are under stress and require upgrades. This proactive approach ensures that adequate capacity is available during normal system conditions, avoiding unexpected outages and delivering reliable power supply to Hydro Ottawa's customers.
- **Load Management:** Hydro Ottawa uses these indices to identify areas of overloading and take measures such as system reconfiguration to redistribute loads or enhancing infrastructure to manage the load effectively.
- **Investment Decisions:** Hydro Ottawa can utilize SLI and FLI insights to prioritize investments in substations or feeders that are nearing/exceeding capacity limits, ensuring optimal use of resources and budget, and implement the appropriate actions required to maximize the value of the distribution assets throughout its lifecycle.
- **Reliability and Service Quality:** By keeping SLI and FLI within safe limits, Hydro Ottawa can maintain high reliability and service quality. This is crucial for customer satisfaction and compliance with regulatory standards.

8.4.1. Station Capacity

To improve System Accessibility, Station Capacity measures are tracked to provide insight for larger medium- and long-term capacity needs, as well as smaller capacity deficits that may be solved through load transfers.

System Service projects are initiated to address capacity constraints. Projects, in order of increasing complexity and cost, include extending distribution ties to other stations with available capacity, upgrading an existing station's planning capacity, and construction of a new station. The following measure quantifies capacity risks through demand comparisons to a station's planning and equipment ratings and by determining if stranded load is possible during the loss of a station transformer, Section 5.2.2 - Distribution System Assessment.

Station Load Index (SLI)

The SLI is a measure used to assess the load on a substation. It is a critical parameter for determining the current utilization of the substation's capacity and for planning future upgrades or expansions. SLI is typically calculated as the ratio of the peak load to the substation's capacity rating (i.e. planning and/or design rating). The formula can be expressed as:

$$\text{SLI} = (\text{Peak Load}/\text{Capacity Rating}) \times 100$$

The station load indices monitored by Hydro Ottawa are defined in Table 28:

Table 28 - Station Load Index

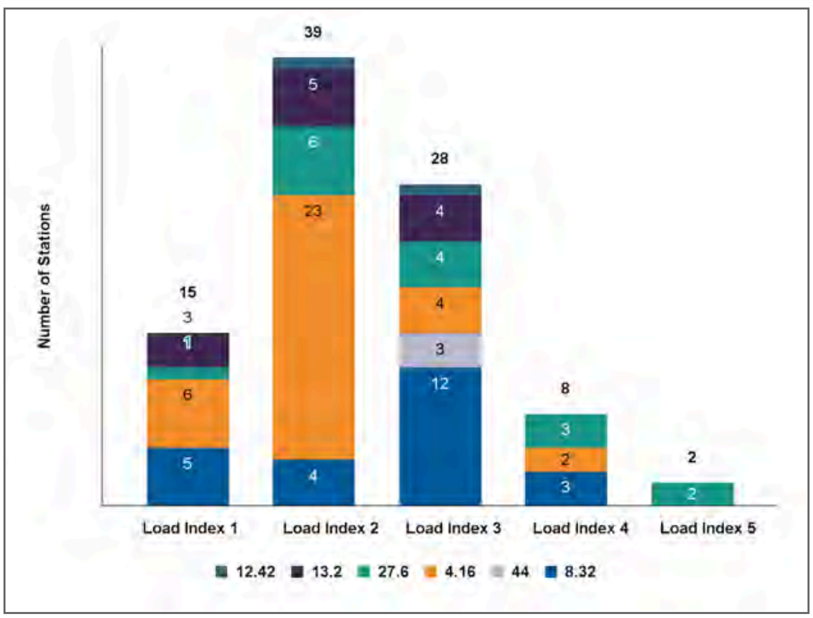
Load Index	Criteria	Explanation
5	x > 70% of Design Rating	Approaching thermal limit
4	x ≥ 100% of Planning Rating	Very heavily loaded, exceeding N-1 contingency
3	70% of Planning Rating ≤ x < 100% of Planning Rating	Heavily loaded, but within contingency
2	40% of Planning Rating ≤ x < 70% of Planning Rating	Moderately loaded
1	x < 40% of Planning Rating	Lightly loaded

- **Planning Rating:** The planning rating is the sum of either the transformers' 10-day LTR or the allowable top load rating if no LTR is published, following the loss of the largest element in the station (N-1 contingency). For stations with a single supply and transformer, feeder ties from adjacent stations provide contingency backup and the planning capacity is based on the single unit's rated capacity (10-day LTR or top load rating if LTR is not available).
- **Design Rating:** A transformer's design rating specifies the maximum electrical power (in kVa or MVA) it can handle under optimal cooling conditions including fan-assisted heat dissipation. This rating ensures the transformer operates reliably within its thermal limits.

Hydro Ottawa monitors the percentage of stations with load indices of 4 and 5 to plan capacity upgrades and has completed significant station expansion projects, improving station performance within planning and design ratings.

In 2023, eight Hydro Ottawa stations had a SLI of 4 and two stations had a SLI of 5, as shown in Figure 69. Stations above 100% of their planning capacity (Load Index 4) limit the flexibility of the system to manage abnormal system states including planned activities. Stations operating at >70% of their design rating (Load Index 5) are approaching their design rating and need intervention to reduce their loading for contingency scenarios.

Figure 69 - Stations by Load Index



The list of stations with a SLI of 4 and 5 have been listed in Table 29.

Table 29 - Stations of Load Index 4 and 5

Region	Station	Voltage	2023 System Peak Day Load (MVA)	Planning Factor (%)	Design Factor (%)	Load Index
West 28kV	Janet King DS 28kV	27.6	26.5	88%	88%	5
West 28kV	Beckwith DS	27.6	3.9	105%	105%	5
West 28kV (North)	Marchwood MTS	27.6	45.7	138%	69%	4
South 28kV	Fallowfield MTS	27.6	32.0	114%	60%	4
East 4kV	Vaughan DS	4.16	7.3	109%	51%	4
West 8kV	Richmond North DS	8.32	6.8	136%	52%	4
East 4kV	Church DS	4.16	5.7	114%	46%	4
South East 28kV	Leitrim DS	27.6	26.6	106%	46%	4
Nepean 8kV	Manordale MTS	8.32	10.9	109%	45%	4
Nepean 8kV	Centrepointe MTS	8.32	14.9	106%	38%	4

Hydro Ottawa is utilizing multiple approaches to address the stations at a Load Index of 4 and 5. For information about Hydro Ottawa's plans to address system capacity, see Section 9.1 - Capacity Needs Assessment.

8.4.2. Feeder Capacity

Hydro Ottawa plans feeder capacity based on coincident peak loading and N-1 contingency. The majority of distribution feeders are paired so that if one feeder fails, its load can be transferred to an adjacent feeder. This arrangement minimizes the number of switching operations and the time required to restore full load. Hydro Ottawa also has feeders with dedicated backups; i.e., an alternative backup feeder that normally carries no load. Feeders with a dedicated backup can carry more load without overheating or sustaining damage. Please refer to Table 30 below.

The following factors are taken into consideration when determining the planning rating for a distribution feeder:

- **Egress Cable:** The conductor size, insulation material, and installation type.
- **Egress Design Rating:** Based on the cable specifications and ampacity calculations, a design rating is identified for the respective cable type.
- **Egress 8-hour Rating:** Based on the cable specification and ampacity calculations, a contingency 8-hour rating is identified for the respective cable type.
- **Overhead Conductor:** The conductor size is identified.
- **Overhead Conductor Rating:** A rating is identified for the respective conductor size based on manufacturer specifications.
- **Other Limitations:** Assets on the distribution system that could cause an ampacity limitation, such as jumpers or switches, are identified for the respective feeders.

Table 30 - Typical Egress & Conductor Ratings

Voltage	Typical Egress Cable	Egress Design Rating (A)	Egress 8hr Rating (A)	Typical Overhead Conductor	Overhead Conductor Rating (A)
4 kV	5 kV 350 Cu PILC	340	405	15 kV, 4/0 Cu	510
8 kV	15 kV, 500 MCM Cu XLPE	455	605	15 kV, 336 Al	500
12 kV	15 kV, 2/0 Al XLPE	210	280	15 kV, 336 Al	500
13 kV	15 kV, 500 MCM Cu PILC	425	510	15 kV, 477 Al	600
28 kV	29 kV, 750 MCM Al XLPE	455	620	29 kV, 556 Al	700
28 kV	29 kV, 1000 MCM Al XLPE	505	685	29 kV, 556 Al	700
44 kV	46 kV, 750 MCM Cu XLPE	545	720	46 kV, 556 Al	700

The planning rating for feeders **without** a dedicated backup is calculated as 50% of the egress 8-hour rating or 50% of the overhead conductor rating, whichever is lesser. This approach ensures that feeders always have capacity to backup adjacent circuits during N-1 contingency conditions.

The planning rating for feeders **with** a dedicated backup is calculated as the egress design rating or the overhead conductor rating, whichever is lesser. These feeders have a higher planning rating as they can rely on the dedicated backup for capacity in N-1 contingency scenarios.

The planning rating is calculated on an individual feeder basis to account for feeder specific limitations. This approach ensures that assets on the feeder never exceed their respective thermal limits while also identifying constrained areas on the network, such as undersized conductors, that could be upgraded to increase capacity on the entire feeder. The FLI is used to assess capacity risks through demand comparisons to a feeder's planning ratings and by determining if stranded load is possible during an N-1 contingency.

Feeder Load Index (FLI)

The FLI measures the load on individual feeders that distribute electricity from substations to consumers. It helps in assessing the performance and capacity utilization of these feeders, which helps in planning for feeder extensions to make station capacity available or create feeder ties between stations to improve reliability.

FLI is calculated as the ratio of the actual load on the feeder to its rated capacity (planning/design rating). The formula is:

$$\mathbf{FLI = (Peak\ Load/Capacity\ Rating)\times 100}$$

The feeder load indices monitored by Hydro Ottawa are defined in Table 31.

Table 31 - Feeder Load Index

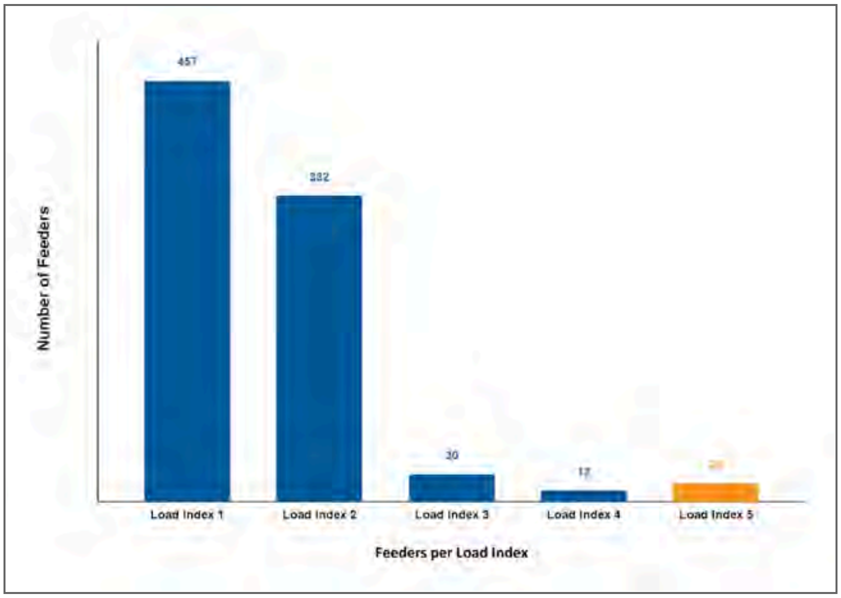
Load Index	Criteria	Explanation
5	x > 70% of Design Rating	Approaching thermal limit
4	x ≥ 100% of Planning Rating	Very heavily loaded, exceeding N-1 contingency
3	85% of Planning Rating ≤ x < 100% of Planning Rating	Heavily loaded, but within contingency
2	40% of Planning Rating ≤ x < 85% of Planning Rating	Moderately loaded
1	x < 40% of Planning Rating	Lightly loaded

Hydro Ottawa monitors the percentage of feeders with a load index of 4 and 5 to plan for feeder capacity upgrades and reliability improvement investments.

In 2023, 12 Hydro Ottawa feeders had a FLI of 4 and 19 feeders at a FLI of 5, as shown in Figure 70. Feeders must be maintained within the planning capacity to allow for efficient load transfer during N-1 contingency situations while respecting equipment ratings.

Feeders equal to or above 100% of their planning capacity (Load Index 4) limit the flexibility of the system to manage abnormal system states, including planned activities. Feeders operating at >70% of their design rating (Load Index 5) signal at approaching rated capacity and need some intervention to reduce the loading to be able to manage contingency scenarios.

1 **Figure 70 - 2023 Feeder Load Index**



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4 The list of feeders with a FLI of 4 and 5 have been listed in Table 32 below.

1 **Table 32 - Feeders with Load Index 4 or 5**

Station	Voltage	Feeder	Planning Factor (%)	Design Factor (%)	Load Index
South March TS	44	A9M3	159%	79%	5
Jockvale DS	8.32	145F1	147%	73%	5
Parkwood Hills DS	8.32	190F5	146%	83%	5
Russell TS	13.2	5304	122%	73%	5
Nepean TS	44	22M27	117%	75%	5
Fallowfield MTS	27.6	FAL01	110%	75%	5
Cambrian MTS	27.6	CBNF5	108%	73%	5
Gladstone DS	4.16	UX03	80%	80%	5
Carling TS	13.2	TC4TM	79%	79%	5
Russell TS	13.2	TB2JP	79%	79%	5
Henderson DS	4.16	UN04	77%	77%	5
Carling TS	13.2	TC2TM	76%	76%	5
Florence DS	4.16	UF07	75%	75%	5
Carling TS	13.2	TC1TM	75%	75%	5
Carling TS	13.2	TC3TM	74%	74%	5
Bayswater DS	4.16	UJ07	72%	72%	5
Nepean DS	4.16	AB03	71%	71%	5
Bronson DS	4.16	SB02	71%	71%	5
Carling DS	4.16	SM12	70%	70%	5
Beckwith DS	27.6	BECKF2	105%	35%	5
Casselman DS	8.32	CAS-F2	168%	55%	4
Barrhaven DS	8.32	140F3	122%	67%	4
Startop DS	8.32	6F10	111%	61%	4
Parkwood Hills DS	8.32	190F2	109%	54%	4
Rideau Heights DS	8.32	180F4	109%	70%	4
Beaconhill DS	8.32	BCHF5	109%	60%	4
Casselman DS	8.32	CAS-F1	108%	36%	4
Richmond North DS	8.32	RHNF3	104%	31%	4
Centrepointe MTS	8.32	87F3	104%	51%	4
Hawthorne TS	44	48M2	103%	66%	4
Bridlewood MTS 8kV	8.32	BRDF6	102%	56%	4
Richmond North DS	8.32	RHNF2	102%	30%	4

9. SYSTEM CAPACITY ASSESSMENT

Hydro Ottawa's capacity planning process ensures that the distribution system is sufficiently sized to deliver reliable electricity to its expanding customer base. With growing energy demand and existing system constraints, Hydro Ottawa is focusing on powering the growing community by addressing the immediate and short-term needs over the 2026-2030 rate period. This requires immediate infrastructure investments aligned with long-term potential outcomes, promoting efficiency in capital deployment.

Hydro Ottawa's planning process takes into account existing and short-term system constraints, new developments, a rise in DERs, and a shift towards electrification informed by known large load requests. Other important drivers considered in the planning process are the need to build a more resilient grid to tackle climate change and its impacts to the distribution system, as detailed in Section 6.4.2 - Future Climate, and customer preferences evident through the engagement survey that supports making investments to further growth and electrification, for further details on the Customer Engagement Survey, see Schedule 1-4-1 - Customer Engagement Ongoing.

Transmission and distribution line availability is another key factor impacting system capacity. Transmission lines carry electricity from generating stations to substations, while distribution lines deliver power from substations to individual customers. If these lines are not adequate in number or capacity, they can limit the amount of electricity that can be delivered to customers. As described in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties, transmission assessment is led by the IESO through the IRRP Process. The current investment plan submitted through this application is in consultation with the IRRP working group and based on the needs assessment completed through the regional planning process. Plans will be revised, if necessary, based on the final IRRP report that is yet to be published.

Hydro Ottawa's System Capacity Assessment is a complex and technical process that analyzes large quantities of data from various sources to enable well-informed decisions about system upgrades and expansions, leveraging the planning forecast as its foundation. By investing in its electrical infrastructure, Hydro Ottawa can ensure that it has the capacity to meet the current needs of its customers by making prudent decisions to support the long term trajectory of the community.

This section describes Hydro Ottawa's capacity planning approach and is organized as follows:

- **Section 9.1:** Capacity Needs Assessment
- **Section 9.2:** Non-Wires Solutions to Address System Needs
- **Section 9.3:** System Capability Assessment for Renewable Energy Generation (REG) & DERs
- **Section 9.4:** Planning Load Forecasting

9.1. CAPACITY NEEDS ASSESSMENT

Hydro Ottawa utilizes the Planning Forecast, as detailed in Section 9.4 - Planning Load Forecasting, to assess and anticipate the immediate needs of the system. This forecast is then compared against established system limits and constraints to pinpoint areas requiring intervention. Identified issues are consolidated to develop a comprehensive and cohesive set of solutions. This section outlines the overall requirements to meet system capacity forecasts and the needs identification process, starting with determination of the immediate needs (by utilizing the Planning Forecast) and an evaluation of the medium to long-term requirements for efficient capital deployment (by utilizing the IRRP Forecast-as detailed in Section 9.4 - Planning Load Forecasting) followed by detailed assessment by planning region.

9.1.1. Overview

Table 33 summarizes the Wires and Non-Wires investment needs by planning region determined through the immediate and medium to long-term needs assessments.

1 **Table 33 - Investment Needs per Planning Region**

Planning Regions	Wire Solutions	Non-Wires Solutions (NWSs)	Capacity Addition (LTR-MVA)
44 kV	• A new 44 kV station (Hydro Road MTS) to cater to a specific need for the OC Transpo's Zero Emission Buses • Hydro One has plans to upgrade South March TS transformers due to end of life. Installing higher capacity transformers would aid in adding capacity to the region		171
South 28 kV	• Construction of a new 28 kV station (Greenbank MTS) to accommodate overloads in the 8 kV system and large load requests including the Regulatory and Science Main Project • Feeder integration plans for new station		120
South-East 28 kV	• Construction of a new station in the region along the 230 kV transmission corridor (Piperville MTS) to accommodate overloads and support future growth • Feeder integration plans for new station		120
East 28 kV	• With plans to decommission Bilberry TS and an Orleans feeder, a new 28 kV station is underway (Mer Bleue MTS) to manage existing load from Orleans TS and Bilberry TS • Cyrville MTS is proposed to be upgraded to support overload in the East 13 kV and East 8 kV regions and support large load requests including TerraCanada National Capital Area project • Feeder integration plans for new station		190
West 28 kV	• Additional transformer upgrade at Richmond South MTS to meet load requirements of the Department of National Defence Dwyer Hill Training Center • Upgrade and maintain transformer-level redundancy	Utility Owned Battery Storage	3
West 28 kV (North)	• Construction of a new 28 kV station to accommodate overloads and support future growth. • Feeder integration plans for new station	Non-Wires Customer Solutions Program	120 (plus NWCS: 10-15 MW)
West 13 kV	• Cable upgrades and remove equipment limitations at Hydro One stations - Carling TS • Slater TS upgrade completed • Conversion of Bronson[28] from 4 kV to 13 kV will help with capacity constraints and support Carling, Lisgar and Riverdale		150

[28] Conversion of Bronson is initiated in this 2026-2030 Rate Period but will only be energized in 2031.

Planning Regions	Wire Solutions	Non-Wires Solutions (NWSs)	Capacity Addition (LTR-MVA)
Core 13 kV	• Riverdale switchgear upgrade underway • Cable upgrades and remove equipment limitations at Hydro One stations - King Edward TS, Lisgar TS • Slater TS upgrade completed • Conversion of Bronson DS from 4 kV to 13 kV will help with capacity constraints and support Lisgar TS and Riverdale TS	Utility Owned Battery Storage Non-Wires Customer Solutions Program	63 (plus NWCS: 10-15 MW)
East 13 kV	• Hydro One has plans to upgrade Russell TS and Albion TS station transformers due to end of life • Installing higher capacity transformers would aid adding capacity to the region		68[29]
West 12 kV	• Strategic and phased voltage conversion		
Nepean 8 kV	• Voltage conversion of 8 kV to 28 kV in the long term supported by the new Greenbank station in the South 28 kV region		
Bells Corner/ Bayshore 8 kV	• None required	Utility Owned Battery Storage	8
Barrhaven 8 kV	• Voltage conversion of 8 kV to 28 kV in the long term supported by Cambrian MTS and the new Greenbank station in the South 28 kV region		
West 8 kV	• Voltage conversion of 8 kV to 28 kV in the long term		
Casselman 8 kV	• None required	Utility Owned Battery Storage	6
East 8 kV	• Voltage conversion of 8 kV to 28 kV in the long term supported by the station upgrades in the East 28 kV stations		
Central 4 kV	• Strategic and phased voltage conversion. Fisher DS is underway and Henderson DS will be initiated. • Strategic 4 kV-to-13 kV voltage conversion of Bronson DS		
East 4 kV	• Strategic and phased voltage conversion. Dagmar DS is underway. Church DS and Vaughan DS will be initiated		

In summary, to balance the need for increased capacity with affordability, Hydro Ottawa has identified areas for upgrades, including enhancing distribution infrastructure, building new stations, upgrading existing stations, utilizing NWSs, and implementing grid modernization initiatives. For new station

[29] Capacity added to the distribution system is driven by Hydro One investments.

capacity projects, please see further details in Section 2.3.2 of Schedule 2-5-8 - System Service Investments, Hydro Ottawa prioritized investments in areas with immediate, confirmed, and committed load requirements. Hydro Ottawa will continuously monitor the impact of electrification to minimize disruptions and ensure the ability to connect new customers.

9.1.2. Immediate Needs Assessment

This section details the assessment of currently overloaded stations and utilizes the Planning Forecast to outline planned investments critical for maintaining system reliability and accessibility required for initiation or completion within the 2026-2030 rate period.

As detailed in Section 8.4.1 - Station Capacity, the 2023 system peak demand assessment reveals ten[30] stations currently operating above planning capacity. To alleviate these constraints and accommodate existing committed loads, Hydro Ottawa is implementing the actions outlined in Table 34. Without these interventions, Hydro Ottawa would be unable to connect new customers and maintain station loading at or below planning levels.

These immediate needs are addressed through the MIPs, specifically Section 2 of Schedule 2-5-8 - System Service Investments and for the new stations, and feeder integration plans for those stations. Some distribution transfer projects may also be undertaken as part of Distribution Enhancements.

[30] Nine stations are operating above planning capacity and one is approaching design capacity.

Table 34 - Immediate System Needs

Planning Region	Need Criteria	Station	Planned Actions
44 kV	Existing Committed Load	Hydro Road MTS	• A new 44 kV station (Hydro Road MTS) to cater to a specific need for OC Transpo's Zero Emission Buses • Provides increased reliability to Hawthorne TS through feeder ties
East 28kV	Existing Committed Load	Cyrville MTS	• With plans to decommission Bilberry TS, a new 28 kV station is underway (Mer Bleue MTS) to manage existing load from Orleans TS and Bilberry TS • Cyrville MTS is proposed to be upgraded to support growth and large loads requests including the TerraCanada National Capital Area project • Distribution transfers to build redundancy and support growth in the East 8 kV system
West 28 kV	Existing Capacity Constraint + Committed Load	Janet King DS	• Utility Owned Battery Storage in the West 28 kV to support minor overloads • To support committed large load request from the Department of National Defence Dwyer Hill Training Center Upgrade, an additional transformer upgrade at the existing station to meet customer need and maintain transformer-level redundancy
		Beckwith DS	
West 28 kV (North)	Existing Capacity Constraint	Marchwood DS	• Construction of a new 28 kV station (Kanata North Station) to accommodate overloads and Kanata North Business developments
West 8 kV	Existing Capacity Constraint	Richmond North DS	• Managed through distribution transfers to build redundancy in the near term • Voltage conversion of 8 kV to 28 kV in the long term
South 28 kV	Existing Capacity Constraint + Committed Load	Fallowfield DS	• Construction of a new 28 kV station (Greenbank MTS) to accommodate overloads in the 8 kV system and large load requests such as the Regulatory and Security Science Main Project • Voltage conversion of 8 kV to 28 kV in the long term
Nepean 8 kV	Existing Capacity Constraint	Manordale DS	
		Centrepointe DS	
South-East 28 kV	Existing Capacity Constraint	Leitrim DS	• Construction of a new station (Piperville MTS) in the region along the 230 kV transmission corridor to accommodate overloads, residential growth and improved area reliability
East 4 kV	Existing Capacity Constraint	Church DS	• Strategic and phased voltage conversion removing limitations for connecting larger loads in the area. Dagmar DS is underway. Church DS and Vaughan DS will be initiated • Distribution transfers to build redundancy improving reliability
	Existing Capacity Constraint	Vaughan DS	

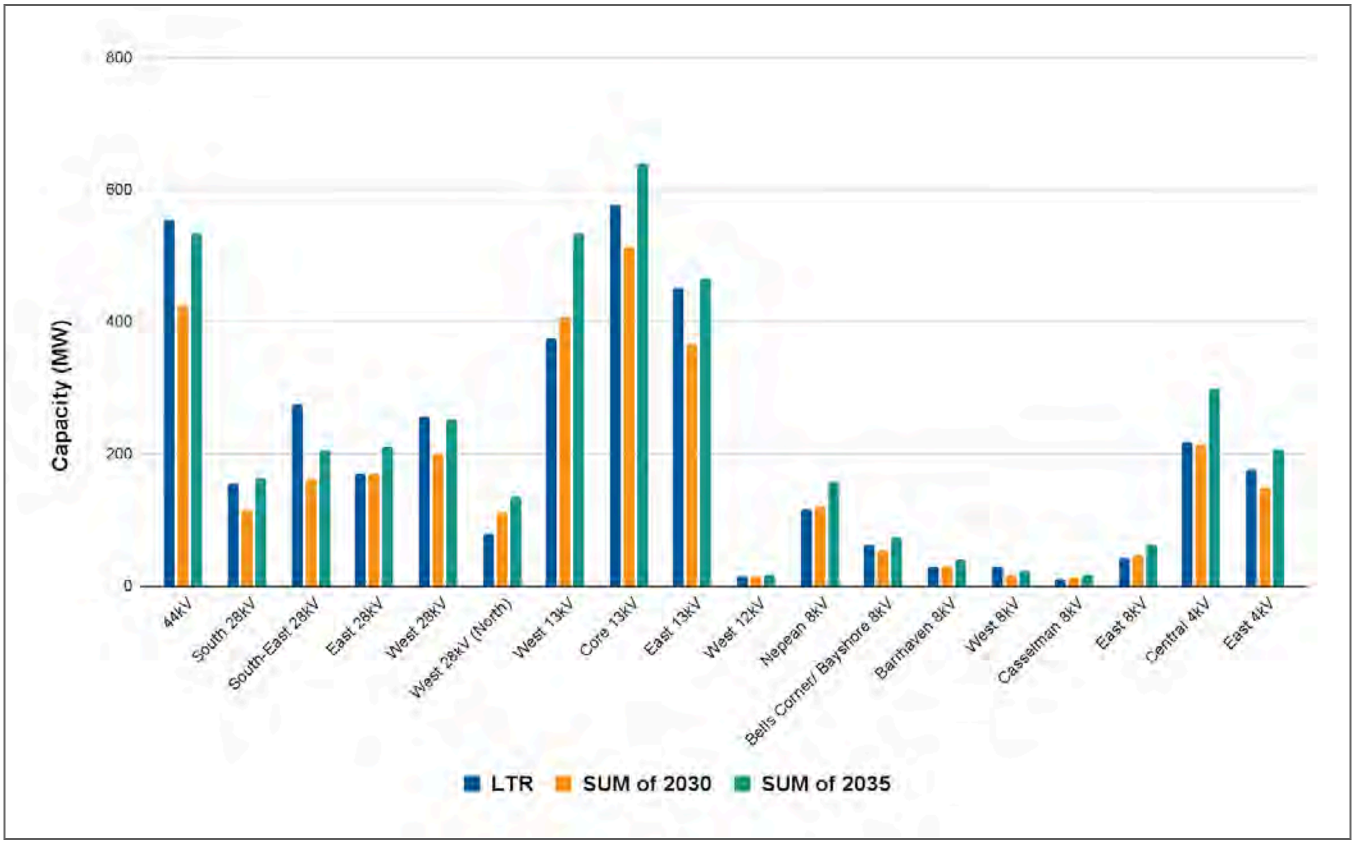
9.1.3. Medium and Long Term Needs Assessment

To proactively identify stations at risk of overload by 2030 and 2035 Hydro Ottawa analyzed the IRRP forecast in all regions, refer to Section 9.1.4 - Investments by Planning Region for the detailed region specific analysis. Given the four- to six-year lead time required for station upgrades and even longer lead times for transmission upgrades, focus on the medium to long-term outlook (beyond 2030) allows Hydro Ottawa to validate that capacity investments for immediate needs (informed through Hydro Ottawa's planning forecast) strategically align with indications of long-term needs, ensuring efficient capital deployment and optimizing asset utilization.

To meet projected capacity needs by 2030, Hydro Ottawa will implement several measures, including distribution infrastructure enhancements, new station construction, existing station upgrades, NWSs, and grid modernization. New station projects are prioritized based on immediate, confirmed, and committed load requirements.

Hydro Ottawa's IRRP forecast shows that, even with the immediate planned actions undertaken, the system will not have enough capacity to meet the growing demand by 2035 in all planning regions. Figure 71 compares the megawatt (MW) forecast for 2030 and 2035 with current available capacity (including Piperville and Hydro Road Station) for the 18 planning regions considering both transmission and the downstream distribution-connected stations.

Figure 71 - 2030 & 2035 Forecast vs. Capacity



Out of the 18 planning regions, 7 will exceed the available capacity and 4 will be over 90% of available capacity by 2030. By 2035, 14 planning regions will exceed available capacity and 2 operating over 90% of available capacity when considering the IRRP forecast. Table 35 details the needs assessment for capacity increases required by 2030 and 2035, beyond the immediate needs outlined in Table 34.

1 **Table 35 - Needs Assessment 2030 and 2035**

Planning Region	Overload Capacity %:		Capacity Upgrade Needs
	2030	2035	
Barrhaven 8 kV	101%	137%	• Voltage conversion from 8 to 28kV to supply from the new Greenbank MTS
Bells Corner / Bayshore 8 kV	89%	118%	• Utility owned battery storage solutions for peak load management
Casselman 8 kV	113%	146%	• Utility owned battery storage solutions for peak load management
Central 4 kV	98%	137%	• Strategic and phased voltage conversion. Fisher AK is underway and Henderson UN will be initiated • Distribution transfers to build redundancy • Bronson SB is proposed to be upgraded to 13 kV to support growth in the West 13 kV region including projects like the Ottawa Hospital's New Campus
Core 13 kV	89%	111%	• Riverdale switchgear upgrade underway • Cable upgrades and remove equipment limitations at Hydro One stations- King Edward TS, Lisgar TS to support growth related to the transit oriented developments and electrification growth • Slater TS upgrade completed • Conversion of Bronson DS from 4 kV to 13 kV will help with capacity constraints and support Carling TS, Lisgar TS and Riverdale TS. Although energization is beyond 2030, construction needs to start in this Rate App to meet forecasted demand • Utility Owned Battery Storage for peak load management
East 8 kV	114%	152%	• Voltage conversion from 8 to 28kV to supply from the new upgraded Cyrville MTS or new Mer Bleue MTS
East 13 kV	81%	103%	• Hydro One has plans to upgrade Russell TS and Albion TS station transformers due to end of life which will add additional capacity to the region • Distribution transfers to build redundancy
West 12 kV	95%	120%	• Strategic and phased voltage conversion
West 13 kV	109%	142%	• Cable upgrades and remove equipment limitations at Hydro One stations- Carling TS to support the Ottawa Hospital New Campus • Slater TS upgrade completed • Conversion of Bronson DS from 4 kV to 13 kV will help with capacity constraints and support Carling TS, Lisgar TS and Riverdale TS including projects like the Ottawa Hospital's New Campus

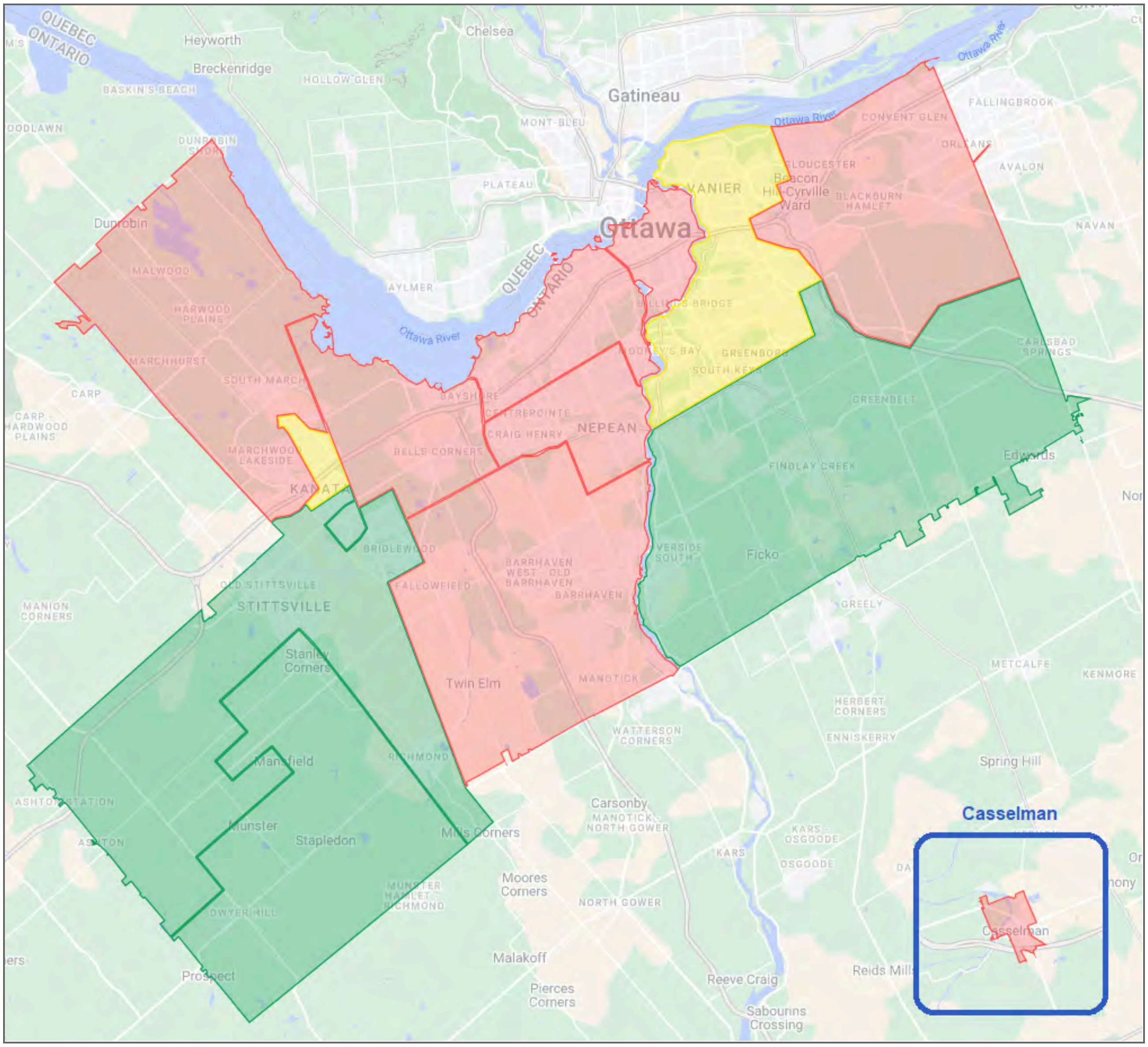
In conclusion, capacity investments identified through the immediate needs assessment as in Section 9.1.2 - Immediate Needs Assessment are efficiently sized to meet projected needs through 2035, maximizing long-term efficiency, as each new station is expected to remain in service for at least 50 years. The incremental cost of appropriately sizing infrastructure for the long term ensures efficient capital deployment and avoids premature rebuilding.

9.1.4. Investments by Planning Region

Hydro Ottawa's distribution system comprises several subsystems, or planning regions, segmented by operating voltage and geographic boundaries, typically aligned with pre-amalgamation utility demarcations as described in Section 6.2.3 - Planning Regions. Detailed summaries of each planning region follow.

Figure 72 visually represents capacity constraints in each of the planning regions based on the IRRP forecast. Red-highlighted regions indicate the highest concern, with projected loads exceeding planning limits within five years (by 2030). Yellow-highlighted regions represent moderate concern, with limits expected to be exceeded within five to ten years (2035). Green-highlighted regions are of least concern, not projected to exceed limits within ten years.

Figure 72 - Heatmap of Capacity Needs



In each of the planning region sub-sections below, there is first a figure of the region and then a second figure to assess the regional needs, which charts the historical weather normalized actuals (trend highlighted in green), Hydro Ottawa planning forecast (trend highlighted in blue), and the

IRRP forecast (trend highlighted in orange) and load inquiries received to date (trend highlighted in purple) over the Rate Application period.

9.1.4.1. 44 kV System

The 44kV system covers Hydro Ottawa's entire service area (excluding Casselman), fed by three stations: Hawthorne TS, Nepean TS, and South March TS.

This system serves numerous large commercial and industrial customers, as well as downstream 8kV, 12kV and 28kV distribution stations. Figure 73 shows the locations and supply areas of the 44kV stations. South March TS supplies the west, Nepean TS supplies the south, and Hawthorne TS supplies the east. There are distribution ties between South March TS and Nepean TS feeders, as well as between Nepean TS and Hawthorne TS feeders.

Figure 73 - 44kV Supply Region

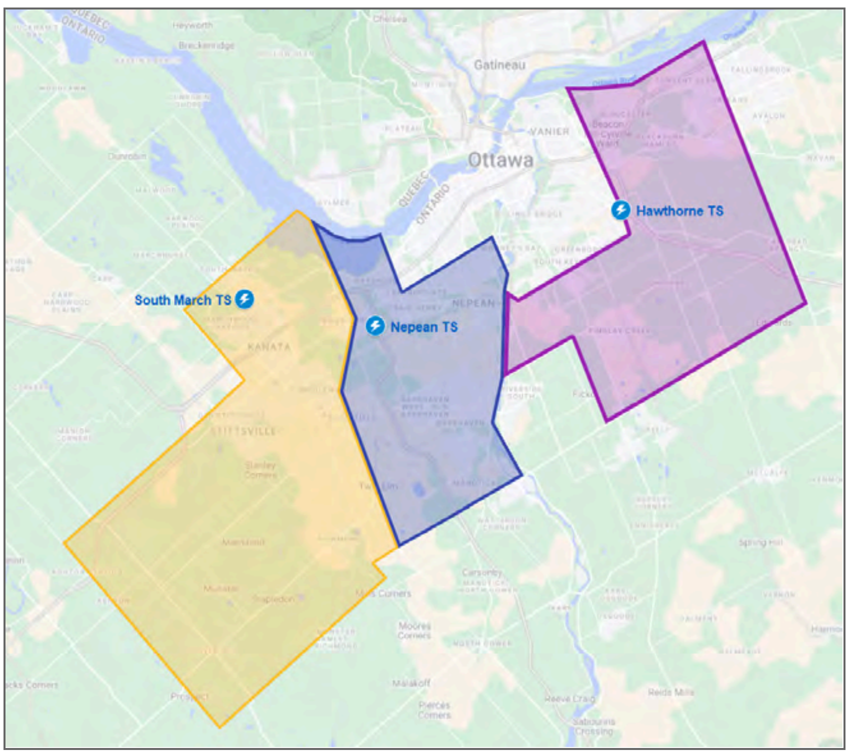


Figure 74 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the 44kV region out to 2035. There are some factors that will reduce this region's load in the coming years mainly due to voltage conversions from the 8kV and 12kV system to the 28kV system and with the planned energization of Piperville TS in 2026, some load will be transferred from Leitrim TS, reducing Hawthorne's total load. However, with natural load growth on the remaining connected 8kV stations and forecasted growth and electrification in the region, the overall region load is expected to increase.

Figure 74 - 44kV Planning Forecast and IRRP Forecast

Investments that will increase the capacity of the 44kV region are listed below:

- **South March TS Upgrade (Hydro One Investment)**
  The South March TS's two 230kV/44kV transformers, commissioned in 1971, need to be replaced due to their asset condition. Given the forecasted developments on the connected stations and overall system electrification that is expected, increasing the transformer capacity is required to meet the long-term demand forecast.
- **New Hydro Road Station (System Access - System Expansion)**
  To support a large load request (OC Transpo's Zero Emission Buses[31]), Hydro Ottawa is constructing a 100 MVA, 230kV to 44kV substation with six feeders, scheduled to be energized in 2027. For more details on the need and justification of this investment please refer to Section 4 of Schedule 2-5-6 - System Access Investments.

These investments align with the Needs Assessments conducted by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

[31] Ottawa-Carleton Transportation, "Zero-Emission Bus," https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/

9.1.4.2. 28 kV System

Hydro Ottawa's 28kV supply system is comprised of five main areas:

1. South 28kV System
2. South-East 28kV System
3. East 28kV System
4. West 28kV System
5. West 28kV (North) System

9.1.4.2.1. South 28kV

The South 28kV supply region, as shown in Figure 75, covers the areas of Nepean south of the Greenbelt. It is supplied by Fallowfield MTS, Longfields DS, Limebank MTS, and Cambrian MTS. Despite the physical barrier of the river between Nepean and Gloucester, Limebank station plays an essential role in supplying both sides of the river, making it one integrated supply region.

Figure 75 - South 28kV Supply Region

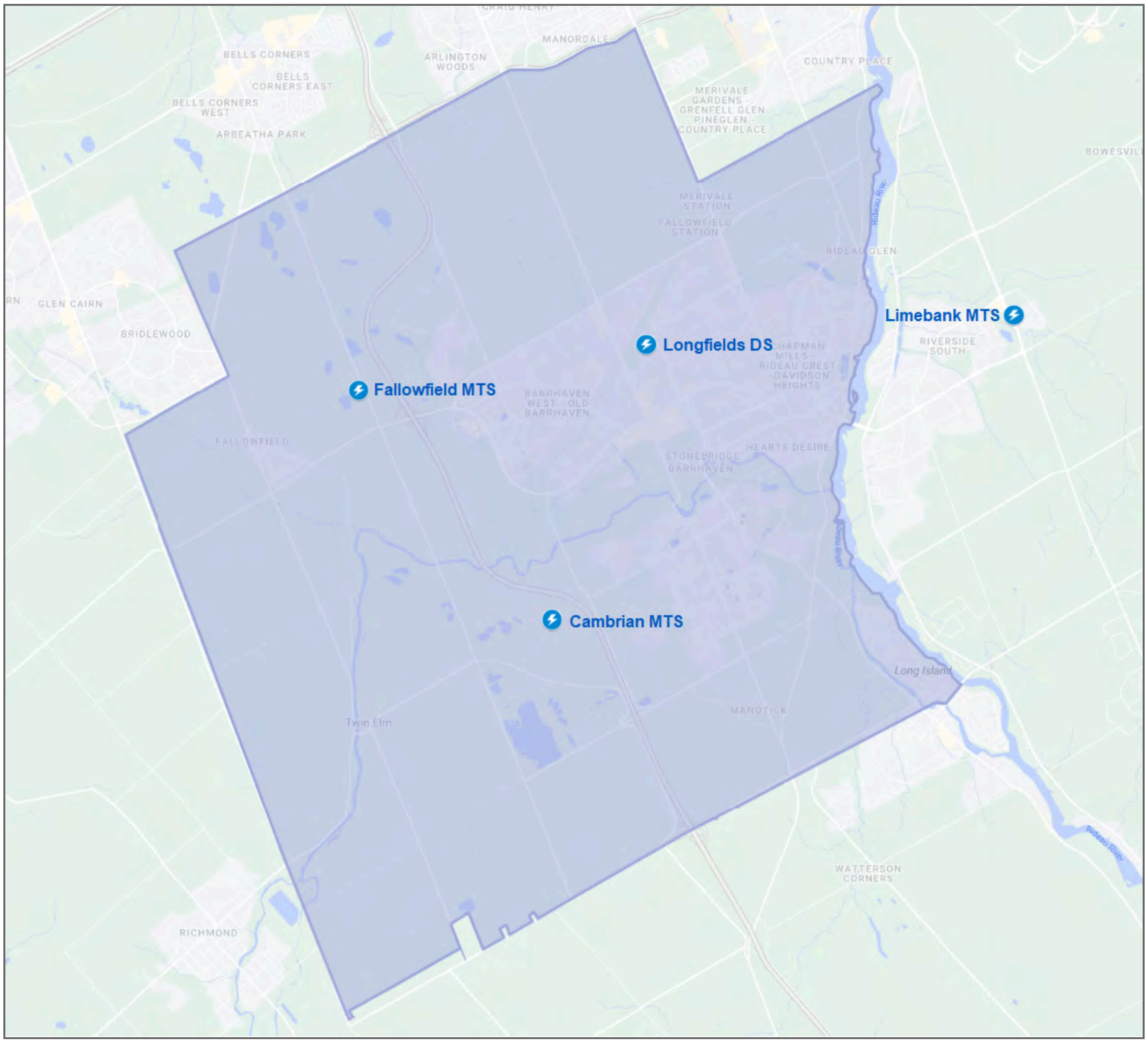
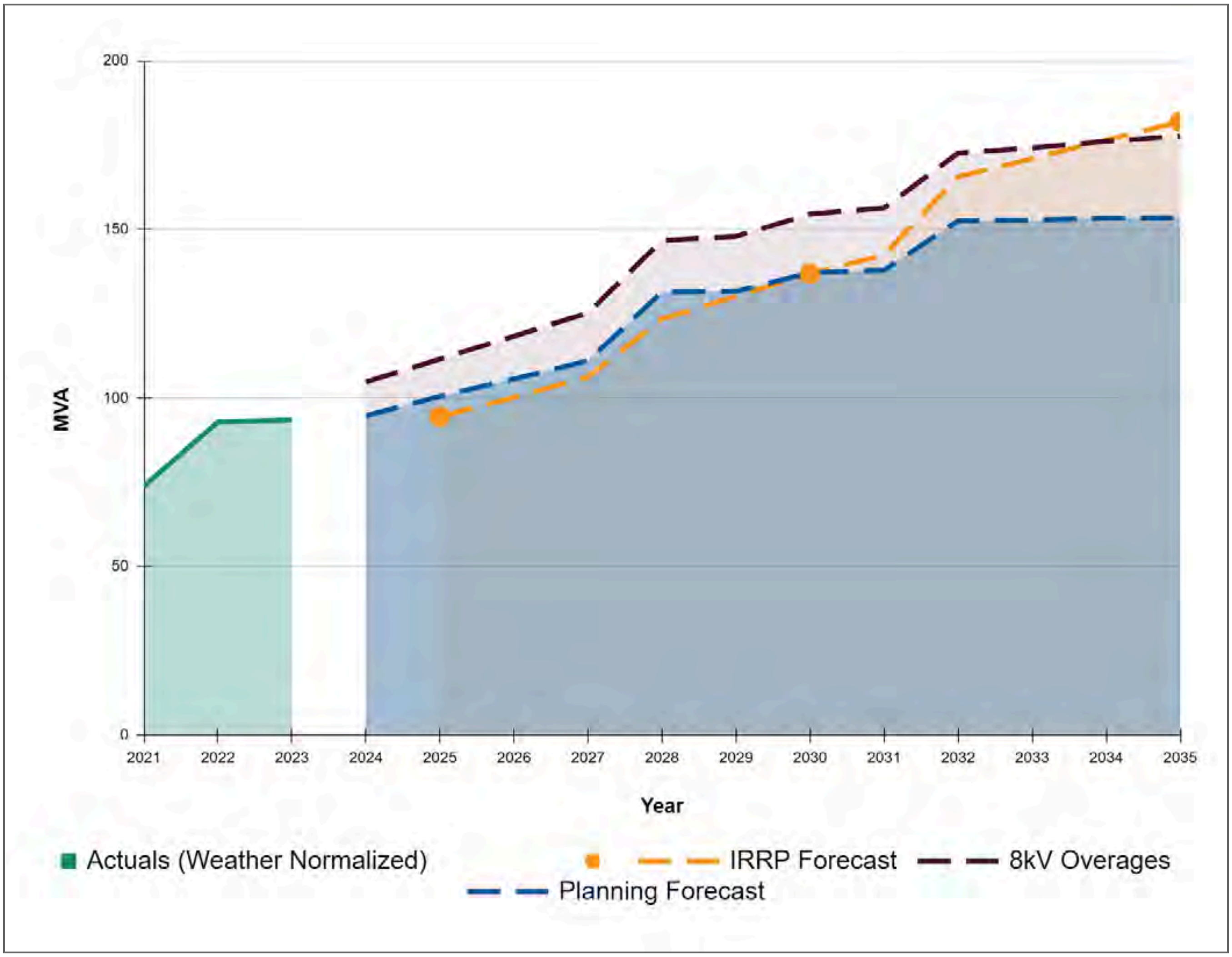


Figure 76 shows the weather normalized actuals, the planning forecast, the IRRP forecast and the new loads to be transferred from 8 kV overloaded stations, which represent the 28 kV Planning Forecast plus the additional capacity needed to address the overloaded 8 kV system for the region out to 2035.

Figure 76 - South 28kV Planning Forecast and IRRP Forecast



Energizing Cambrian MTS in 2022 has relieved the immediate capacity constraints just in time for Fallowfield MTS to reach its rated capacity in 2021. The increase in the South 28kV region's load between 2021 and 2023 can be explained by the transfer of load from Limebank MTS. Limebank MTS forms part of the South-East 28kV region and supported the South 28kV region while Cambrian MTS was being built; as such, post-energization, this load was transferred back to Cambrian MTS. The region is anticipating a large load request,[32] a laboratory facility staging major energizations in 2028 and 2032.

New Greenbank MTS (System Service-Capacity Upgrade)

A new 230 kV-connected 28 kV station with 100 MVA capacity and eight new feeders is proposed in the South 28kV region. This station is scheduled to be energized in 2028. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 System Service Investments.

This capacity upgrade aligns with the Needs Assessments completed by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties. A comprehensive transmission supply evaluation, conducted with Hydro One and the IESO through the regional planning process, will determine the most feasible and reliable power delivery option for the new substation.

[32] Government of Canada, "Government of Canada invests in laboratories to support science in Canada." https://www.canada.ca/en/public-services-procurement/news/2024/03/

9.1.4.2.2. South-East 28kV System

The South-East 28kV supply region, encompassing southern Gloucester, is supplied by Limebank MTS, Uplands MTS, and Leitrim DS, as shown in Figure 77. Although geographically separated from Nepean by the river, Limebank MTS is crucial for supplying both areas, creating interdependence between the South 28kV and the South-East 28kV systems.

Figure 77 - South East 28kV Supply Region

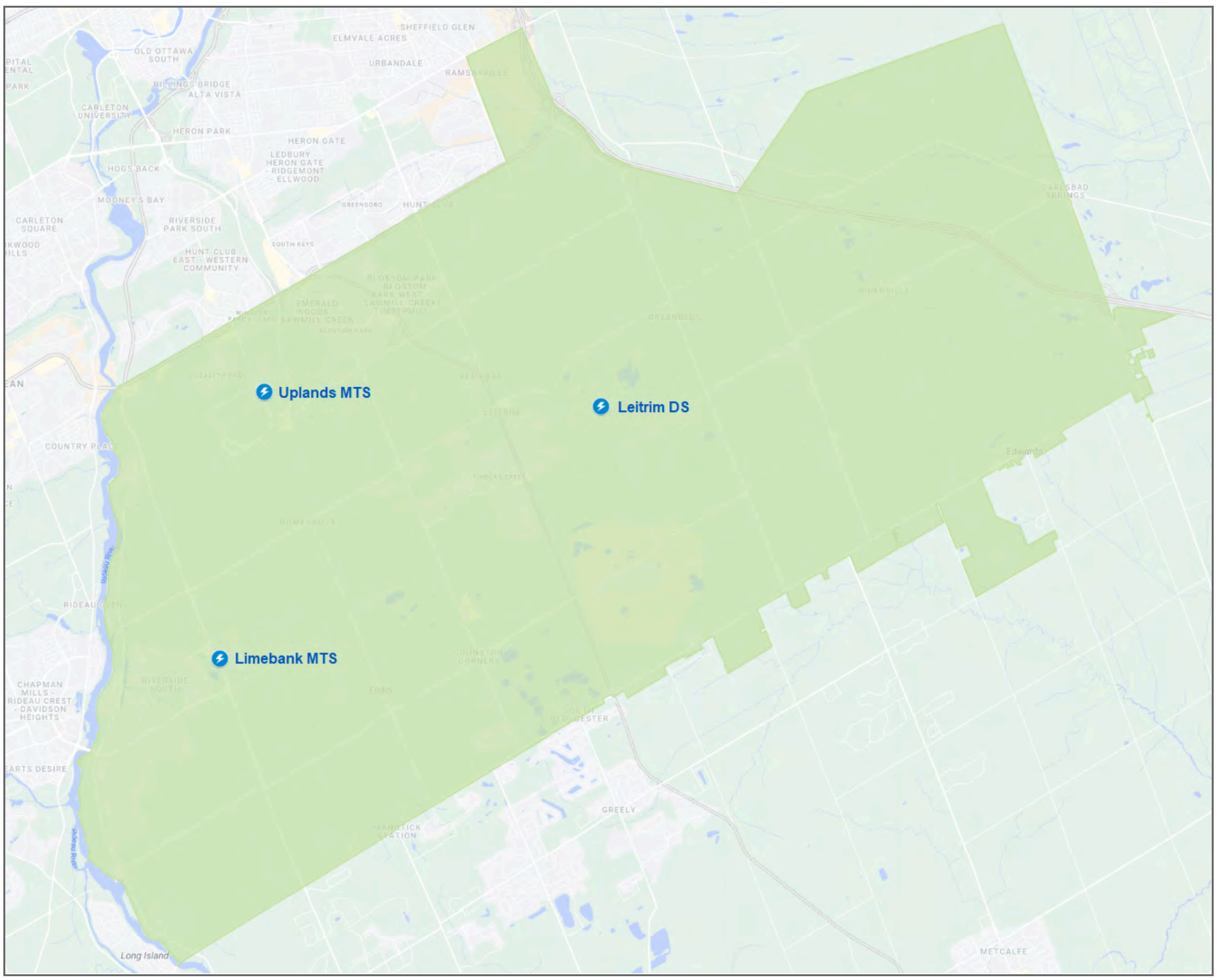
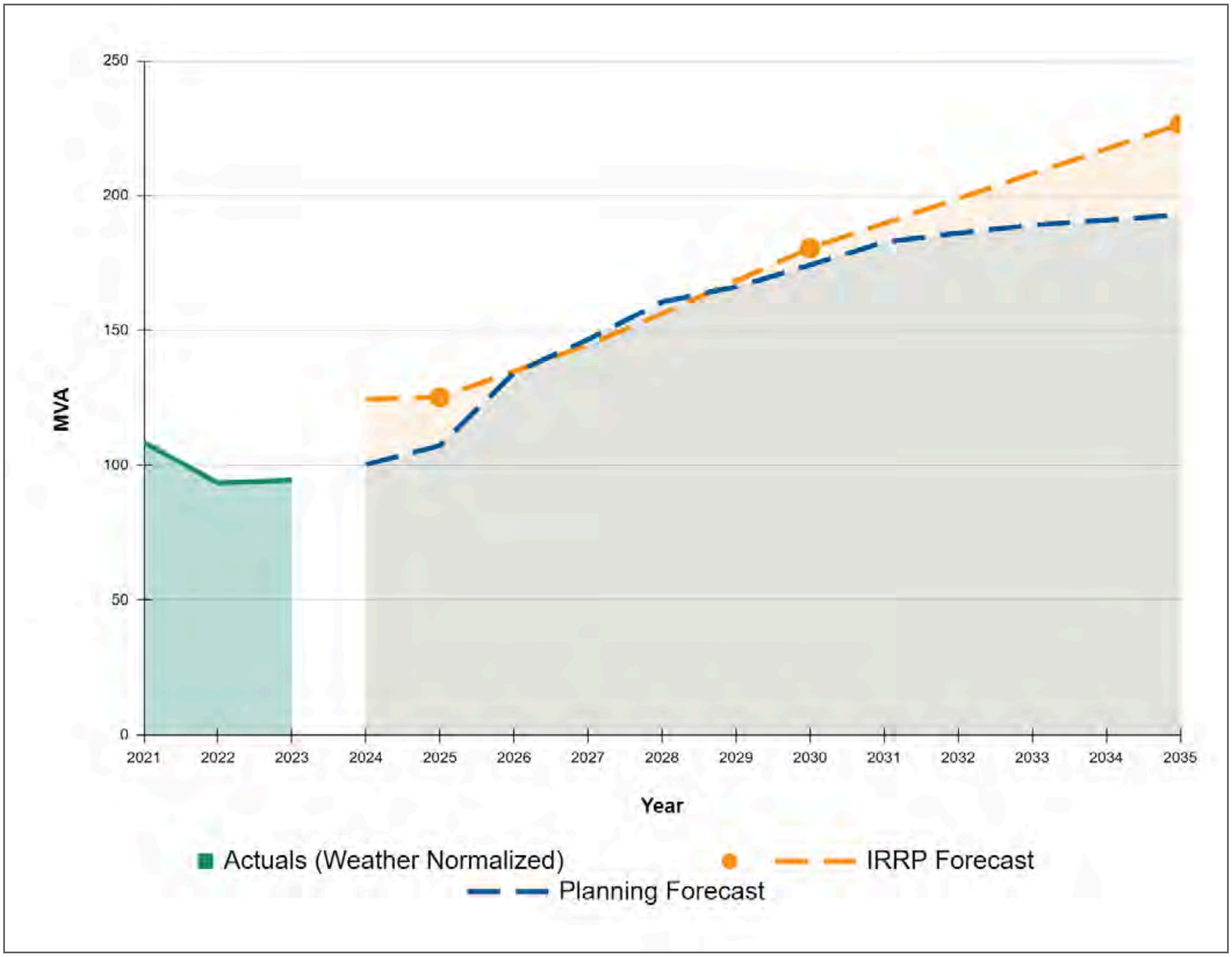


Figure 78 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 78 - South East 28kV Planning Forecast and IRRP Forecast



New Piperville MTS (System Service-Capacity Upgrade)

To accommodate growing load forecast in the South-East region, shown in Figure 78, the new Piperville MTS is under construction, with planned energization in 2026. This project, approved as part of the 2021-2025 Rate Application, will be a 230kV-connected station with two 100 MVA transformers and capacity for eight new feeders. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This capacity upgrade investment is consistent with the Needs Assessments conducted by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties. A comprehensive transmission supply evaluation, in collaboration with Hydro One and the IESO, was completed to determine the most feasible and reliable power delivery solution for Piperville MTS, ensuring its optimal operation.

9.1.4.2.3. East 28kV System

The East 28kV supply region is defined by the former Gloucester and Ottawa municipal boundary and Highway 417 to the south. The region is supplied by transmission-connected 28kV stations Cyrville MTS, Bilberry TS, Orleans TS, and Moulton MTS, as shown in Figure 79. Hydro Ottawa also owns a single 28kV circuit from Hydro One's Orleans TS station, which supports the region.

Figure 79 - East 28kV Supply Region

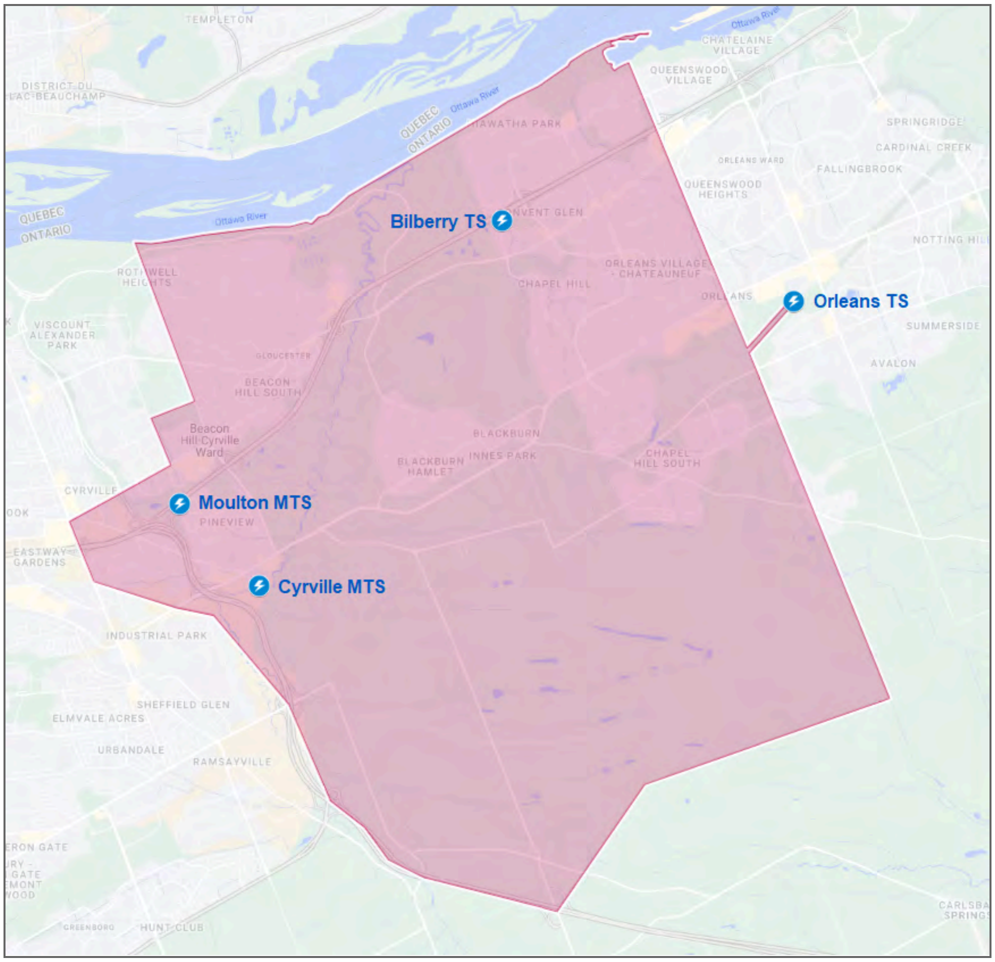
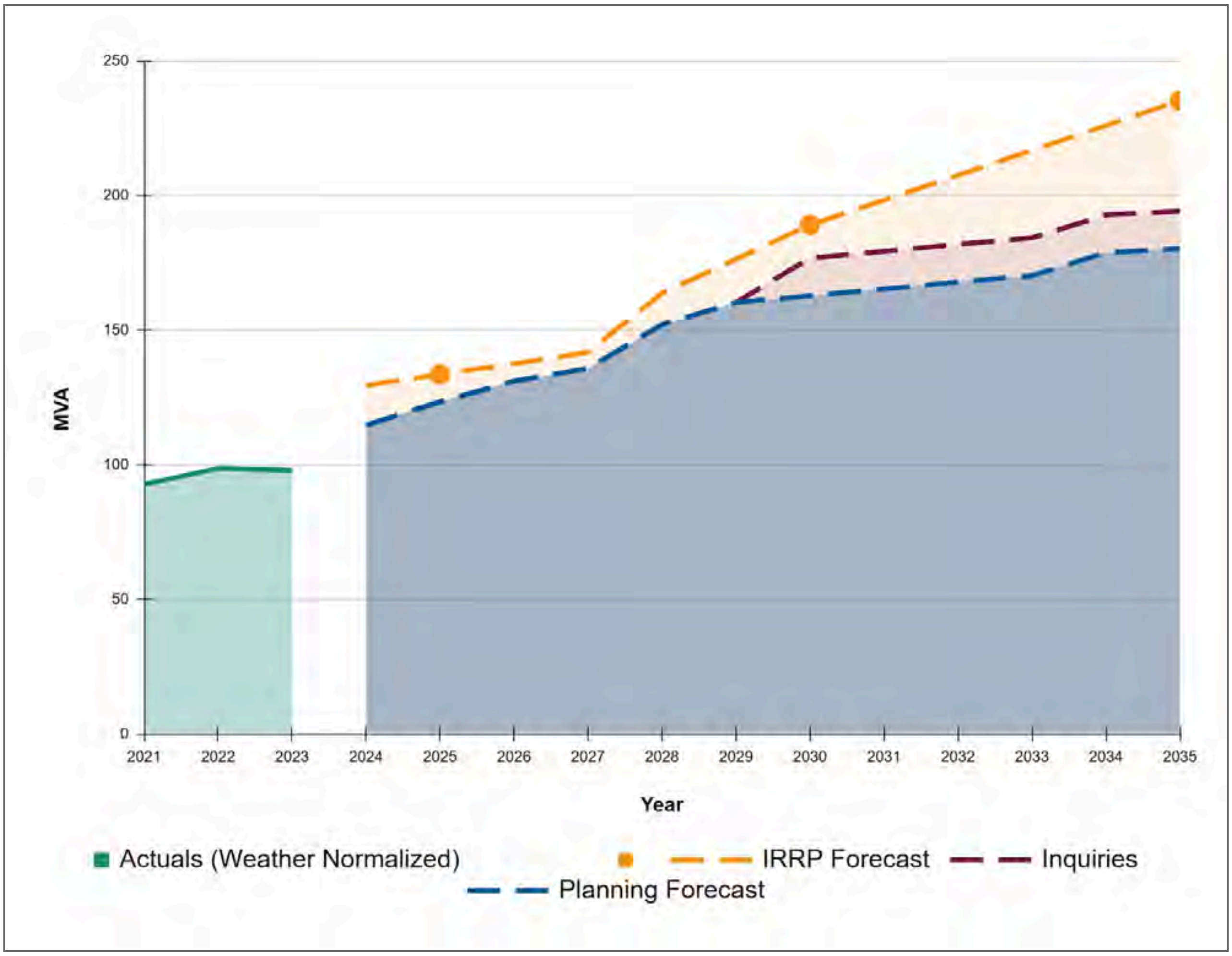


Figure 80 illustrates the weather normalized actuals, the planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

Figure 80 - East 28kV Planning Forecast and IRRP Forecast



New Mer Bleue MTS (System Service-Capacity Upgrade)

Hydro Ottawa will energize a new station in 2028, Mer Bleue MTS. The station will include two 100 MVA transformers and eight feeders. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This capacity upgrade investment is consistent with the Needs Assessments by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 -

Coordinated Planning with Third Parties. A joint transmission supply evaluation with Hydro One and the IESO through the regional planning process is underway to determine the most feasible and reliable power delivery option for Mer Bleue MTS.

Cyrville MTS Upgrade (System Service-Capacity Upgrade)

The existing Cyrville MTS is proposed to be upgraded by replacing two existing 50 MVA transformers with 100 MVA by 2028 to cater to a large load request.[33] For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This capacity upgrade aligns with the IRRP working group Needs Assessments as part of the regional planning process. A comprehensive transmission supply evaluation, conducted with Hydro One and the IESO, will determine the most feasible and reliable power delivery solution for the upgraded Cyrville MTS.

9.1.4.2.4. West 28kV System

The West 28kV supply region encompasses the majority of Kanata South, most of the township of Stittsville, and the western region of Goulbourn. These areas are supplied by Bridlewood MTS and Terry Fox MTS in Kanata South, Janet King DS in Stittsville, and the BECK-F2 feeder, supplied from Hydro One-owned Beckwith DS, in Goulbourn, as shown in Figure 81. Upon completion, the upgraded Richmond South MTS will provide 28kV supply to the Richmond area, which is currently supplied at 8kV.

[33] Government of Canada,"Government of Canada announces milestones for new science facilities in National Capital Area" https://www.canada.ca/en/public-services-procurement/news/2024/07/government-of-canada-announces-milestones-for-new-science-facilities-in-national-capital-area.html

Figure 81 - West 28kV Supply Region

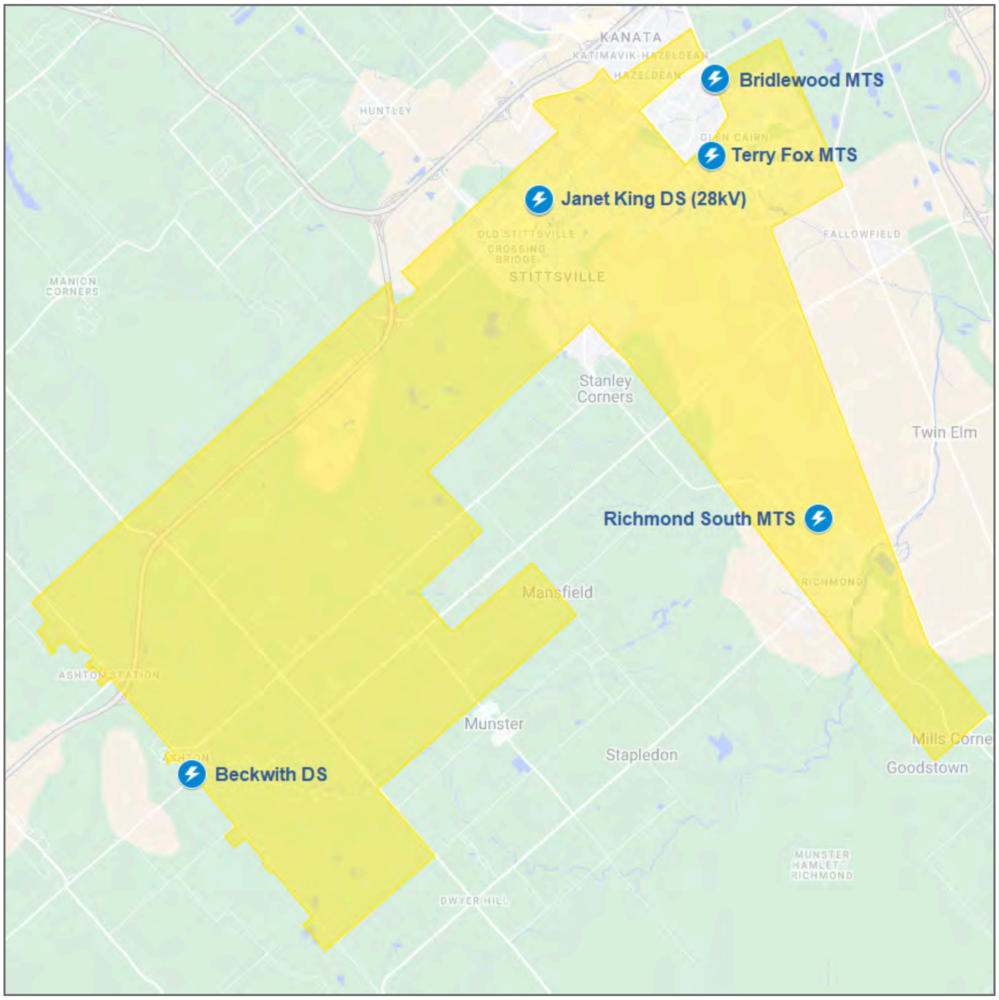
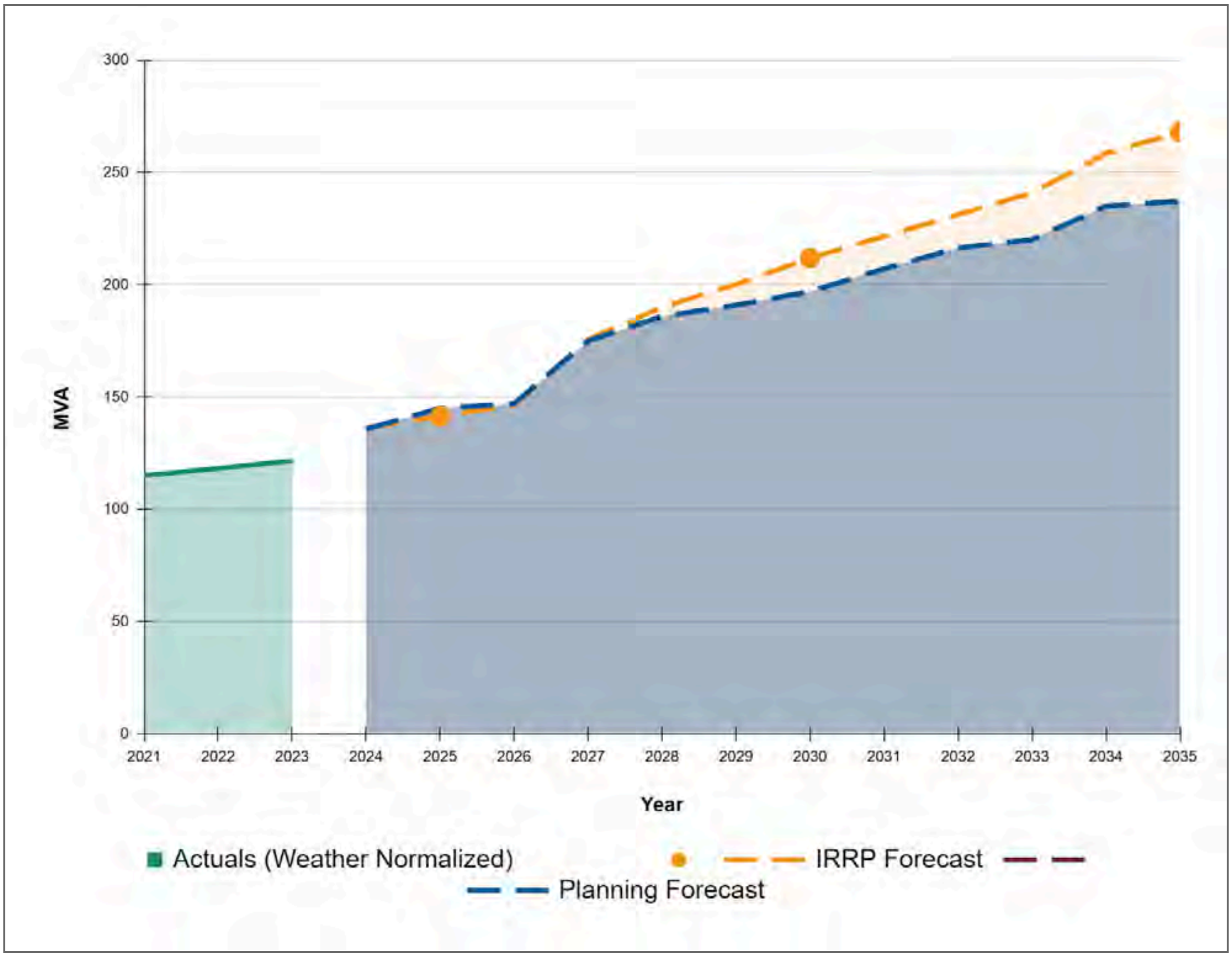


Figure 82 the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. primarily due to the large load from the Department of National Defence in this area, coupled with ongoing electrification and development projects.

Figure 82 - West 28kV Planning Forecast and IRRP Forecast



Richmond South MTS Station Upgrade (System Access - System Expansion)

The Richmond South MTS station upgrade and feeders expansion addresses a large load request from the Department of National Defence.[34] For more details on the need and justification of this investment please refer to Section 4.3.2 of Schedule 2-5-6 - System Access Investments.

[34] Department of Nation Defence, “Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure,” https://www.canada.ca/en/department-national-defence/news/2023/03/

Non-Wires Solutions

A 2.5MW utility owned BESS is being proposed for this region. For more details on the need and justification of these solutions refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.2.5. West 28kV (North) System

The West 28kV (North) region encompasses the areas supplied by Kanata MTS and Marchwood MTS, both located at the Station Road site in Kanata North, as shown in Figure 83.

Figure 83 - West 28kV (North) Supply Region

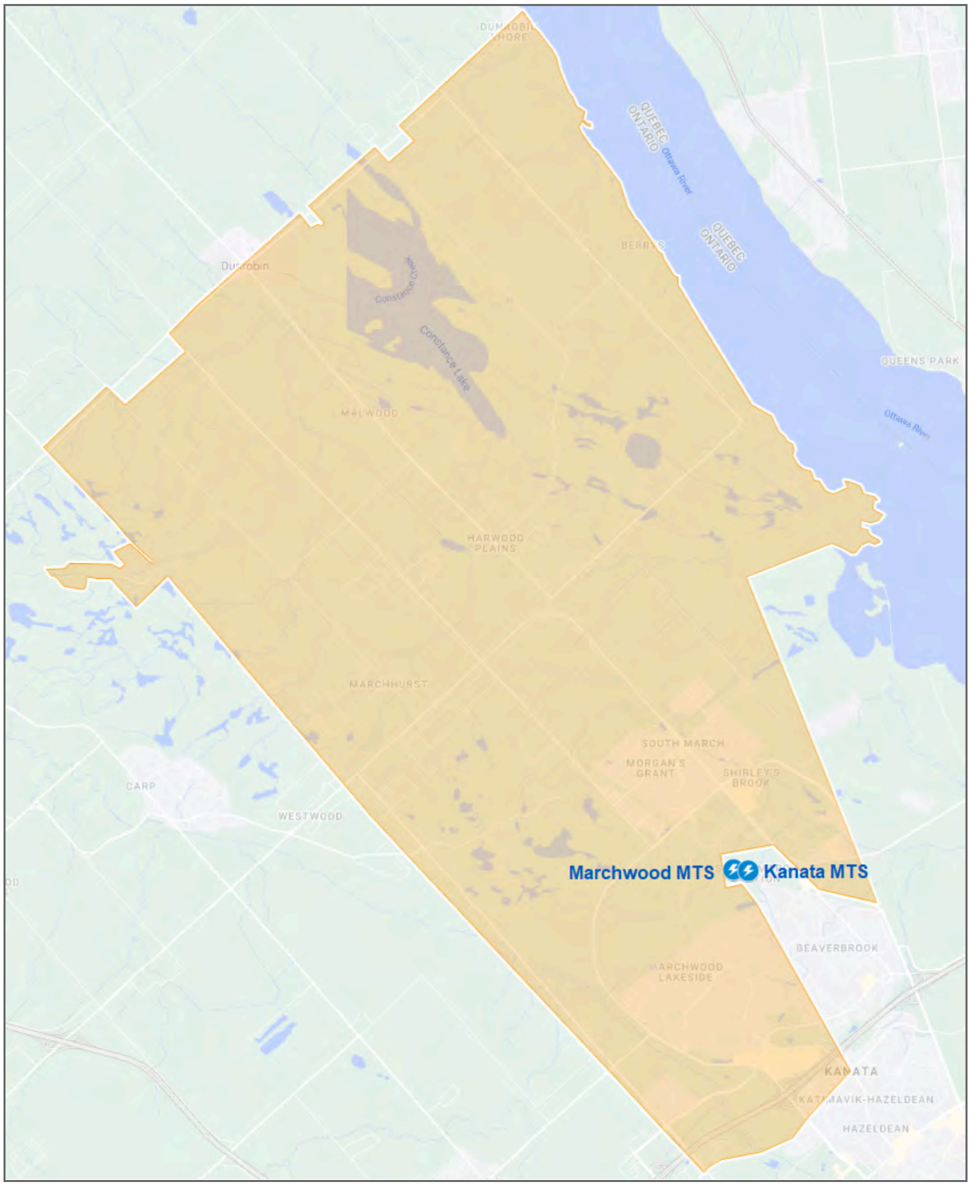
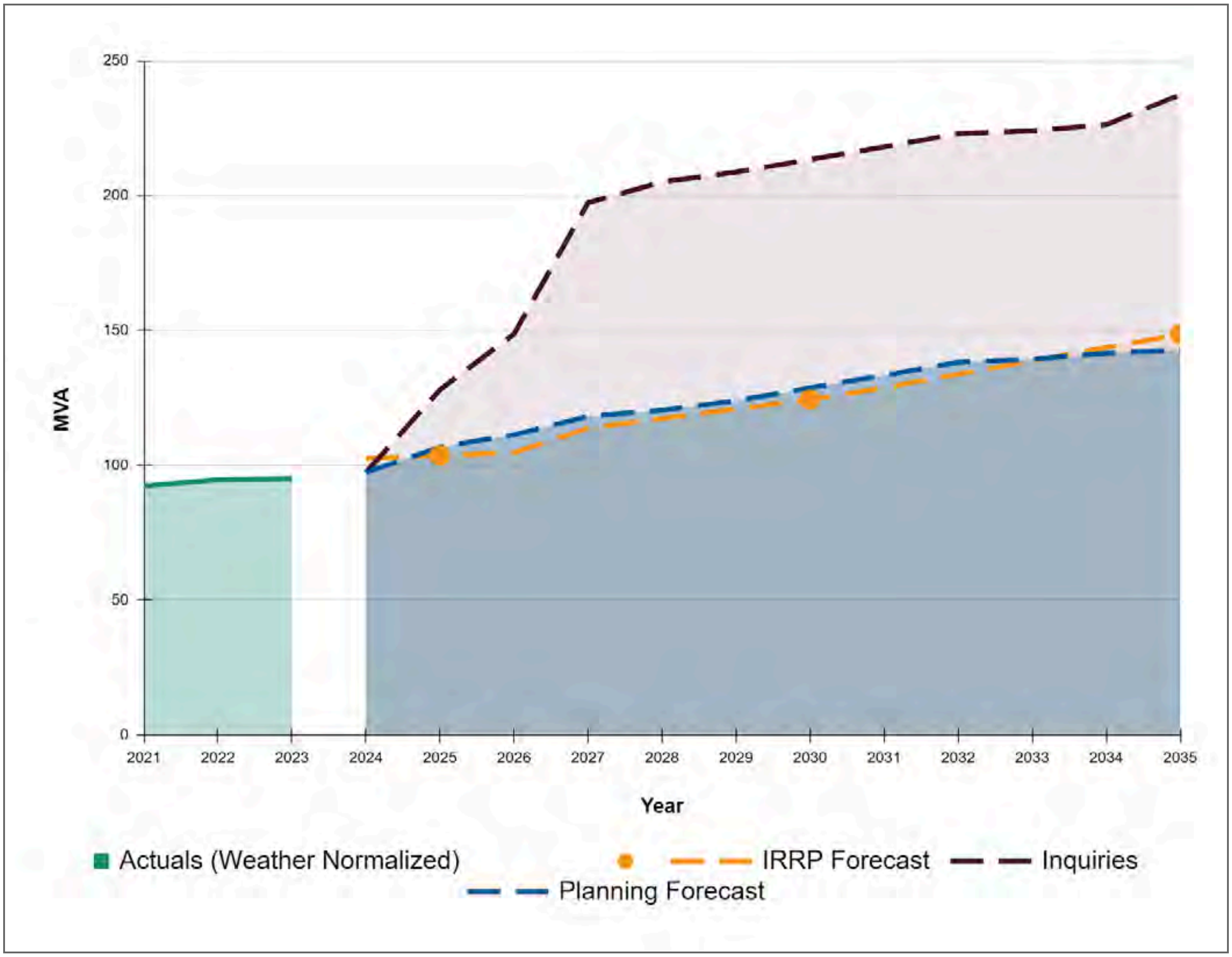


Figure 84 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

Figure 84 - West 28kV (North) Planning Forecast and IRRP Forecast



Since completing the planning forecast, Hydro Ottawa has seen increased data center connection requests in the region. While increased data center load is expected, market uncertainty exists regarding grid connectivity versus on-site generation and load growth within the service territory. Given these uncertainties, Hydro Ottawa will continue to monitor and assess the need as the market evolves.

New Kanata North MTS (System Service-Capacity Upgrade)

A new 230 kV-connected 28 kV station with 100 MVA capacity and eight new feeders is proposed in the West 28kV (North) region. This station is scheduled to be energized in 2028. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This investment aligns with the Needs Assessments completed by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties. A joint transmission supply evaluation with Hydro One and the IESO through the regional planning process is underway to determine the optimal power delivery solution.

Non-Wires Solutions

Non-Wires Customer Solutions are being evaluated to provide peak demand support as an interim measure to manage capacity constraints. For more details on the need and justification of these solutions refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.3. 8 kV System

Hydro Ottawa 8kV supply system is comprised of five main regions:

1. Nepean 8kV
2. Bells Corners/Bayshore 8kV
3. Barrhaven 8kV
4. West 8kV
5. Casselman 8kV
6. East 8kV

Of the twenty-three 8kV stations, five are supplied by the 115kV transmission system, one is supplied by both 44kV and 115kV sources, and the remaining seventeen are supplied from 44kV.

9.1.4.3.1. Nepean 8kV System

The Nepean 8kV supply region includes the northern portions of Nepean. This region is supplied by the Manordale MTS, Centrepointe MTS, Woodroffe DS, Epworth MTS, Merivale MTS, Parkwood Hills DS, Borden Farms DS, and Rideau Heights DS. Figure 85 shows the supply region of the Nepean Core 8kV System.

Figure 85 - Nepean 8kV Supply Region

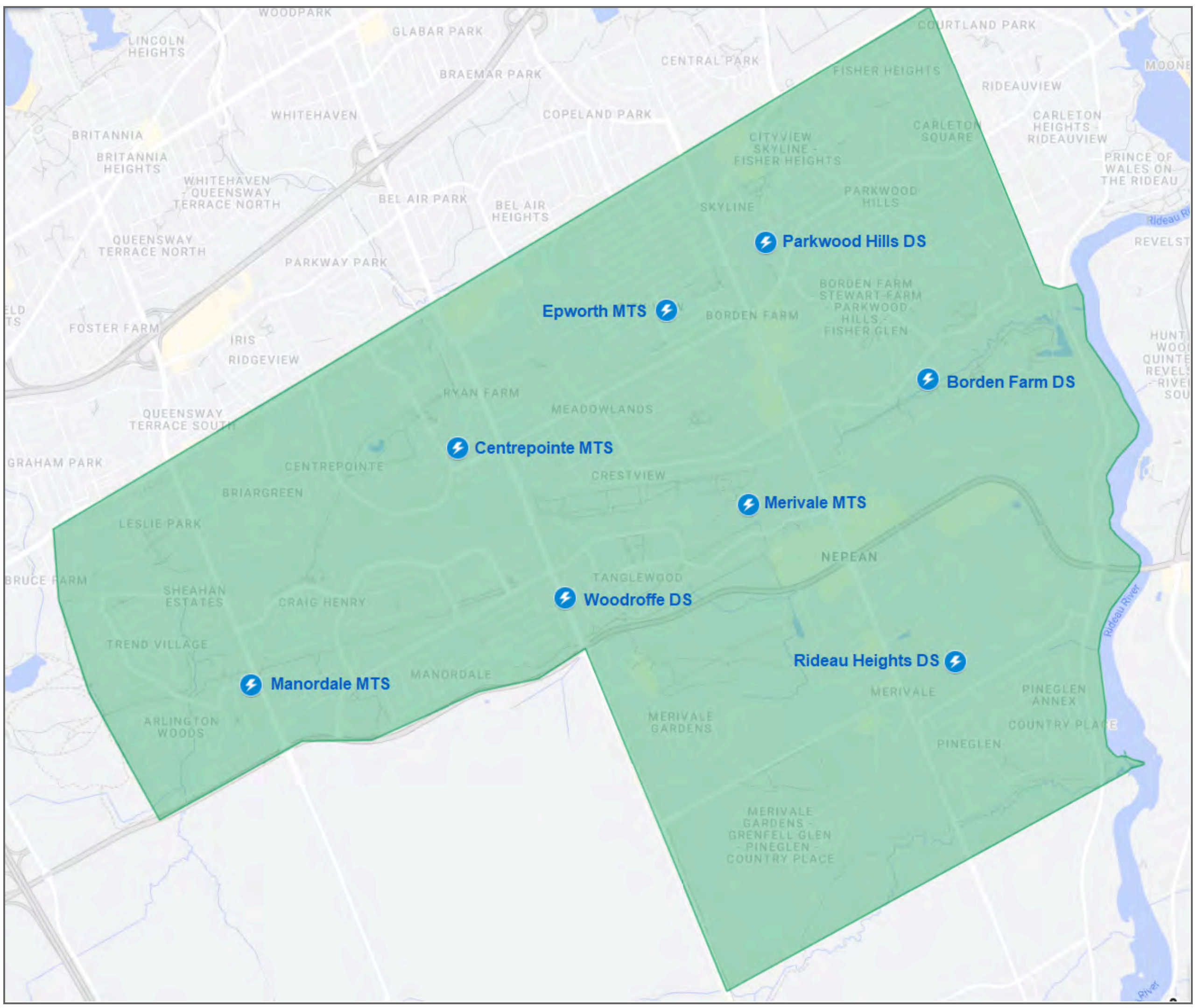
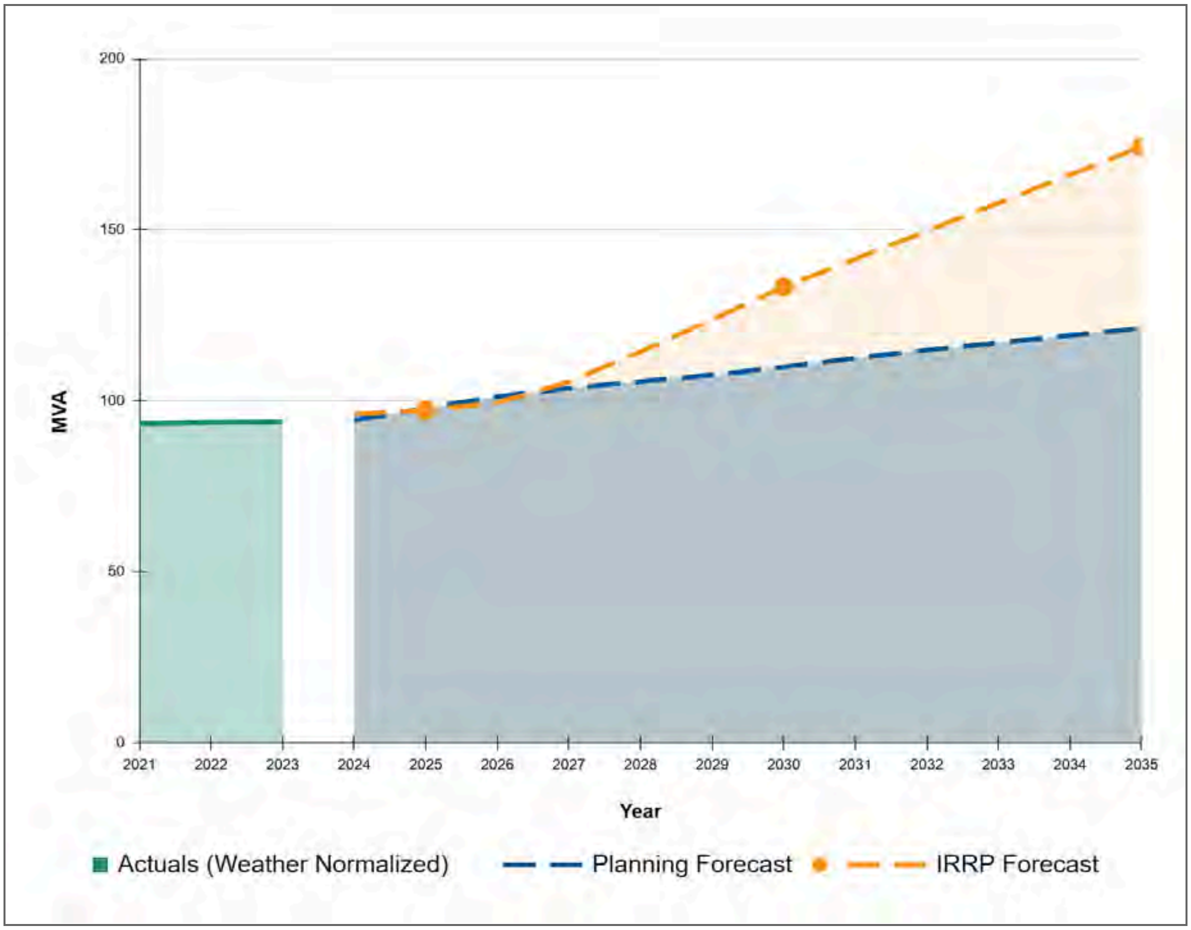


Figure 86 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. Centrepointe MTS and Manordale MTS in this region are exceeding their planning capacity ratings, as noted in Table 29 above. Growth is concentrated in the Nepean employment area, where trunk feeders are at or nearing their capacity limits and existing feeder interconnections are limited. Several feeders in this region have exceeded their planning capacity, as noted in Table 32 above.

Figure 86 - Nepean 8kV Planning Forecast and IRRP Forecast



Switching operations were performed on Parkwood Hills DS feeders in 2024 to reduce overloaded feeders below planning capacity. Similar switching operations are planned for the Borden Farm DS feeder. Rideau Heights DS has limited ties options, making load transfers difficult.

- The 8 kV system presents several challenges:
  - Compared to 28 kV, 8 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 28 kV remains effective up to 15km.
  - The maximum capacity of an 8 kV feeder is 3.6MVA, versus 16.4MVA for a 28 kV feeder, significantly limiting the ability to accommodate the large load requests.
  - Heavy loading on the 8 kV stations in the Nepean and Barrhaven regions is hindering new customer connections.

The new Greenbank MTS expected to energize in 2028 will support the growth in this region, please see further details in Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

9.1.4.3.2. Bells Corners/Bayshore 8kV System

The Bells Corners/Bayshore 8kV supply region covers the northwest portion of Nepean. This region is supplied by Bayshore DS, Queensway-Carleton Hospital (Q.C.H) DS, Stafford Road DS, and Bells Corners DS, as shown in Figure 87.

Figure 87 - Bells Corners/Bayshore 8kV Supply Region

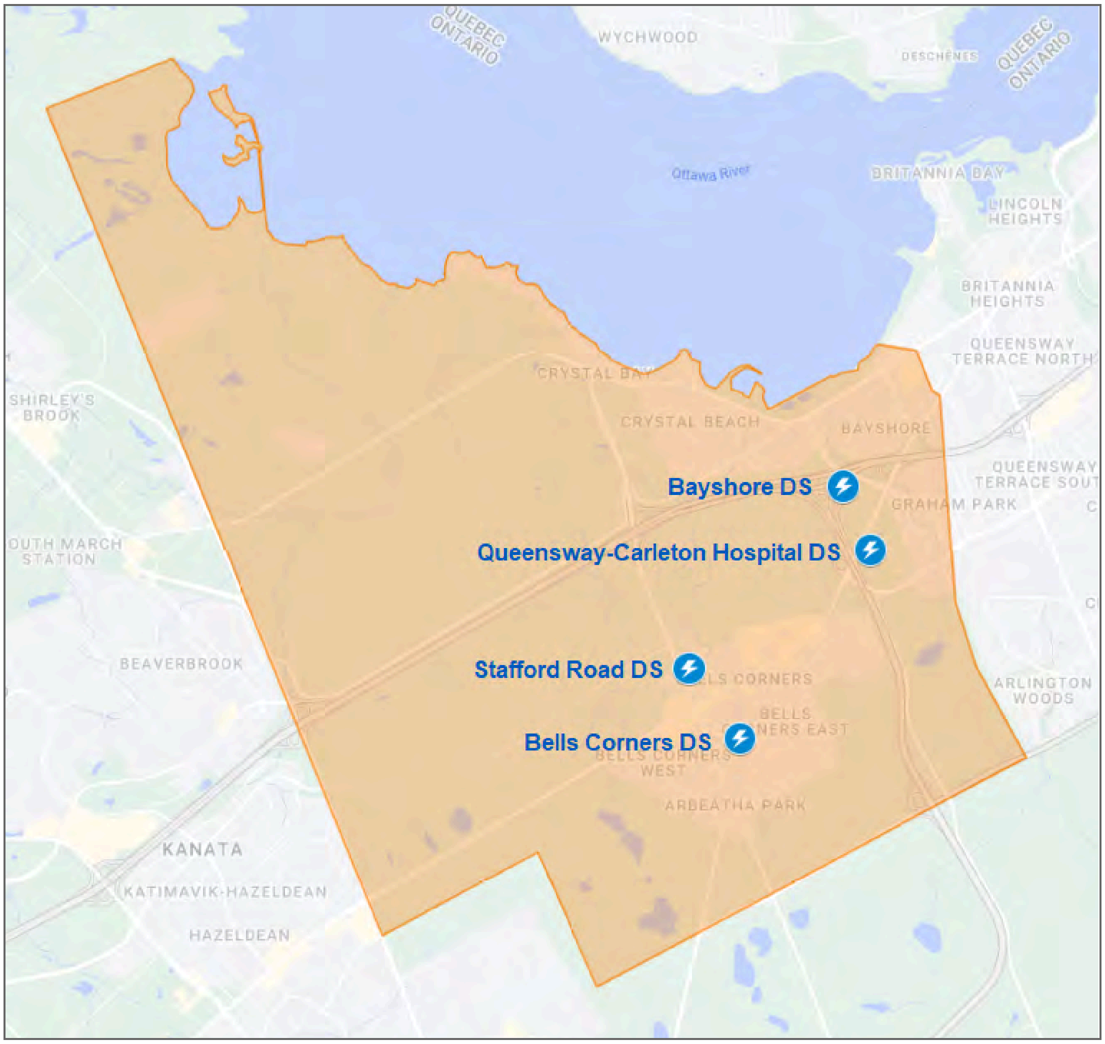
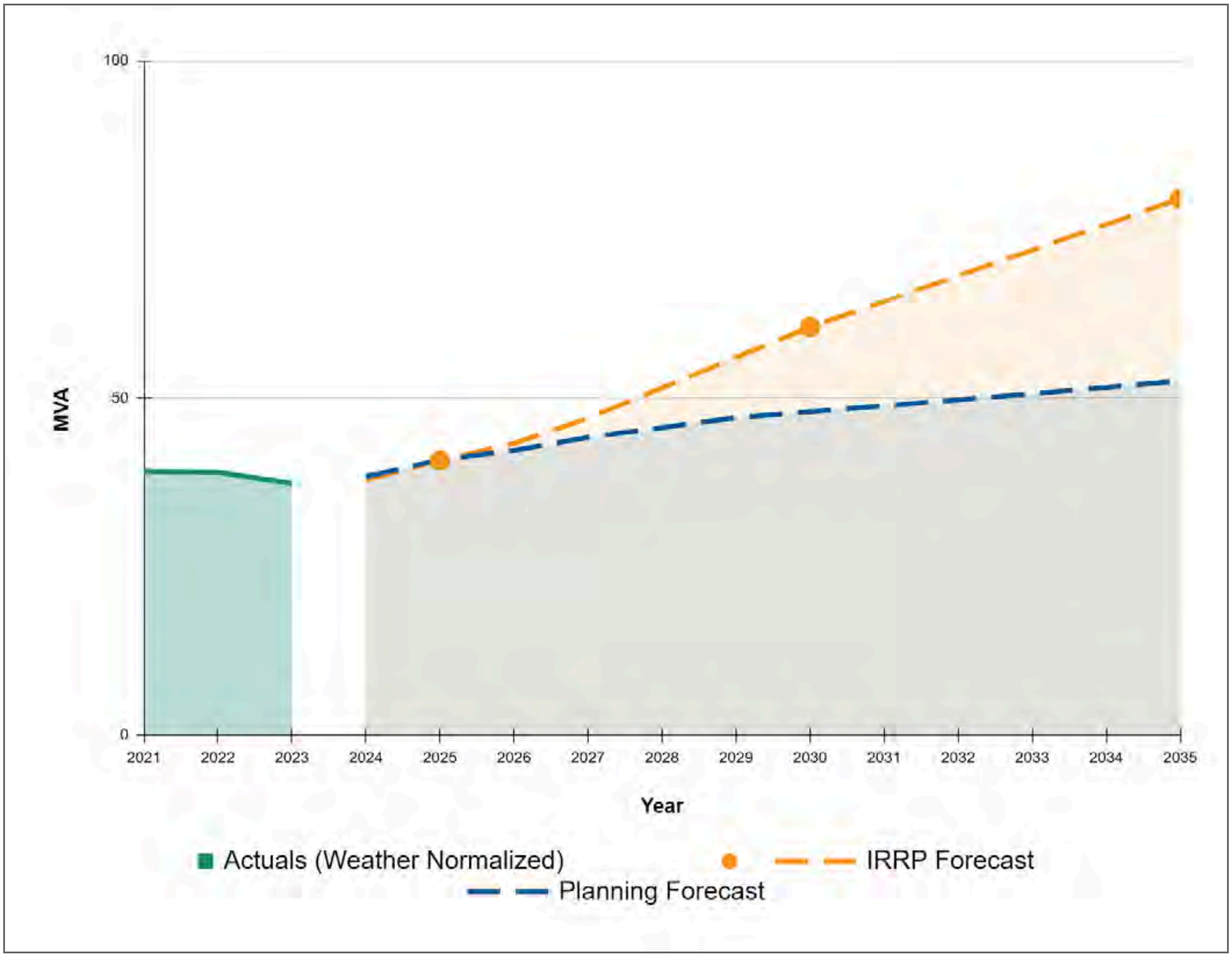


Figure 88 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. While no stations are exceeding their planning capacity, Bayshore DS and Stafford DS are approaching their limits.

Figure 88 - Bells Corners/Bayshore 8kV Planning Forecast and IRRP Forecast



Bells Corners DS underwent a full rebuild in 2023, replacing two transformers with three 12.5MVA units to facilitate the decommissioning of Stafford DS by 2026. Load from Stafford DS T2 has already been transferred to Bells Corners DS, and the T1 is scheduled for transfer in 2025 after feeder extensions from Bells Corners are completed.

Non-Wires Solutions

Hydro Ottawa proposes 7 MW of utility owned BESS to manage peak load in this region. For more details on the need and justification of this solution refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.3.3. Barrhaven 8kV System

Hydro Ottawa operates two 8kV substations in the Barrhaven 8kV region: Barrhaven DS and Jockvale DS, as shown in Figure 89.

Figure 89 - Barrhaven 8kV Supply Region

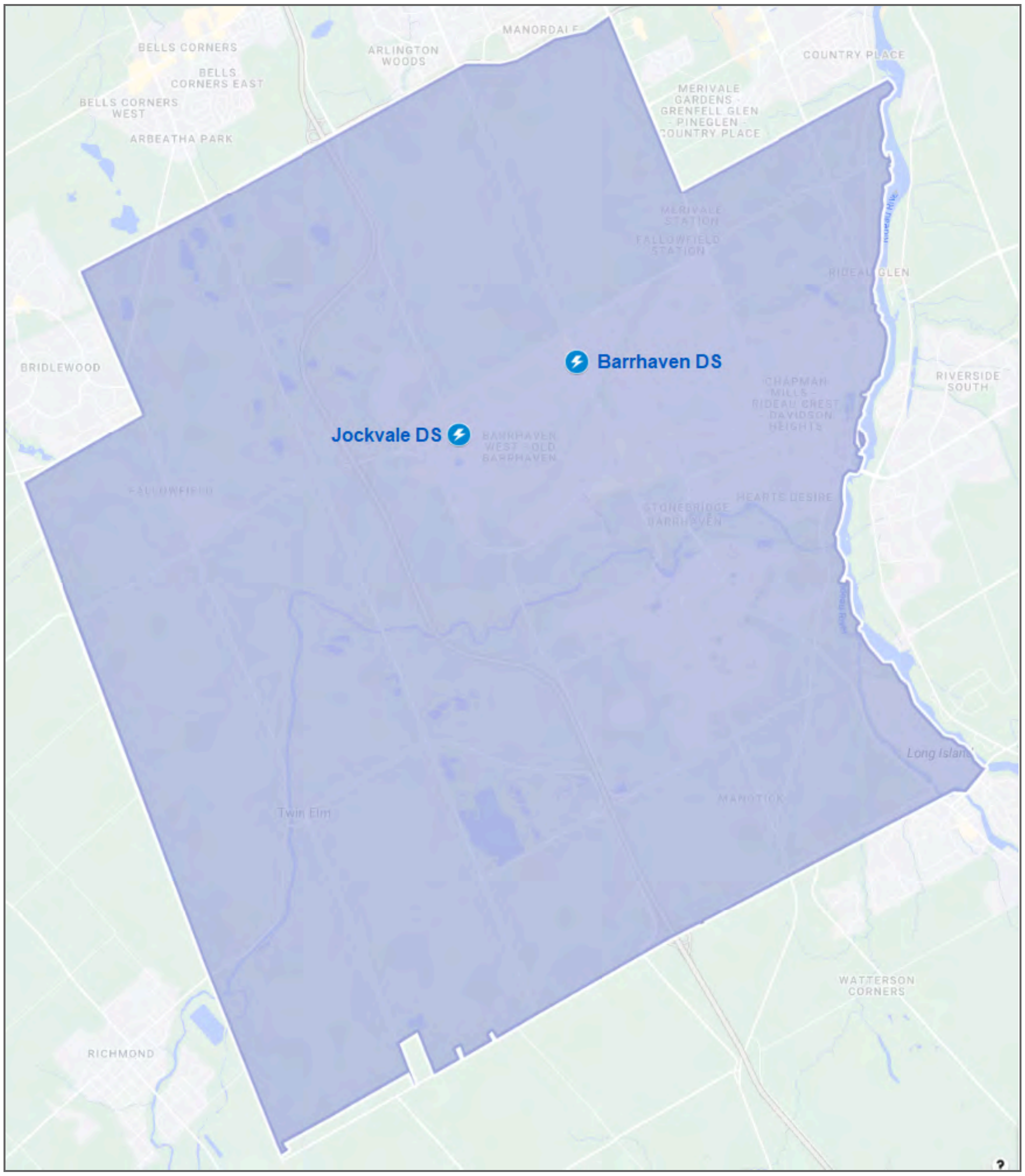
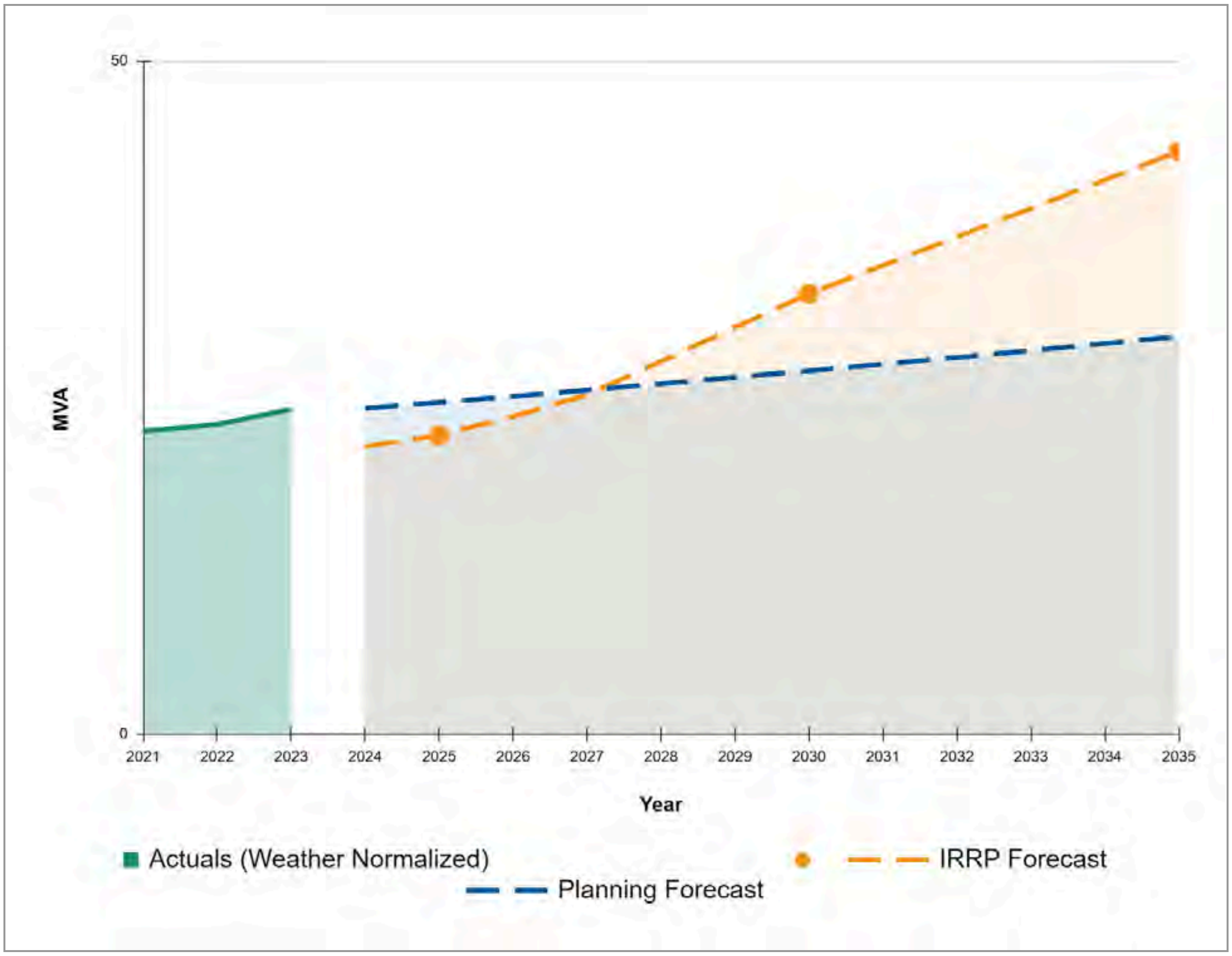


Figure 90 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. Since the Barrhaven 8kV region falls within the South 28kV supply region, most new developments will connect to the 28kV system. To address the overloaded feeders, switching operations are planned to balance the loading and customer count, ensuring all feeders operate within the established limits. Long-term plans include gradually decommissioning the Barrhaven 8kV system through voltage conversion to 28kV.

Figure 90 - Barrhaven 8kV Planning Forecast and IRRP Forecast



- The 8 kV system presents several challenges:
    - Compared to 28 kV, 8 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 28 kV remains effective up to 15km.

- ○ The maximum capacity of an 8 kV feeder is 3.6MVA, versus 16.4MVA for a 28 kV feeder, significantly limiting the ability to accommodate the large load requests.
- ○ Heavy loading on the 8 kV stations in the Nepean and Barrhaven regions is hindering new customer connections.

The new Greenbank MTS expected to energize in 2028 will support the growth in this region, please see further details in Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

9.1.4.3.4. West 8kV System

The West 8kV supply region covers Glen Cairn, parts of Stittsville, Richmond Village, Munster and rural Goulbourn. These areas are supplied by Bridlewood MTS in Kanata, Janet King DS in Stittsville, Richmond North DS and Richmond South MTS in Richmond Village and Goulbourn, and Munster DS in Munster. Figure 91 shows the supply region of the West 8kV System.

Figure 91 - West 8kV Supply Region

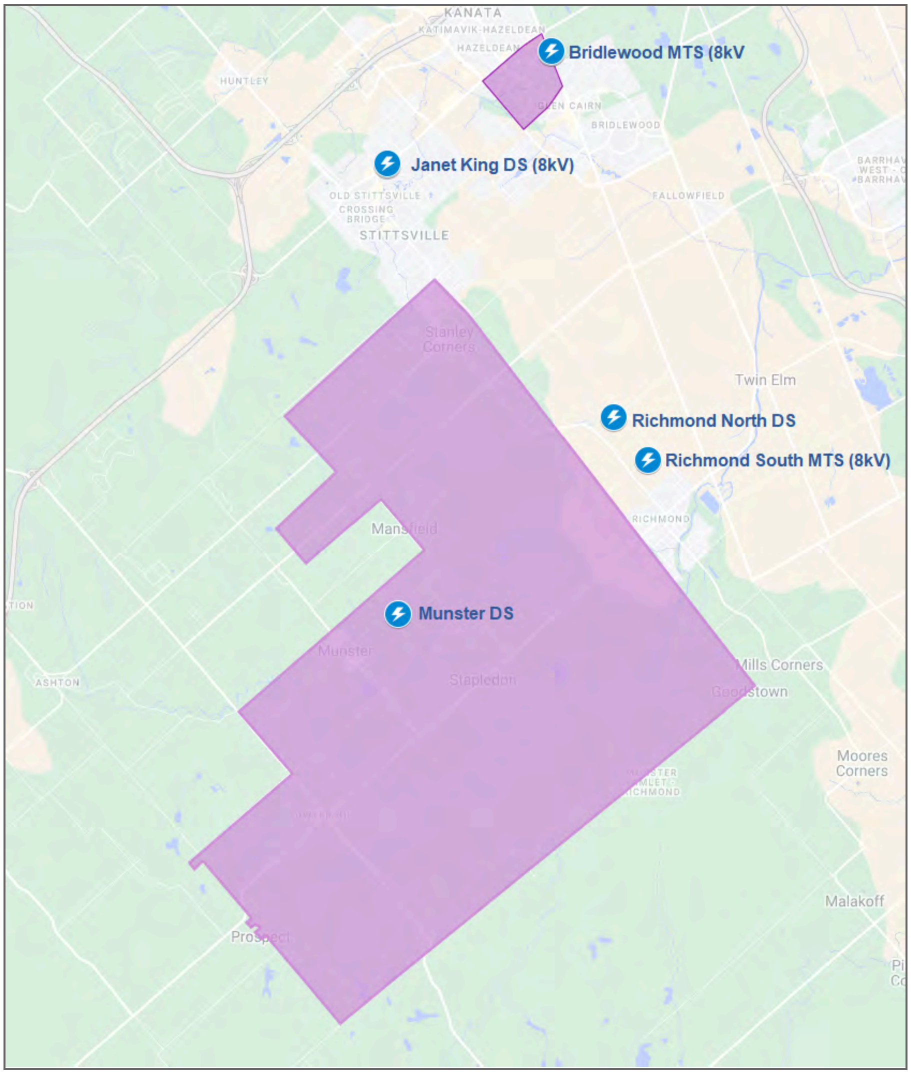
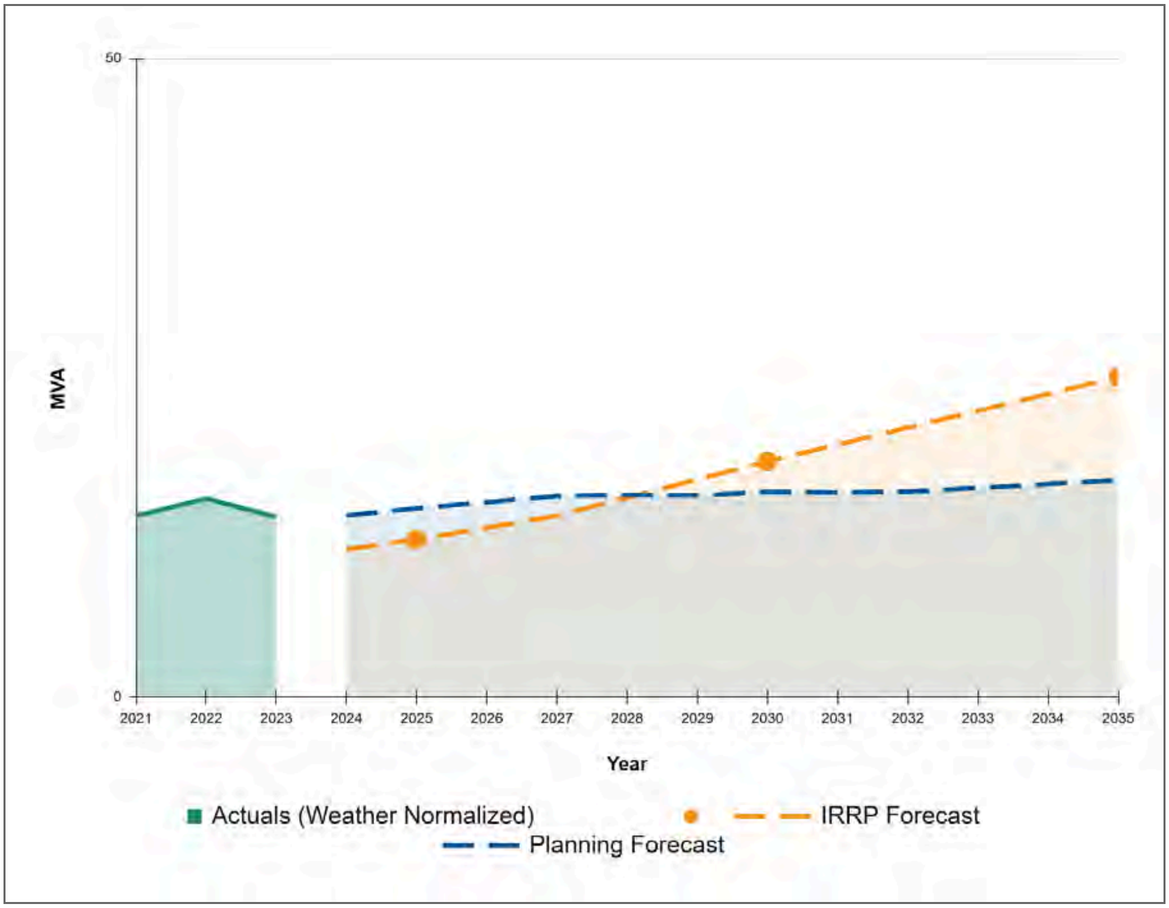


Figure 92 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 92 - West 8kV Planning Forecast and IRRP Forecast



The West 8kV area covers a large geographical region with limited backup feeder options between stations, except for Richmond North DS and the 8kV feeders from Richmond South MTS. Completed in 2019, upgrades to Richmond South MTS introduced the 28kV system in this region. The station has two 3MVA step-down transformers to supply the remaining 8kV load until the phased voltage conversion to 28kV is complete. Voltage conversion projects in this region will be done through System Renewal as assets reach end of useful life and are identified for replacement due to limitations on the 8kV system elaborated in Section 9.1.4.3.1 - Nepean 8kV system.

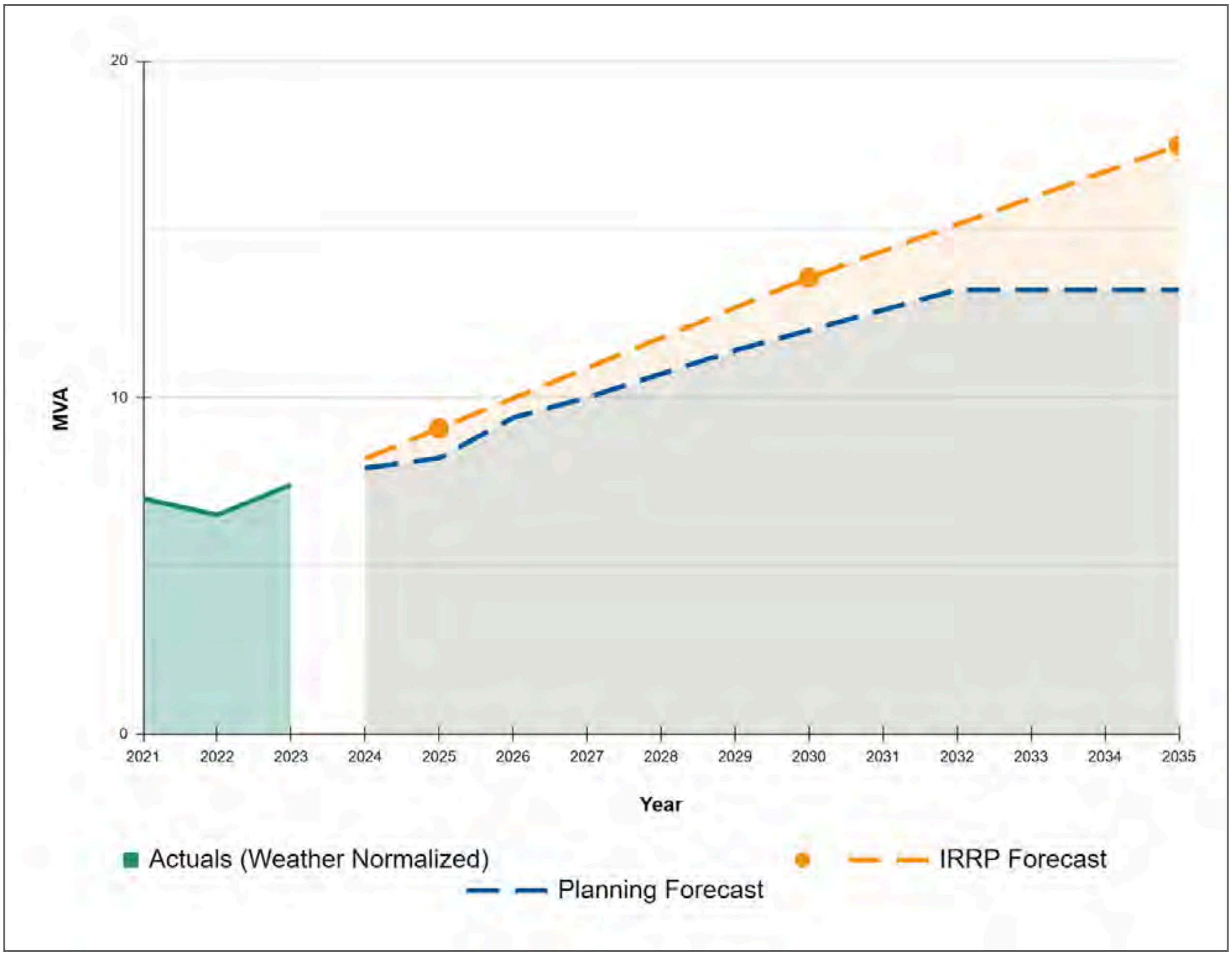
9.1.4.3.5. Casselman 8kV System

The Municipality of Casselman is supplied from a single Hydro Ottawa station, Casselman DS, via four 8kV feeders. One of these feeders serves as a dedicated backup for the others. The Casselman supply area is shown in Figure 93.

Figure 93 - Casselman 8kV Supply Region

Figure 94 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. Two feeders, CAS-F2 and CAS-F1, are overloaded, see Table 32 above. To address these issues, switching operations and new switches will balance the load among the feeders, ensuring they operate within the established limits.

Figure 94 - Casselman 8kV Planning Forecast and IRRP Forecast



Non-Wires Solutions:

Hydro Ottawa proposes a 5 MW battery to manage peak load in this region. For more details on the need and justification of this solution refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.3.6. East 8kV System

The East 8kV supply region, bounded by the former Gloucester and Ottawa municipal boundary and Highway 417 to the south, as shown in Figure 95, is served by Startop DS, Blackburn DS, and Beacon Hill DS. These stations are supplied from Hawthorne TS.

Figure 95 - East 8kV Supply Region

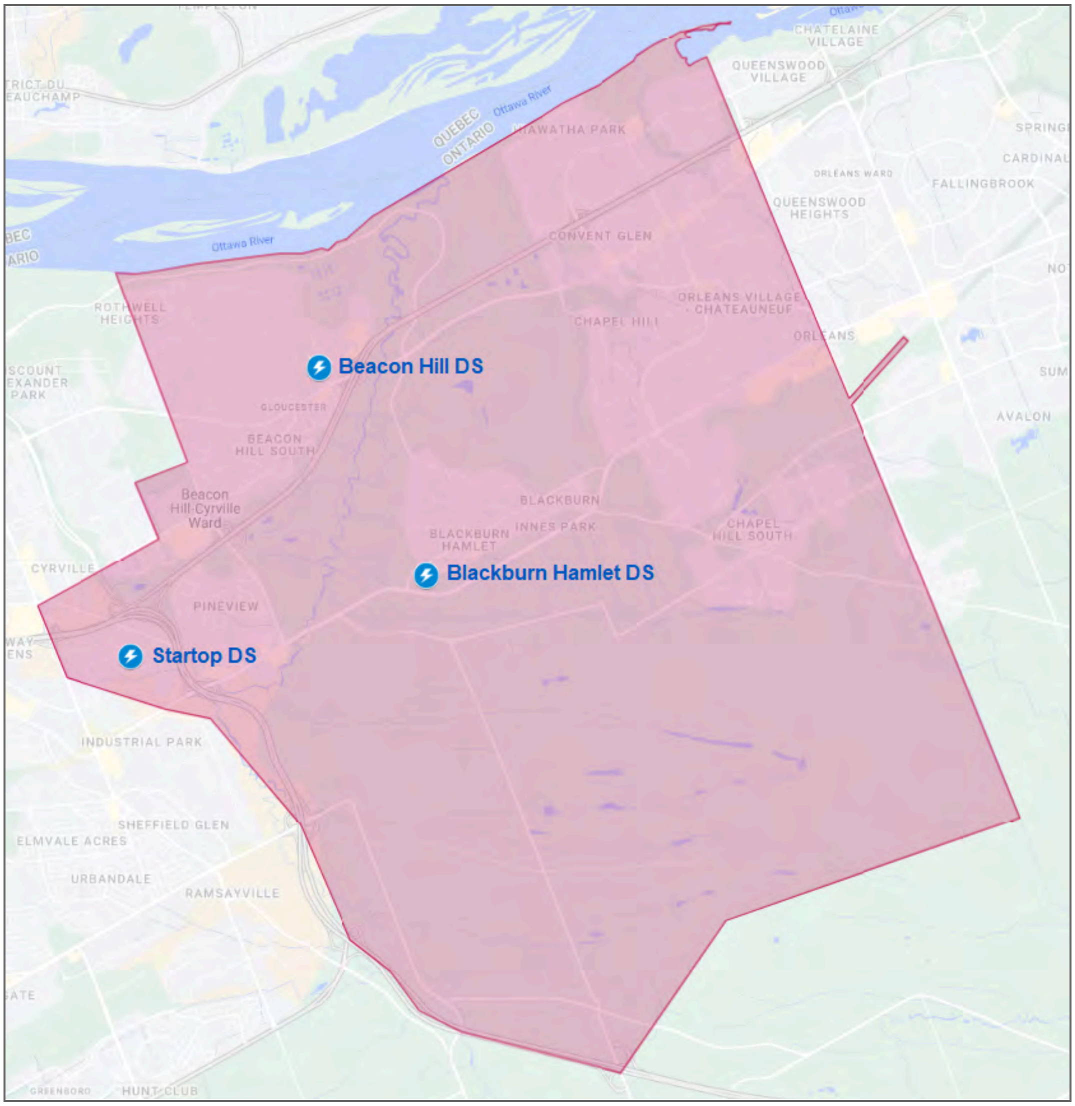
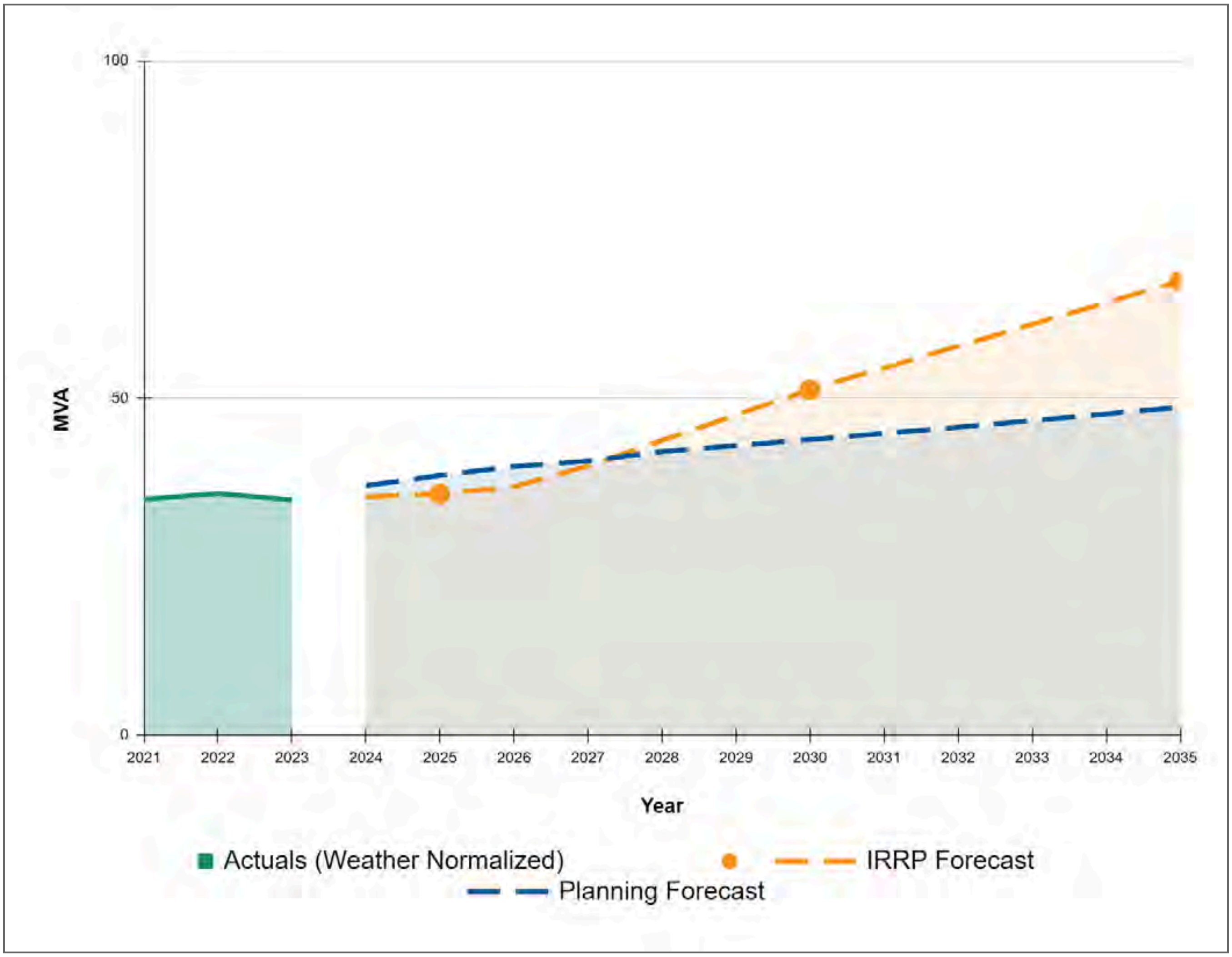


Figure 96 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

1 **Figure 96 - East 8kV Supply Area Planning Forecast and IRRP Forecast**



2
3
4 One feeder from each of the three stations is currently overloaded, see Table 32 above. To address
5 this, Hydro Ottawa has planned several mitigation strategies. Switching operations are planned to
6 redistribute load from the overloaded feeder at Startop DS and to balance the load at Beacon Hill
7 DS, which has available capacity on other feeders. Additionally, a voltage conversion has been
8 planned at Blackburn DS to transfer several sections to the 28kV system. Since the East 28kV
9 supply region is nearby, any large developments will connect to the 28kV system instead of the East

8kV due to limitations in the 8kV system. This multi-pronged approach aims to ensure the continued reliable operation of the East 8kV system while accommodating future growth and development in the region.

9.1.4.4. 12 kV System

The 12kV system supplies two areas of Kanata, located north and south of Highway 417 at Eagleson Road. These communities are supplied by Beaverbrook MS and South March DS, with the only 12kV distribution ties being connections between these two stations. Refer to Figure 97 for a visual representation of this region.

Figure 97 - 12kV Supply Area

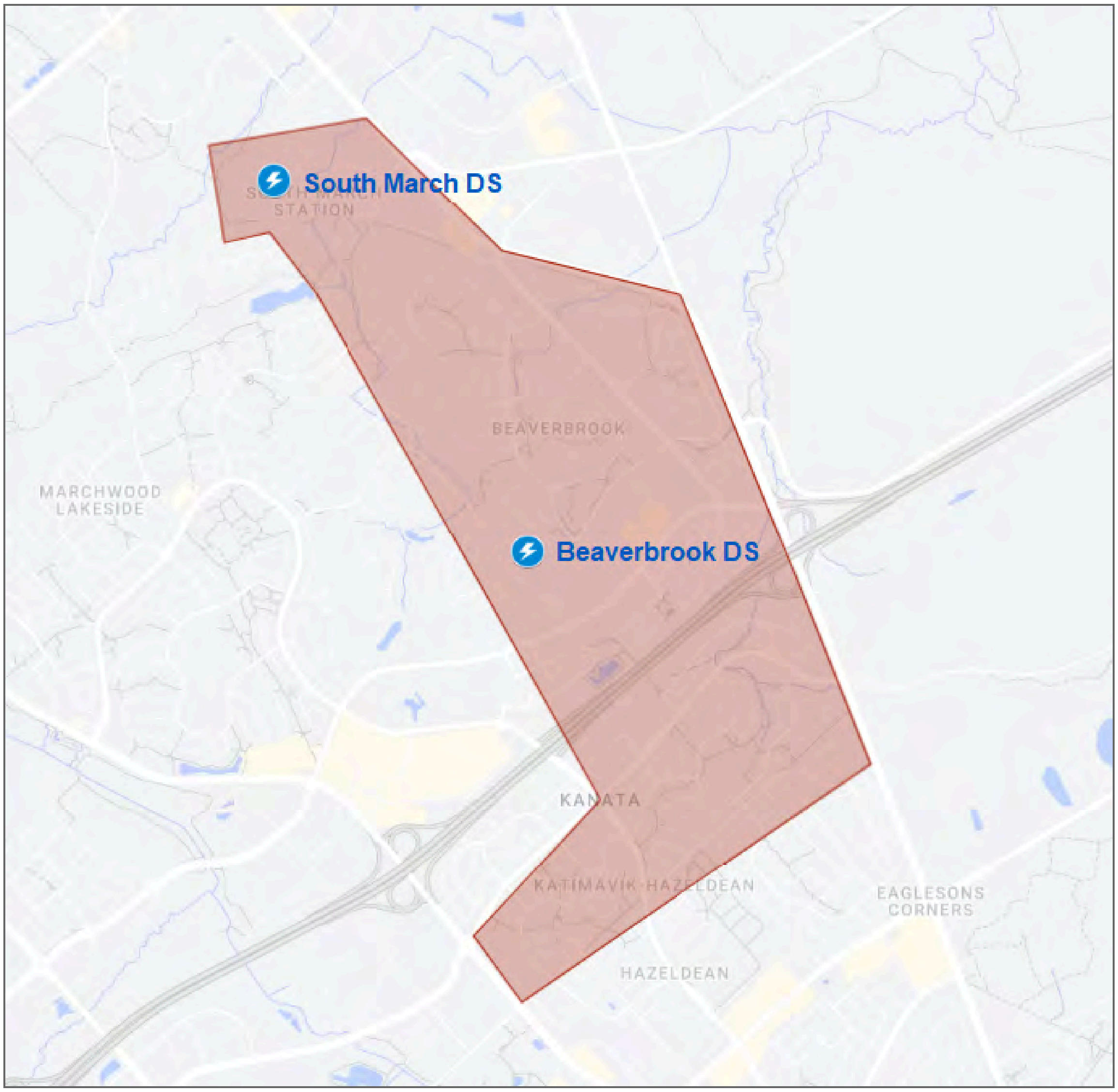
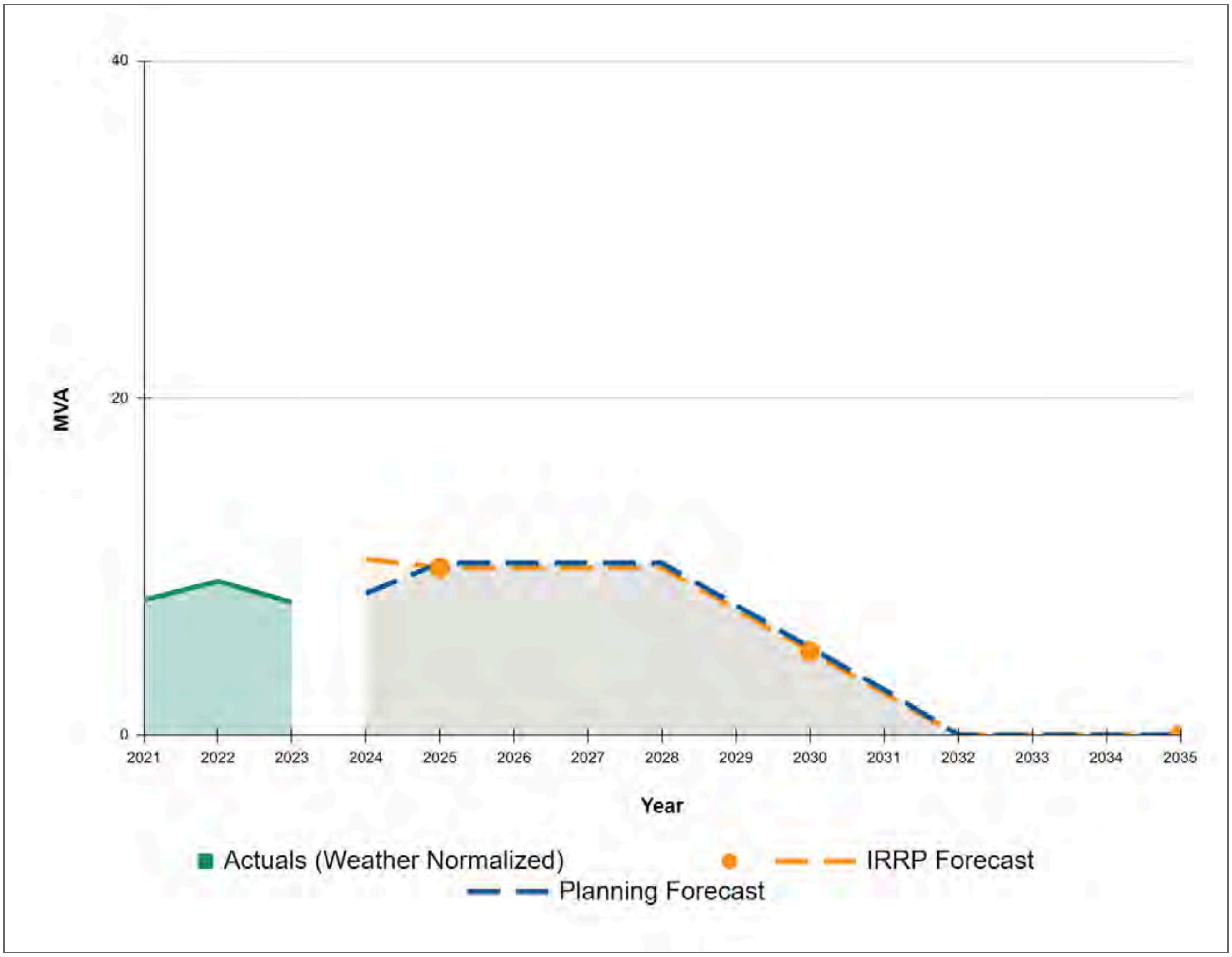


Figure 98 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 98 - 12kV Planning Forecast and IRRP Forecast

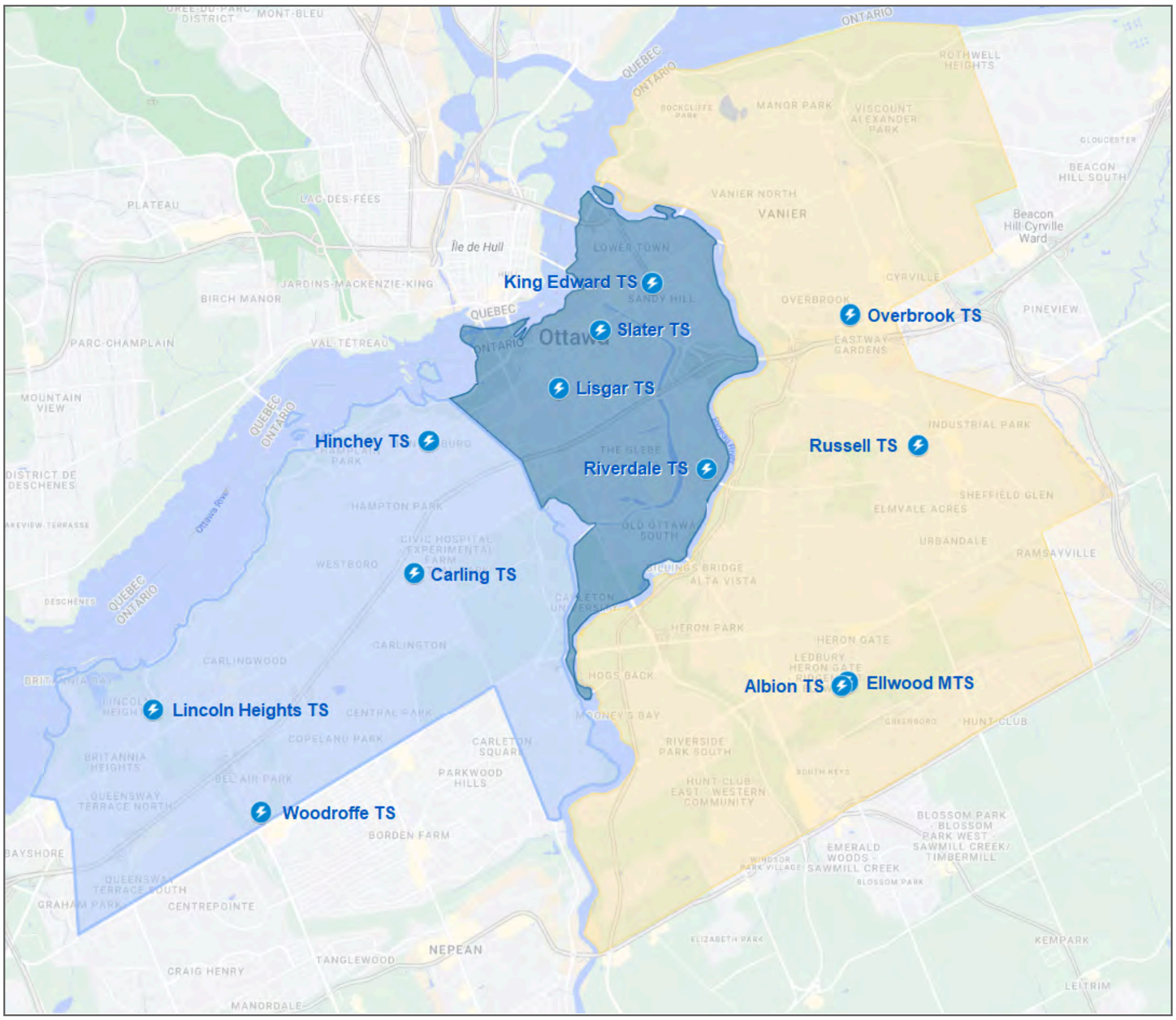


Work has begun to replace end-of-life distribution cables and transformers in preparation for a 28kV conversion. After the new 28kV station in Kanata North, see more details in Section 9.1.4.2.5 - West 28kV (North) System, is energized and the 12kV load is fully transitioned, Beaverbrook DS and South March DS will be decommissioned in phases, starting in 2028.

9.1.4.5. 13 kV System

The Hydro Ottawa 13kV supply region is divided into three areas: West 13kV, Core 13kV, and East 13kV, encompassing 12 stations. These areas align with the 4kV system described in Section 9.1.4.6 - 4kV System. Figure 99 shows the 13kV supply region and station locations.

Figure 99 - 13kV Supply Region

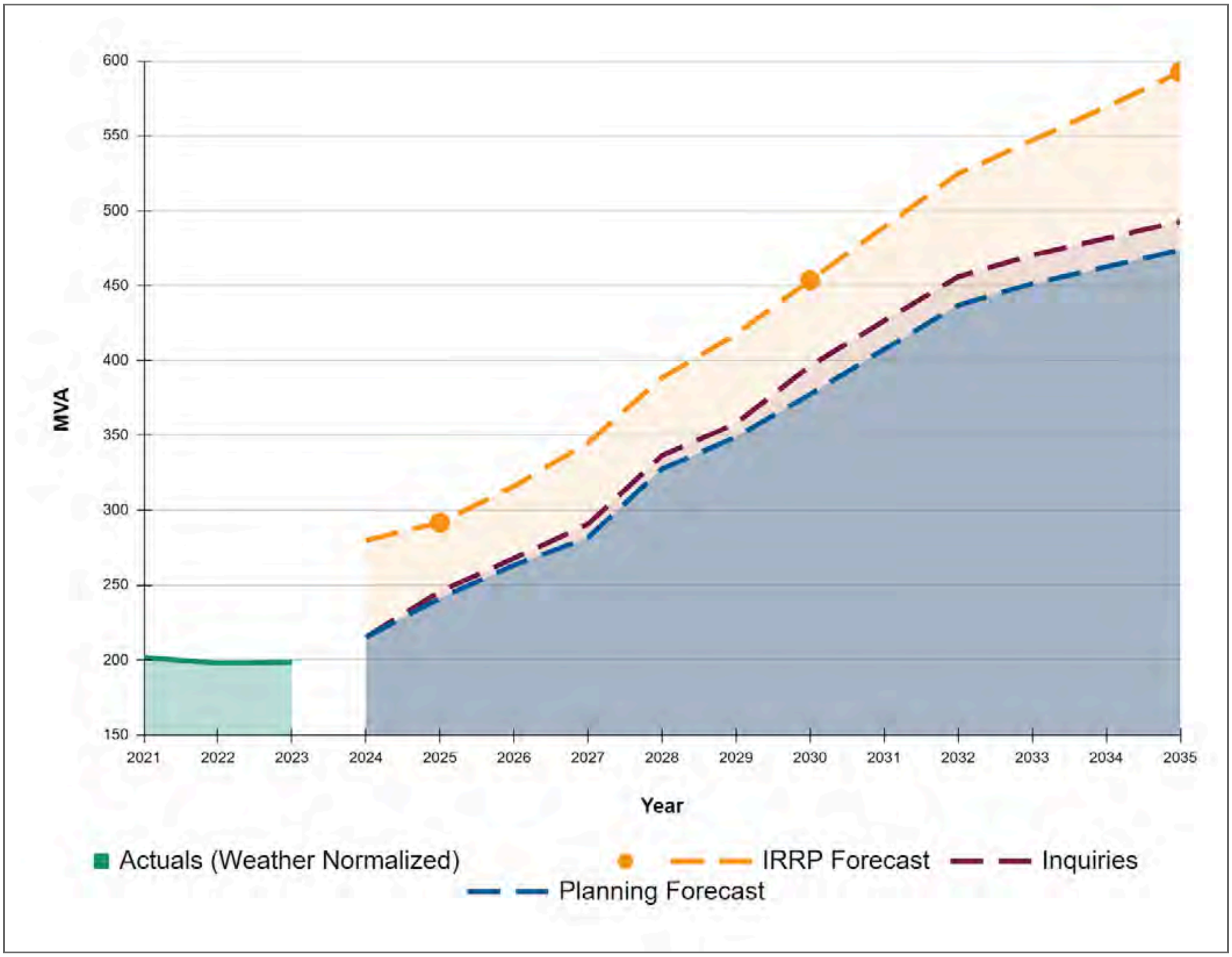


Through the Official Plan, the City of Ottawa is promoting new growth by means of intensification within central Ottawa. This impacts the 13kV system as it covers mostly established areas. Many new developments are trading in low-rise apartments for larger, high-density residential buildings.

West 13kV System

The West 13kV supply region extends from Bayview Yards and west of Preston Street to Bayshore Drive, north of Baseline Road. This region is supplied by Hinchey TH, Carling TS, Woodroffe TS, and Lincoln Heights TS. Hinchey TH also supports the Core 13kV supply region. Figure 100 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

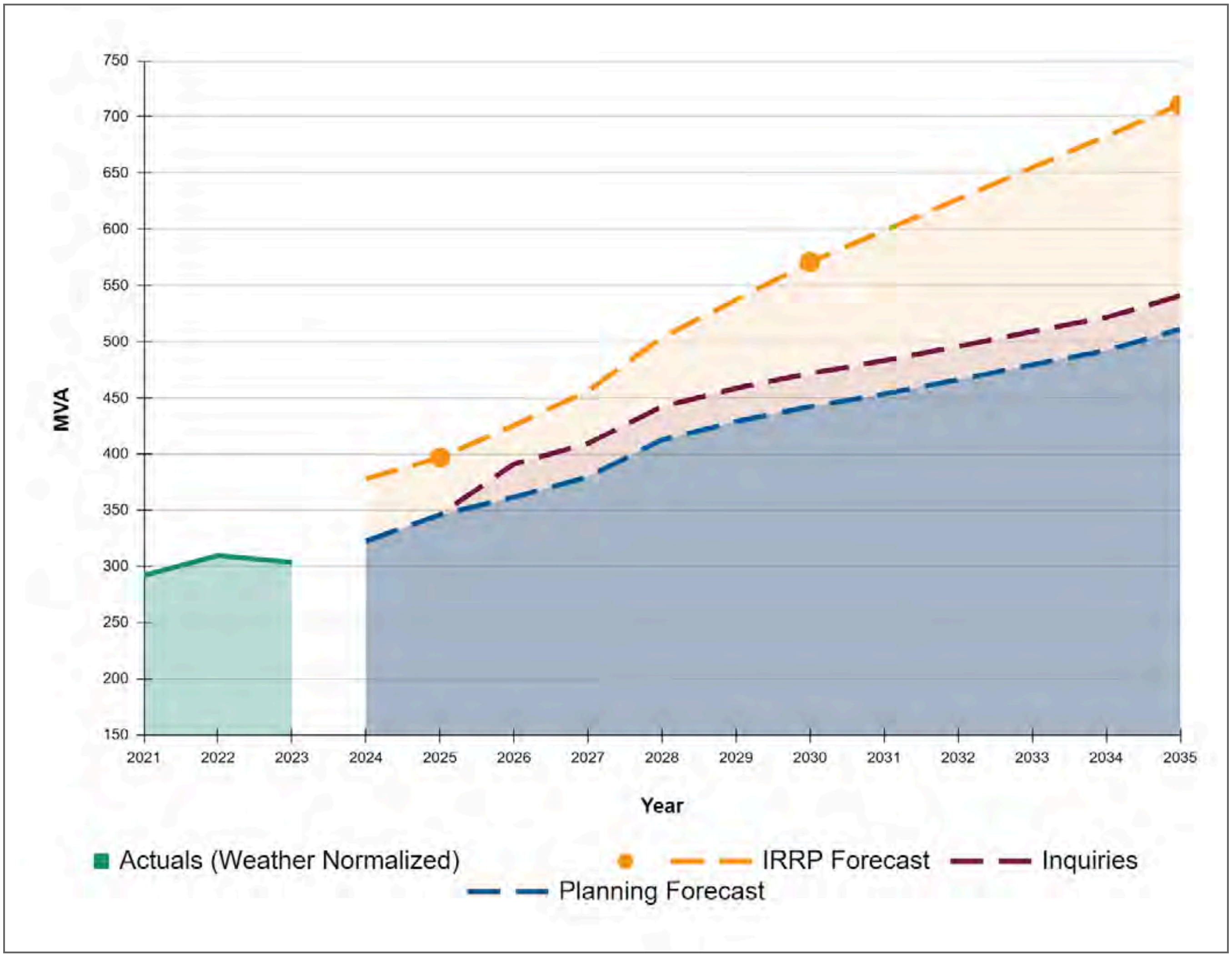
Figure 100 - West 13kV Planning Forecast and IRRP Forecast



Core 13kV System

The Core 13kV area follows the Rideau River to the east and covers LeBreton Flats to the west. This region is supplied by King Edward TS, Slater TS, Lisgar TS and Riverdale TS. Riverdale TS and King Edward TS also support the East 13kV supply region. Figure 101 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

1 **Figure 101 - Core 13kV Planning Forecast and IRRP Forecast**



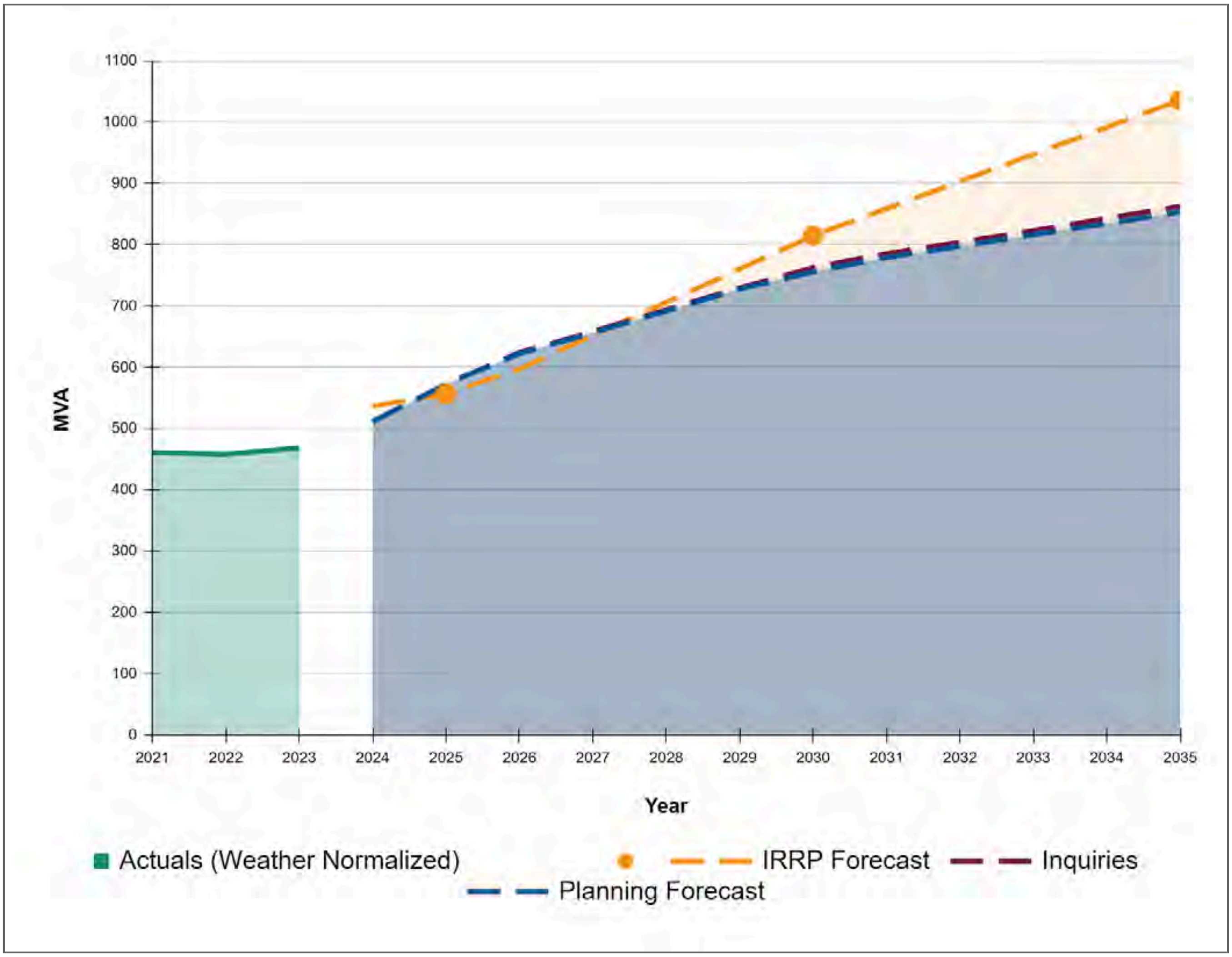
2

3

4 **East 13kV System**

5 The East 13kV supply region covers the eastern portion of the Old City of Ottawa. This region is
6 supplied by the Russell TS, Albion TS, Ellwood MTS and Overbrook TS. Figure 102 shows the
7 weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in
8 planning stages for the region out to 2035.

Figure 102 - East 13kV Planning Forecast and IRRP Forecast



Overall Strategy

Capacity upgrades and new station interconnections are needed to manage and transfer load within the 13kV system. System expansions will also be necessary to meet growing demand. Feeders with minor overloads and minimal growth forecasts will be monitored.

Several limitations currently prevent some Hydro One owned stations from operating at full capacity. These station-specific limitations include issues with secondary cables, transformers, switches, and protection and control equipment. Plans are in place to address and eliminate these constraints as explained below. In addition, conversion of Bronson DS from 4kV to 13kV and NWSs will further increase 13kV system capacity and support load growth in the adjacent stations like Riverdale TS, Carling TS and Lisgar TS, see further details in Section 9.1.4.6 - 4kV system.

These initiatives are vital for supporting regional growth and electrification plans. By enabling each station to operate at its full potential, Hydro Ottawa can provide more reliable service and meet the increasing electricity needs of its customers and large load requests such as the Ottawa Hospital[35] slated to be connected to the 13kV system, facilitating the transition to a more electrified and sustainable future. The investments detailed below are consistent with the Needs Assessments by the IRRP working group as part of the regional planning process, see Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Riverdale TS Switchgear Capacity Upgrade (System Service-Capacity Upgrade)

The overall station capacity is limited by a lack of available breakers in the secondary switchgear lineup. To address this, the switchgear will be replaced by 2027, adding eight feeder breakers. This project, approved as part of the 2021-2025 Rate Application, will allow the station to utilize the full capacity, connect new customers, and support future growth in Old Ottawa East and South regions. Additionally, the bus ampacity will be increased to accommodate potential future transformer upgrades. These enhancements will ensure Riverdale TS can meet the region's growing electricity needs.

Slater TS Transformer Upgrade (Hydro One Investment)

Slater TS's T1 transformer failed in early 2018 and was replaced by Hydro One with a larger 100 MVA unit to support future growth and provide contingency capacity for the Core 13kV region. The

[35] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/.

remaining transformers, T2 and T3, are nearing end-of-life and have been replaced with larger 100 MVA units in 2024. This upgrade also eliminated short circuit constraints, allowing for greater DER integration in the region.

Lisgar TS Transformer and Cable Upgrade (Hydro One Investment)

Lisgar TS currently has two transformers with a total capacity of 81 MVA. Thermal constraints due to existing generation sources are limiting the connection of new DERs. To address this and increase the station's capacity, Transformer T1 will be replaced by 2026.

In addition to the transformer replacement, the secondary cable at Lisgar TS is also limiting its operational capacity. Upgrading this cable will allow the station to operate at its full potential, supporting future developments and customer connections.

King Edward TS Cable Upgrade (Hydro One Investment)

The secondary cable at King Edward TS is currently preventing the transformers from operating at full capacity. The station, with two transformers and an available capacity of 97 MVA, is projected to exceed its N-1 rating in 2026 due to near-term load growth. Upgrading the secondary cable will increase the station's capacity, relieving capacity constraints in the Core 13kV system and supporting the load growth resulting from the Ottawa LRT project.

Carling TS Cable Upgrade (Hydro One Investment)

The cables at Carling TS are currently preventing the transformers from operating at full capacity. Replacing aging and limiting cables at the station will increase the available station capacity, relieving capacity constraints and supporting the load growth.

Russell TS Transformer Upgrade (Hydro One Investment)

Russell TS is projected to exceed its capacity by 2027. To address this, the two transformers will be replaced in 2027, increasing capacity. Additionally, new distribution ties will allow transfer from Russell TS to neighboring stations including Ellwood MTS, Albion TS, and Overbrook TS.

Albion TS Transformer Upgrade (Hydro One Investment)

Albion TS is projected to exceed its limits by 2034. Hydro One plans to replace the two transformers due to end-of-life equipment and the new transformers will be efficiently sized to meet the forecasted growth. Additionally, new distribution ties will enable load transfer from Albion TS to neighboring stations including Ellwood MTS, Russell TS, and Overbrook TS. Loads across the 13kV system will be continuously monitored and forecasted to ensure adequate supply.

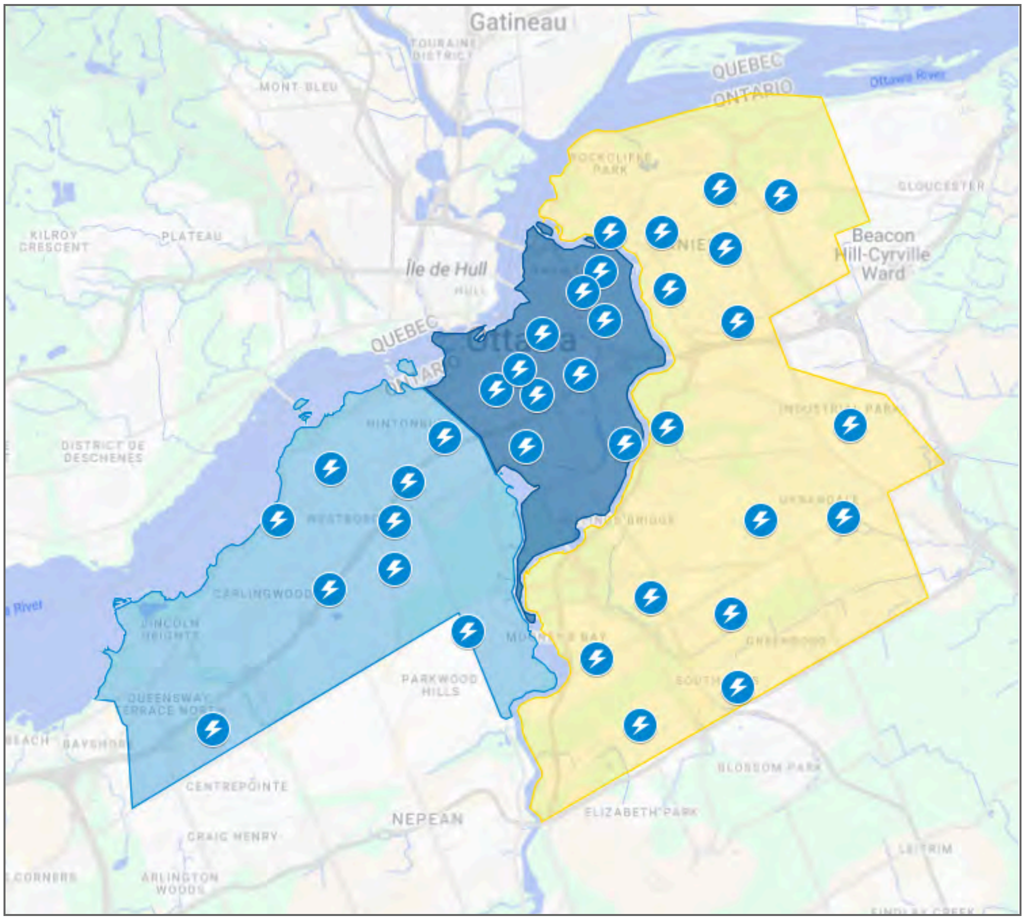
Non-Wires Solutions

Hydro Ottawa proposes 10 MW of utility owned BESS and non-wire customer solutions to manage short term and long term peak load in this region. For more details on the need and justification of this solution refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.6. 4kV System

Hydro Ottawa's 4kV system consists of two supply regions, Central 4kV (highlighted in blues), and East 4kV (highlighted in yellow). Figure 103 below illustrates this region as it spans across the more historical parts of Ottawa.

Figure 103 - Overall 4kV Supply Region[36]



Central 4kV

The Central 4kV supply region covers the area west of the Rideau River, east of Highway 416, along the north shore of the Ottawa River, and south to Baseline Road. This region includes 19 stations: Augusta DS, Bayswater DS, Bronson DS, Cambridge DS, Carling DS, Clifton DS, Clyde DS, Edwin DS, Fisher DS, Florence DS, Gladstone DS, Henderson DS, Hillcrest DS, Holland DS, King Edward DS, Nepean DS, Riverdale DS, Shillington DS, Slater DS. Figure 104 shows the Central 4kV supply region.

[36] The station names are deliberately left out as it would be too cluttered to have all of them on the same map; see Figure 106 (Central 4kV Supply Region) and Figure 108 (East 4kV Supply Region) for the station names.

Figure 104 - Central 4kV Supply Region

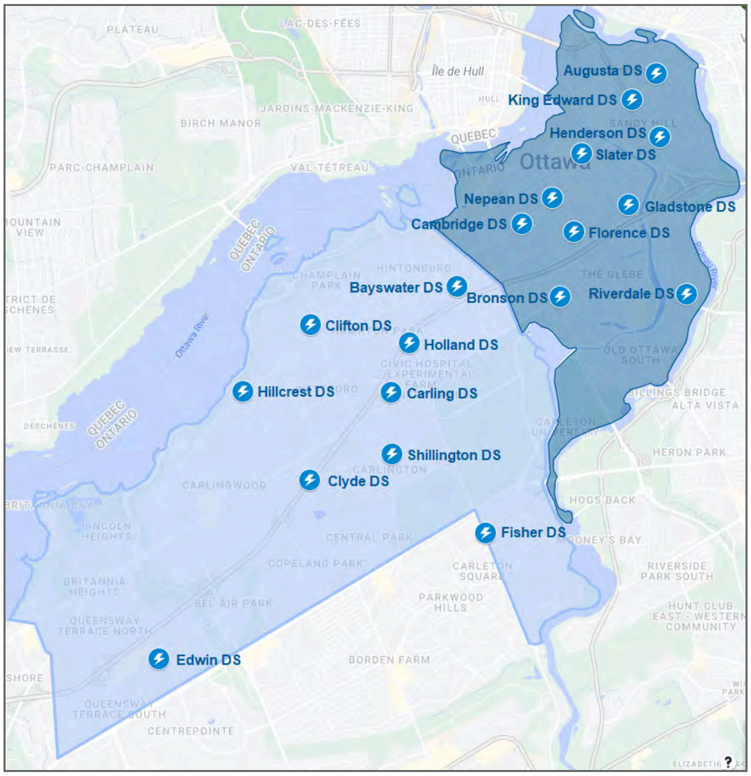
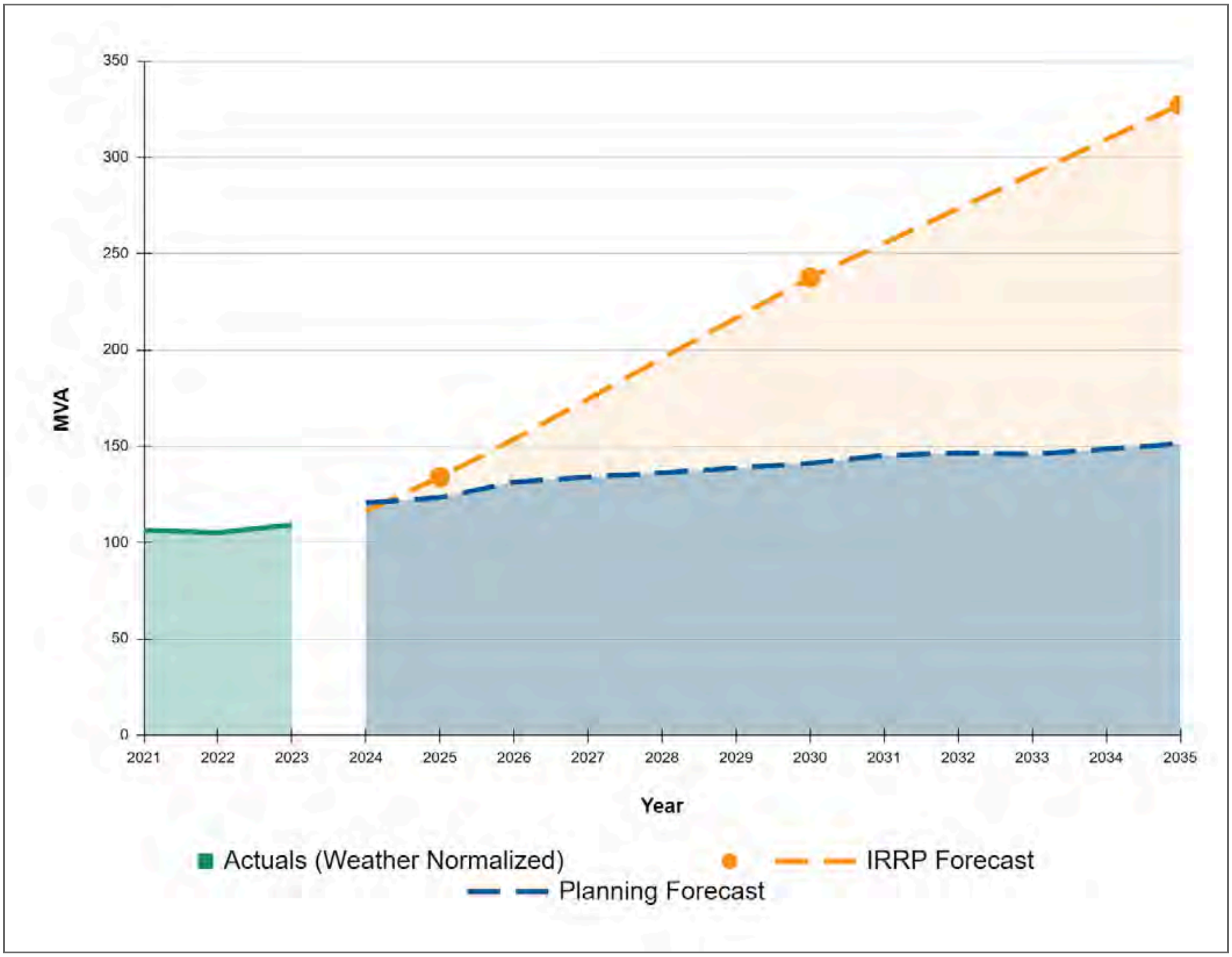


Figure 105 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 105 - Central 4kV Planning Forecast and IRRP Forecast



East 4kV

The East 4kV supply region covers the area west of Blair Road, east of the Rideau River, and north of Hunt Club Road. This region is supplied by 16 substations: Albion DS, Bantree DS, Beechwood DS, Brookfield DS, Cahill DS, Church DS, Dagmar DS, Eastview DS, Langs Road DS, McCarthy DS, Overbrook DS, Playfair DS, Queens DS, Urbandale DS, Vaughan DS, and Walkley DS. Figure 106 shows the East 4kV supply region and substations.

Figure 106 - East 4kV Supply Region

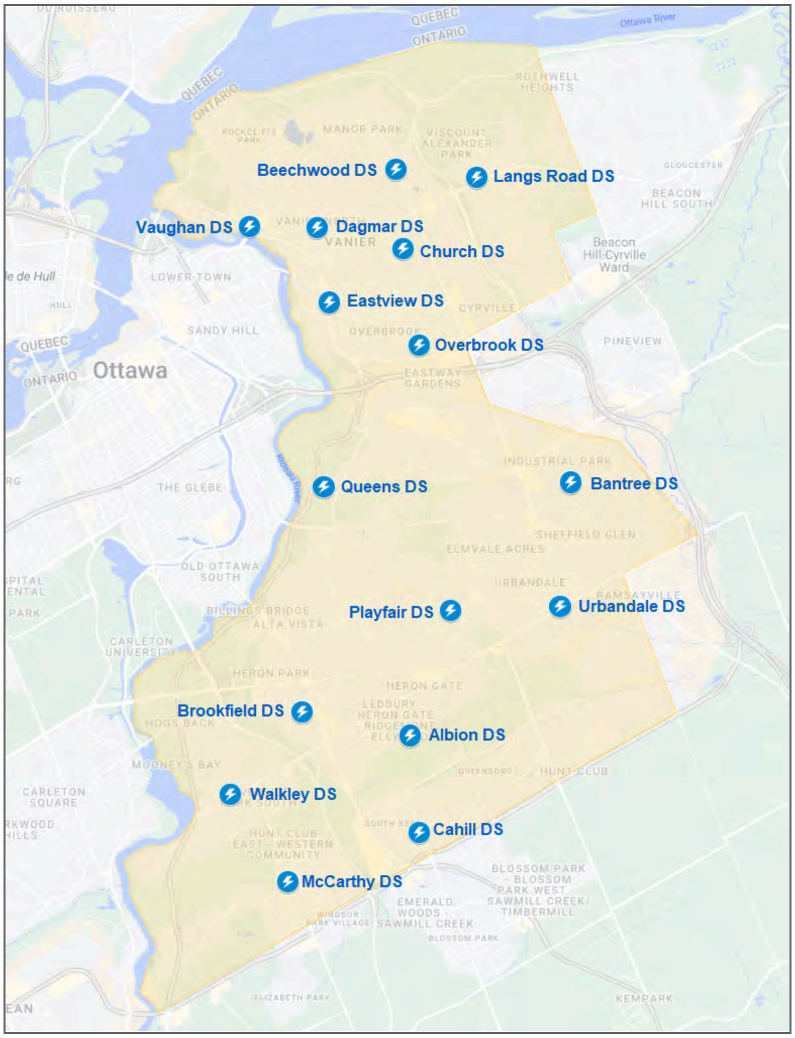
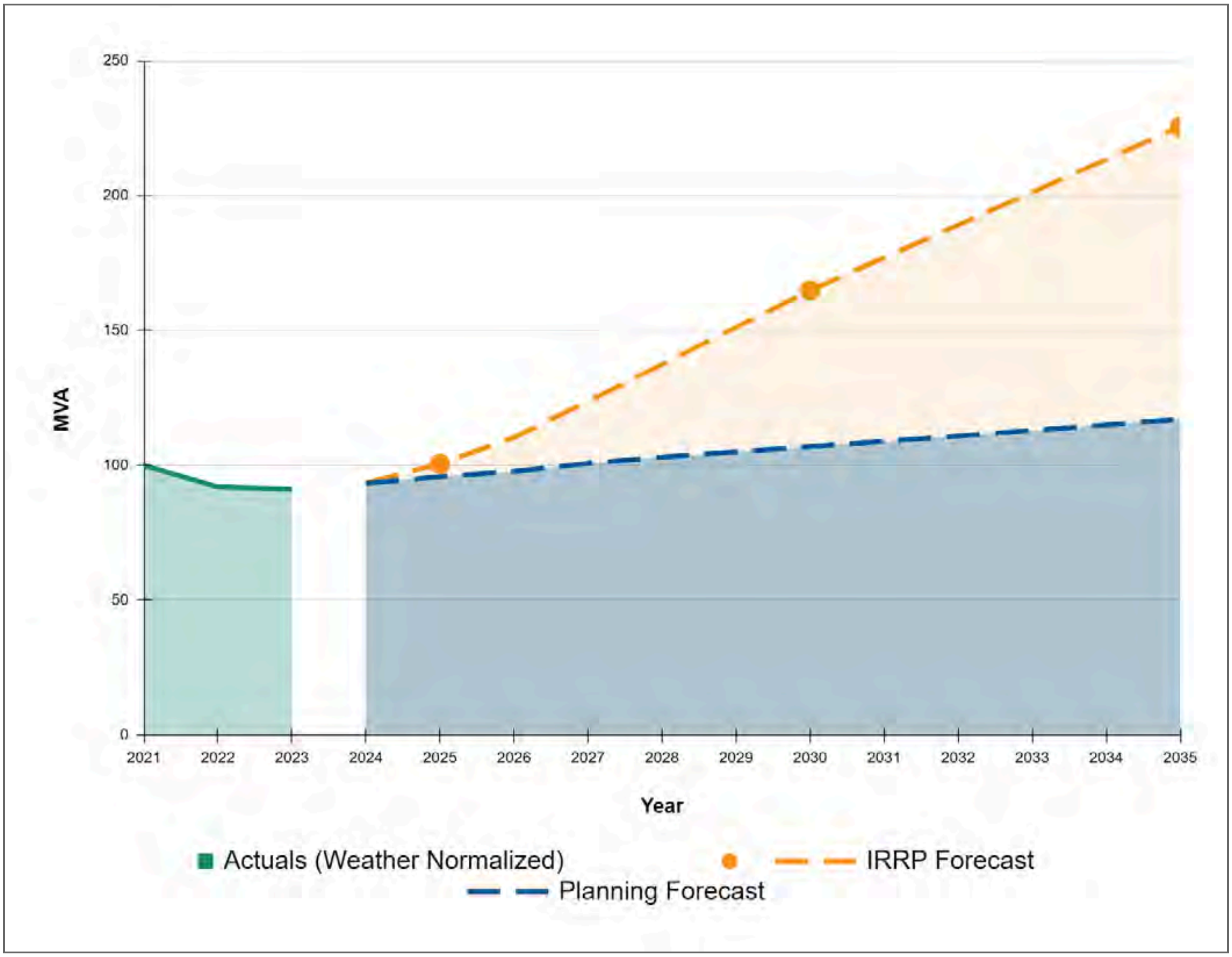


Figure 107 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 107 - East 4kV Planning Forecast and IRRP Forecast



All thirty-five 4kV substations are supplied by twelve 13kV stations, providing electricity for the majority of the residential load in the regions. The City of Ottawa's Official Plan promotes intensification, with many new developments transitioning from low-rise apartments to larger, high-density condos and apartment buildings and transit oriented development. This growth, teamed up with electrification needs, speaks towards demand growth in the 4kV system. Areas like the Glebe, Rideauview, and Vanier are expected to experience significant growth in the near future.

Voltage Conversion Strategy

Hydro Ottawa is phasing out its 4kV system by strategically converting to 13kV during renewal. This shift is driven by the 4kV system's inability to handle increasing loads from electrification, which require higher service sizes and loop transformation only achievable at 13kV. Instead of rebuilding aging 4kV stations, Hydro Ottawa is prioritizing voltage conversions to enhance system reliability, accessibility, and capacity. The challenges faced by the 4 kV system is elaborated below:

- Compared to 13 kV, 4 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 13 kV remains effective up to 10km.
- The maximum capacity of a 4 kV feeder is 2.3MVA, versus 9.7MVA for 13 kV, significantly limiting the ability to accommodate the large load requests.

Beyond completion of the planned conversions of Dagmar DS and Fisher DS initiated in the 2021-2025 period, Vaughan DS, Henderson DS, and Church DS will also be converted to 13kV due to the condition and age of their 4kV assets, Section 2 of Schedule 2-5-7 - System Renewal Investments. Additionally, strategic voltage conversions are planned in the Bronson DS region to prepare for its upgrade to 13kV mainly driven by capacity constraints.

Dagmar DS voltage conversion

Dagmar DS, a 4kV substation in the East 4kV region serving part of Vanier, as well as its distribution network, have reached end-of-life. Due to capacity and site space constraints, voltage conversion to 13kV was chosen over asset renewal. Initially planned for completion within this application, the project is now expected to start in 2025 and be completed by 2027.

Fisher DS voltage conversion

Fisher DS, a 4kV substation in the Central 4kV region serving Rideauview as its distribution network, has reached end-of-life. Voltage conversion to 13kV was determined to be more beneficial than a station rebuild at 4kV, offering improved reliability and capacity to meet growing demand. This conversion requires replacing and upgrading all distribution assets to 13kV standards. Construction began in 2022 and is expected to be complete by 2027.

Henderson UN, Church AA and Vaughan UG voltage conversion

As part of the overall voltage conversion strategy, Henderson DS, parts of Church DS, and Vaughan DS, will be converted to 13kV. This is primarily driven by end-of-life 4kV station assets. Converting these customers to a 13kV supply and decommissioning the 4kV stations is advantageous to meet growing demand, support electrification, and progress towards phasing out the end-of-life 4kV system in the service territory.

Bronson DS upgrade and associated voltage conversion

Bronson DS, a 4kV substation serving the Glebe and part of Bank Street, will be upgraded to 13kV to increase capacity and reliability. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This capacity upgrade aligns with the Needs Assessments completed by the IRRP working group as part of the regional planning process, see Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

9.2. NON-WIRES SOLUTIONS TO ADDRESS SYSTEM NEEDS

In March 2024, the OEB updated its "Non-Wires Solutions Guidelines for Electricity Distributors"[37] (previously known as the CDM Guidelines for Electricity Distributors) to reflect "the fact that Non-Wires Solutions to address system needs can encompass a broader range of solutions than traditional conservation and demand management, including, but not limited to, third-party distributed energy resources such as energy storage and distributed (embedded) generation".

It is the OEB's expectation that LDCs submitting rate filings in 2026 and beyond be fully consistent with the OEB's Benefit-Cost Analysis Framework (BCA Framework) and will be "required to incorporate consideration of NWSs into their distribution system planning process, by considering whether a distribution rate-funded NWSs may be a preferred approach to meeting a system need, thus avoiding or deferring spending on traditional infrastructure."[37] While Hydro Ottawa's Application is submitted in advance of requirements for rate applications to be fully consistent with the BCA Framework, Hydro Ottawa has been working to update its planning process to include evaluating NWSs potential for meeting local distribution system needs. Where feasible, and where there is overlap between local distribution system and bulk system needs, this process has and will continue to include collaborating with the IESO, and making use of their Local Initiatives Program (LIP) within the Electricity Demand Side Management (eDSM) Framework for mutual benefit. Also within the eDSM Framework, there is proposed new funding dedicated for LDCs to develop and implement local eDSM programs that address distribution system needs and also provide upstream benefits to the IESO-controlled bulk system.

Of note, regulatory and policy work regarding funding and implementing NWSs and local eDSM activities is evolving, with updated mechanisms and additional guidance anticipated in 2026 or 2027. When regulatory policy solidifies, and guidance and the process to share costs between the local and bulk systems are formalized, Hydro Ottawa will adjust its NWSs Assessment Process

[37] Non Wire Solutions Guidelines for Electricity Distributors- https://www.oeb.ca/sites/default/files/uploads/documents/regulatorycodes/2024-04/OEB_2024%20NWSs%20Guidelines_20240328.pdf

described below accordingly. Refer to Section 9.2.4.3 - “Stream 2” Local NWSs Program Opportunities for additional insight around future regulatory and policy changes.

9.2.1 Hydro Ottawa NWSs Assessment Criteria

Hydro Ottawa's System Capacity Assessment is a crucial process that analyzes planning forecasts to inform decisions about necessary system upgrades and expansions. This ensures that Hydro Ottawa can reliably and adequately meet both current and future customer energy needs. The NWSs assessment utilizes the IRRP forecast, which specifically focuses on the medium- to long-term outlook (beyond 2030) and takes into account the potential effects of decarbonization efforts. By considering these long-term impacts, Hydro Ottawa can better contextualize potential challenges and opportunities that may arise in the future. For more details regarding the IRRP Forecast refer to Section 9.4.2.

A key benefit of this forward-looking approach is that it allows Hydro Ottawa to validate that the capacity investments made to address immediate needs in the near term (until 2030)—as informed by Hydro Ottawa’s planning forecast—are also strategically aligned with the anticipated long-term energy requirements. This alignment ensures efficient capital deployment and optimizes asset utilization.

Based on a thorough analysis of the needs identified for each of the Hydro Ottawa planning regions described in Section 9.1.4 - Investments by Planning Region; it has been determined that the majority of these needs will require wire solutions, meaning upgrades and expansions to the physical grid infrastructure. While NWSs are not expected to cause substantial avoidance or deferral of the identified wire capacity investment needs, they will play a crucial role in moderating the pace of system demand growth and enhancing reliability in the 2026-2030 period, while continuing to support the grid in the long term. This moderation will provide Hydro Ottawa with the lead time to construct the necessary long-term grid infrastructure solutions that are aligned with the evolving system demand. There are three scenarios identified where NWSs would have the greatest potential in supporting capacity needs:

Scenario 1: Stations Requiring Capacity Risk Mitigation in the Near-Term

This scenario applies to stations that are currently facing capacity constraints and require immediate risk mitigation measures until a permanent wire solution can be implemented. This may be due to an inability to transfer loads to nearby stations or due to anticipated additional capacity needs in the near term. In these cases, NWSs can manage demand and ensure reliable service while the necessary grid infrastructure upgrades are being planned and constructed.

Scenario 2: Distribution Connected Stations with Minor Overloads

This scenario focuses on distribution connected stations where both the planning and IRRP forecasts project overloads of less than 7.5MVA (50% of maximum capacity for a new 8kV station/ 50% of maximum capacity of a 28kV feeder) by 2030. These stations must have limited connections to adjacent stations to support overloads. Additionally, wire alternatives would require a combination of distribution and station expansion along with potential transmission upgrades, resulting in significant capital investments which is not economically feasible. NWSs can play a supportive role by managing demand and reducing the need for near-term infrastructure investments, and they can provide additional reliability benefits by helping to balance loads.

Scenario 3: Planning Regions Overloaded by 2030

This scenario pertains to planning regions where overloads by 2030 are expected based on the IRRP forecast, even after the implementation of proposed wire solutions. It also includes planning regions that are already experiencing transmission system constraints, as identified through Regional Planning. In these cases, NWSs will be essential in managing demand to ensure that the system can operate reliably within limits.

9.2.2 NWSs Under Consideration

The rapid advancement and adoption of DER present an unprecedented opportunity to revolutionize grid planning, operations and management. By strategically leveraging DER technologies as NWSs, Hydro Ottawa can innovate its approach to planning and addressing distribution system needs and empower customers while paving the way for a more reliable, resilient and sustainable energy future.

9.2.2.1 Non-Wires Customer Solutions Program

There are four initial programs under further evaluation within the Non-Wires Customer Solutions portfolio for deployment, which are described below. Hydro Ottawa also expects to use outputs from the IESO's Local Achievable Potential Study (L-APS), scheduled to complete in Q2 2025, to validate the programs. Hydro Ottawa expects that its Non-Wires Customer Solutions Program could eventually include, where feasible and cost effective, other demand side management programs delivering both distribution grid benefit as well as greenhouse gas emission reductions.

These programs will build on province-wide incentive offers available within the eDSM Framework, where applicable. It is anticipated that cost-sharing will be determined based on the split of bulk and local system benefits determined by the BCA and informed by the L-APS. Funding requested will support customer participation with incentives, and will be used to raise awareness of these local programs through targeted marketing. As advancements and understanding of the broader use of DER technology continues to evolve, regulatory policy around DERs solidifies, and additional sources of funding emerge, additional opportunities for NWSs will be reviewed and considered for implementation.

1. **Save on Energy Retrofit Adder Program**

   Hydro Ottawa is working with the IESO to explore relaunching an updated version of a retrofit adder program, similar to the "Kanata North Retrofit+" (KNR+) program. From 2020-2022 and funded by Interim Framework (IF), Hydro Ottawa administered the KNR+ program cost effectively in the targeted area of Kanata North and achieved 2.47MW of gross demand savings by providing enhanced incentives and technical support to eligible customers, leveraging the existing platform used for the province-wide Retrofit Program. During recent conversations, IESO has signaled that opening access to the Retrofit Regional Adder[38] - required for this program concept - is a strong possibility.

As stated in the KNR+ program evaluation report,[39] enhanced technical support provided to customers by Hydro Ottawa was a key differentiator in the success of the KNR+ program. Under this new program, Hydro Ottawa will assign a CDM Energy Conservation engineer to assist customers in identifying and developing potential projects in the targeted area of need. Existing customer relationships and communication channels can be utilized to promote the program as Hydro Ottawa has CDM staff already in place who can leverage these relationships for initial engagement and technical support. Please refer to Schedule 1-4-1 - Customer Engagement Ongoing for greater detail on how the CDM team is engaging with and supporting customers. Funding within the Non-Wires Customer Solutions Program would be used for targeted marketing campaigns, and a possible local incentive adder further encouraging customers to participate.

2. Residential Demand Response (DR) Program

Residential DR has the potential to deliver significant benefits to both the local distribution grid and the bulk system. To achieve maximum benefits, Hydro Ottawa would need to establish reliable and predictable load reduction through the program by effectively monitoring enrollment and leveraging technology to schedule and operate curtailment events. Curtailment events would need to be targeted to specifically address distribution system needs while prioritizing a positive customer experience.

Hydro Ottawa has been exploring the potential of leveraging IESO's existing "Peak Perks"[40] residential DR platform for mutual benefit. Peak Perks offers incentives to customers with

[38] https://www.saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Local-Initiatives#regionaladders
[39] Kanata North Retrofit+ program evaluation report, https://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2022/PY2022-IF-Hydro Ottawa-Kanata-North-Evaluation-Report.pdf
[40] https://saveonenergy.ca/en/For-Your-Home/Peak-Perks

eligible smart thermostats in exchange for allowing minor temperature setbacks during peak demand periods. Further evaluation with IESO is needed in order to determine whether the Peak Perks program and platform can support Hydro Ottawa's system planning and deliver tangible distribution system benefits in its current form. Funding within the Non-Wires Customer Solutions Program would be used for targeted marketing campaigns, and allow for the possibility of an enhanced incentive to further encourage customers located in priority areas of need to enroll.

3. Commercial Demand Response Program

While the IESO's Capacity Auction already allows for commercial customer participation in DR, Hydro Ottawa recognizes the potential for further opportunity adjacent to the Capacity Auction.

Program operation is expected to involve third-party aggregators for customer qualification, event management, and measurement/verification. In addition to those activities, funding within the Non-Wires Customer Solution Program could be used for targeted marketing campaigns and incentive payments to enroll participants.

IESO's 2025-2027 eDSM plan[41] also states IESO plans to launch a new commercial HVAC DR program in 2026. Hydro Ottawa will explore the possibility of a commercial DR program that - following BCA evaluation - addresses distribution needs and delivers bulk system benefit.

4. Solar PV and Energy Storage Program

Hydro Ottawa has collaborated with the IESO and supported the delivery of the Ottawa DER Large Solar PV Funding Incentive that was operating within the IESO 2021-2024 CDM Framework. This measure, launched on January 8, 2024, was available to commercial customers within eligible postal codes in the Ottawa area. This regional program attracted strong interest from customers, and solar incentive programs have now been expanded to all

[41] 2025-2027 Electricity Demand Side Management Program Plan- https://ieso.ca/-/media/Files/IESO/Document-Library/eDSM/2025-2027-DSM-Plan-with-Beneficial-Electrification.pdf

customers across the province as part of the new eDSM Framework announced on January 9, 2025.[42]

To maximize the value of intermittent solar generation, Hydro Ottawa is evaluating the benefits of local incentive adders for behind the meter customer owned solar PV and energy storage. A combined offering would enhance benefits to both the local distribution grid and the bulk system by allowing for predictability in output during times of system need.

Funding within the Non-Wires Customer Solution Program would be used to incentivize customers and for targeted marketing campaigns to encourage participation.

For further details on the costs associated with the Non-Wires Customer Solutions Program, see Schedules 6-3-5 - Other Income & Deductions and 4-1-2 - Operations, Maintenance and Administrative Program Costs.

9.2.2.2 Battery Energy Storage System (BESS)

In the electric utility industry, BESS is emerging as a viable solution to address a variety of challenges, including peak load management, grid reliability, and the integration of renewable energy sources. BESS involves the use of advanced battery technologies to store excess energy generated during periods of low demand or high production and release it during periods of high demand or low production. This capability offers numerous benefits to the overall electricity grid.

9.2.2.2.1 Utility Owned Battery Energy Storage System

Utility-owned BESS installations are being strategically deployed in areas where minor grid overloads are predicted that do not necessitate the construction of an entirely new substation, and where options to offload are limited or nonexistent. Additionally, BESS solutions will play a crucial

[42] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

role in areas where wire solutions are being implemented, but smaller-scale overloads are still anticipated in the mid-term. These installations align with the assessment criteria outlined in Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria and aim to provide targeted support where traditional grid infrastructure may not be immediately necessary or where additional capacity is required in the near future.

Utility-owned BESS installations present several advantages, including direct control and localized grid support. By owning and operating these installations, Hydro Ottawa can efficiently integrate them into the existing grid infrastructure, allowing for streamlined maintenance, optimized performance, and reduced reliance on third-party providers. This is critical since the areas selected for utility owned BESS installations have limited to no alternative options to support excess demand in the near term.

9.2.2.2.2 Commercial Customer Owned Battery Energy Storage Systems

BESS solutions that are located behind the meter, and owned and operated by commercial customers in partnership with the LDC, have the potential to deliver tangible distribution system grid benefits when located in targeted areas and deployed in concert with system needs. Although interest in BESS facilities is growing, current penetration of these systems is low across Hydro Ottawa's service territory, with only 3 BESS assets larger than 100kW connected to the distribution system, none of which are located in areas of need.

Hydro Ottawa has been exploring partnering with a customer planning for a behind the meter BESS in an area of need. After extensive discussions over several years, significant challenges remain. Namely the complexities of the customer's decision-making process including needs assessment, Industrial Conservation Initiative participation, cost-benefit analysis for both parties and implementation timelines. Despite technical, economic, regulatory, and customer-related barriers, Hydro Ottawa is continuing to pursue the potential of partnering with customers interested in BESS to support grid needs as policy and regulatory frameworks adapt around the use of DERs.

9.2.3 Proposed NWSs by Planning Region

Following the assessment criteria outlined in 9.2.1, NWSs were considered as part of the capacity planning process by Hydro Ottawa's planning region. Table 36 summarizes the regions and solutions being proposed.

Table 36 - Non-Wires Solutions by Planning Region

NWSs Assessment Criteria	Planning Regions	Non-Wires Solutions
Scenario 1, 3	West 28kV (North)	● Non-Wires Customer Solutions Program
Scenario 2	West 28 kV	● 2.5 MW of Utility Owned BESS at Beckwith DS
Scenario 2	Bells Corners/ Bayshore 8 kV	● 7 MW of Utility Owned BESS in the Bells Corners/Bayshore 8kV region
Scenario 2	Casselman 8 kV	● 5 MW of Utility Owned BESS at Casselman DS
Scenario 1, 3	Core 13 kV, West 13kV	● 10 MW of Utility Owned BESS in the 13kV region ● Non-Wires Customer Solutions Program

9.2.3.1 West 28kV (North)

Selection of this region for the deployment of NWSs was based on Scenario 1 and 3 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. There are existing capacity constraints in the Kanata North region due to rapid technology sector growth which has spurred a surge in large load requests. Immediate risk mitigation through Non-Wire Customer Solutions is being proposed until the new Kanata North station is energized. Non-Wires Customer Solutions will continue supporting this region in the long term considering the IRRP forecast. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments

9.2.3.2 West 28kV

Selection of this region for the deployment of NWSs was based on Scenario 2 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. The Beckwith DS is currently capacity constrained and has limited transfer capability with adjacent stations. The demand forecast of this station until 2030 is minimal and wire upgrades will not be economically viable. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.2.3.3 Bells Corners/Bayshore 8kV

Selection of this region for the deployment of NWSs was based on Scenario 2 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. Bayshore DS and Q.C.H DS are approaching their planned capacity and are forecasted to exceed their capacity by 2030. They have limited inter-station ties between each other and are otherwise isolated from the rest of the 8kV system. The demand forecast of this station until 2030 is minimal and wire upgrades will not be economically viable. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.2.3.4 Casselman 8kV

Selection of this region for the deployment of NWSs was based on Scenario 2 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. The forecasted demand at Casselman DS is expected to exceed its planning capacity by 2030 and is isolated from Hydro Ottawa's distribution system not allowing for the capability to create inter-station ties. The demand forecast of this station until 2030 is minimal and wire upgrades will not be economically viable. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.2.3.5 Core 13kV and West 13kV

Selection of this region for the deployment of NWSs was based on Scenario 1 and 3 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. The combined forecast of Carling TM, Lisgar TL and Riverdale TR is expected to exceed planned capacity by 2028 and the 115kV transmission supply for this region is constrained. Even with the proposed wire upgrade (Bronson DS upgrade in 2032), support will be required from NWSs considering the long term outlook. Immediate risk mitigation through Non-Wire Customer Solutions and Utility Owned

BESS solutions are being proposed until Bronson station is upgraded. Non-Wires Customer Solutions will continue supporting this region in the long term considering the IRRP forecast. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.2.4 Evolution of the NWSs Assessment Process

Hydro Ottawa has evolved to incorporate the NWSs evaluation process within the capacity planning process. As with all processes, the expectation is to make continued improvements by integrating lessons learned from the deployment of NWSs by Hydro Ottawa, its customers, and peers in Ontario and across North America, as the technology, regulations and landscape evolves. For example, the Non-Wires Customer Solutions Program described in Section 9.2.2.1 - Non-Wires Customer Solutions Program has the potential to be deployed across other areas of the distribution system in the future to address the scenarios described in Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria as they occur. Additionally, Hydro Ottawa is making investments in systems and tools - including behind the meter disaggregation technology and energy analytics tools - that are able to provide powerful insights and further inform both the NWSs assessment process and the design and deployment of Non-Wires Customer Solutions. Refer to Section 6 of Schedule 2-5-9 - General Plant Investments for additional details. By adapting its process, Hydro Ottawa will ensure that NWSs become an integral part of meeting local system needs to drive customer value.

9.2.4.1 EV Everywhere Pilot

Hydro Ottawa has been working with project partner BluWave-ai on EV Everywhere[43] - an innovation project funded in part by the IESO's Grid Innovation Fund. The pilot project pairs PA with local DR programming for electric vehicles as well as battery storage with the aim to test how the technology can help address localized system needs as EV adoption increases. The intent is to further understand the potential impacts and operational needs of EVs for DR. With over 150 customers enrolled in the pilot, surpassing the pilot target of 50 customers, electric vehicle

[43] https://hydroottawa.com/en/save-energy/save-energy-homes/ev-everywhere

on-command charging dispatch is being tested with participating customers. The learnings for the EV dispatch portion of EV Everywhere include:

- Determining how to accurately forecast available NWSs capacity;
- Understanding the coordination required to communicate with EV users;
- Designing and testing the DR system, the actual response rates (i.e. registrants that are plugged in and are not opting out) amongst participants, and evaluating the benefits.

In parallel, to provide a proxy of the impact of a future state with wider adoption of EVs with bi-directional energy flow, two BESS solutions will be installed within the Hydro Ottawa system in early 2025 to prepare and familiarize the company with the operation and dispatch of energy storage in response to a predicted overload scenario. Lessons learned from the EV Everywhere BESS portion are intended to support standards creation, selection considerations for BESS units (such as siting, MW and MWh capacity, and battery and energy management system features), BESS Integration (use impact assessment, data value, information visibility to stakeholders), strategic application, and maintenance.

A key component to the EV Everywhere project is communication network, data management, and data security. In a prior residential EV charging pilot, as described in Section 2.1.1.4 of Schedule 1-4-1 - Customer Engagement Ongoing, pilot data was obtained that was used to help provide initial expectations of how EVSEs would be used. This data has also supported forecasting load expectations and assessing how to size electrical service entrances and distribution transformers to meet expected capacity needs and adjust distribution and power design standards accordingly. Overall, the EV Everywhere project will drive learnings and inform opportunities to further expand the use of NWSs to address local system needs.

9.2.4.2 Ottawa DER Accelerator Project (ODERA)

The ODERA project is envisioned to build on the learnings from EV Everywhere, to further develop PA and granular demand-response technology for application to a larger ecosystem of customer devices (e.g. thermostats, EV chargers, battery storage and electric water heaters), while advancing Hydro Ottawa's grid modernization roadmap. With further technology development, this project could become a scalable and viable NWSs option to address needs in other areas. This project - which has received the support of federal funding - is further described in Section 3 of Schedule 2-5-8 - System Service Investments.

9.2.4.3 "Stream 2" Local NWSs Program Opportunities

Regulatory and policy work around NWSs will continue to evolve. The OEB has released the phase 1 BCA Framework - the Distribution Service Test (DST) - while phase 2, which will outline the approach to calculate both local and bulk system benefits and costs, known as the Energy System Test (EST) is forthcoming. Secondly, an IESO-LDC working group was established to assist with operationalizing "Stream 2" eDSM activities and in which Hydro Ottawa participates, has not completed its work.

Stream 2 programs are local NWSs programs, designed and administered by local distribution companies, that benefit both the local and bulk systems. The IESO's initial eDSM plan allocates funding to LDCs for local eDSM programs addressing distribution system needs, beginning in 2027. Once the working group's work is finalized and the process and funding mechanisms are available, Hydro Ottawa will align its NWSs efforts accordingly.

9.2.4.4 Alternative Energy Models

Alternative Energy Models such as local flexibility markets, Distribution System Operator capabilities, and Total Grid Orchestration capabilities are relatively new approaches in the energy sector to help manage the complex grid of the future. As Ontario pushes for greater DER participation, Hydro Ottawa will continue to evolve its processes and capabilities to be ready to unlock the value DERs can provide at the local level. Hydro Ottawa is exploring the constructs of these models and is starting to put in place the controlling elements for DER enablement needed to support any of these alternative models. Hydro Ottawa will continue to explore options to achieve benefits and will adapt to new responsibilities in the future around planning, facilitation, and coordination of DERs as these energy business models continue to evolve.

9.3. SYSTEM CAPABILITY ASSESSMENT FOR RENEWABLE ENERGY GENERATION AND DISTRIBUTION ENERGY RESOURCES

9.3.1. Historical Connections DER Applications

Within Hydro Ottawa's service territory, there is a considerable amount of connected distributed generation, or DERs. These energy resources represent all manners of electric generation and storage, including grid-connected solar panels, hydro-electric generators, natural-gas turbines, and battery storage facilities. In the last five years, the Hydro Ottawa service region has seen strong growth in the connected capacity of renewable generation, entirely as grid-connected photovoltaic generators, as can be seen in Figure 108.

Non-photovoltaic DERs have not seen significant growth. The Ottawa region's natural hydroelectric potential has largely been captured already, and there is strong disincentivization to construct carbon-producing combustion generation facilities, while there are strong incentives to construct renewable energy facilities. Additionally, BESS facilities continue to grow, with four in its service territory with an aggregate capacity of ~2MW, the highest individual capacity being 1,000kW.

In 2017, the IESO discontinued the microFIT program, which was a popular means of connecting small-scale residential photovoltaic systems (less than 10kW) to the grid. Despite the end of this program, Hydro Ottawa remains committed to ensuring that proposed DERs may connect to the grid whenever possible. Hydro Ottawa's programs for net metering (bidirectional flow of power to a premise) or load displacement (on-site generation that offsets premise's load) are available to customers as an alternative to the microFIT program. From 2019 to 2023, almost 300 new renewable DERs were connected under the net metering and load displacement programs, as can be seen in Figure 109 below, representing a 26% increase over that period. Of these, 88% were 10kW or under DERs.

Figure 108 - Total System DER Capacity 2019-2023

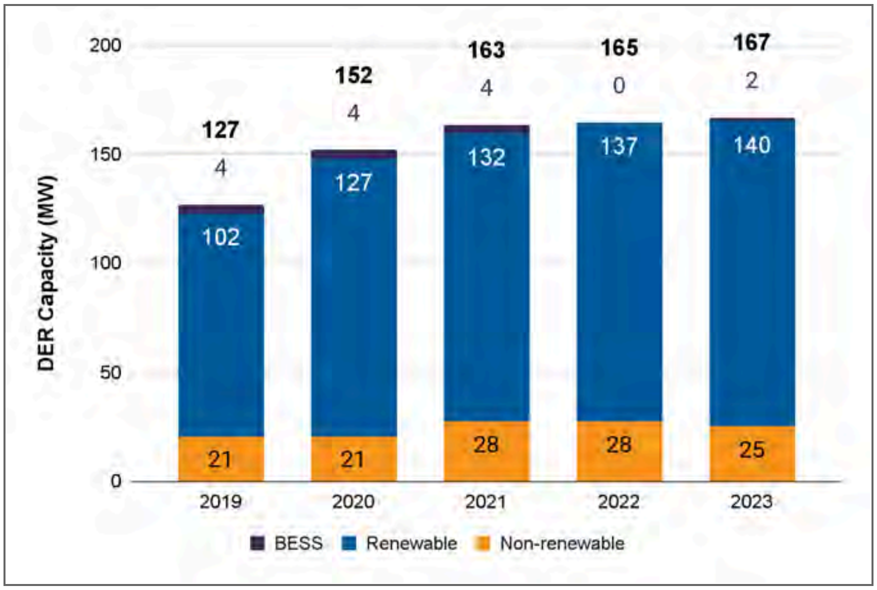
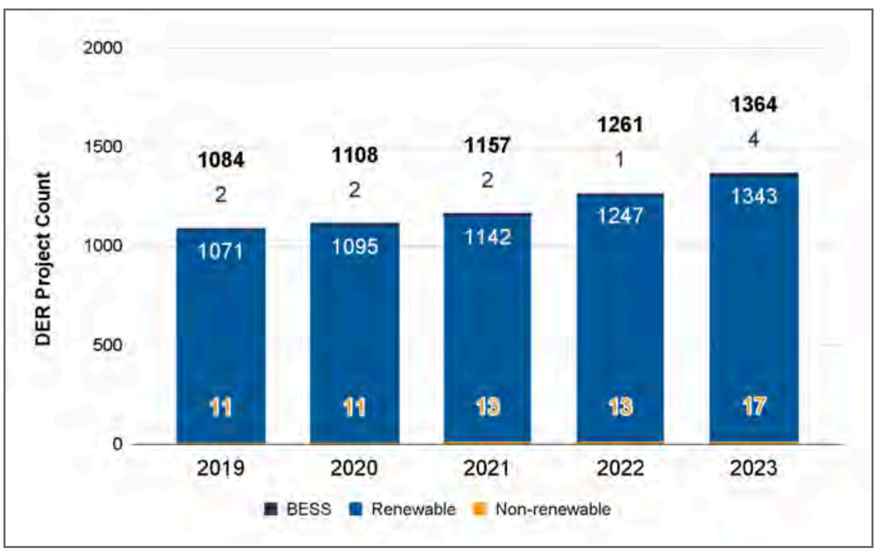
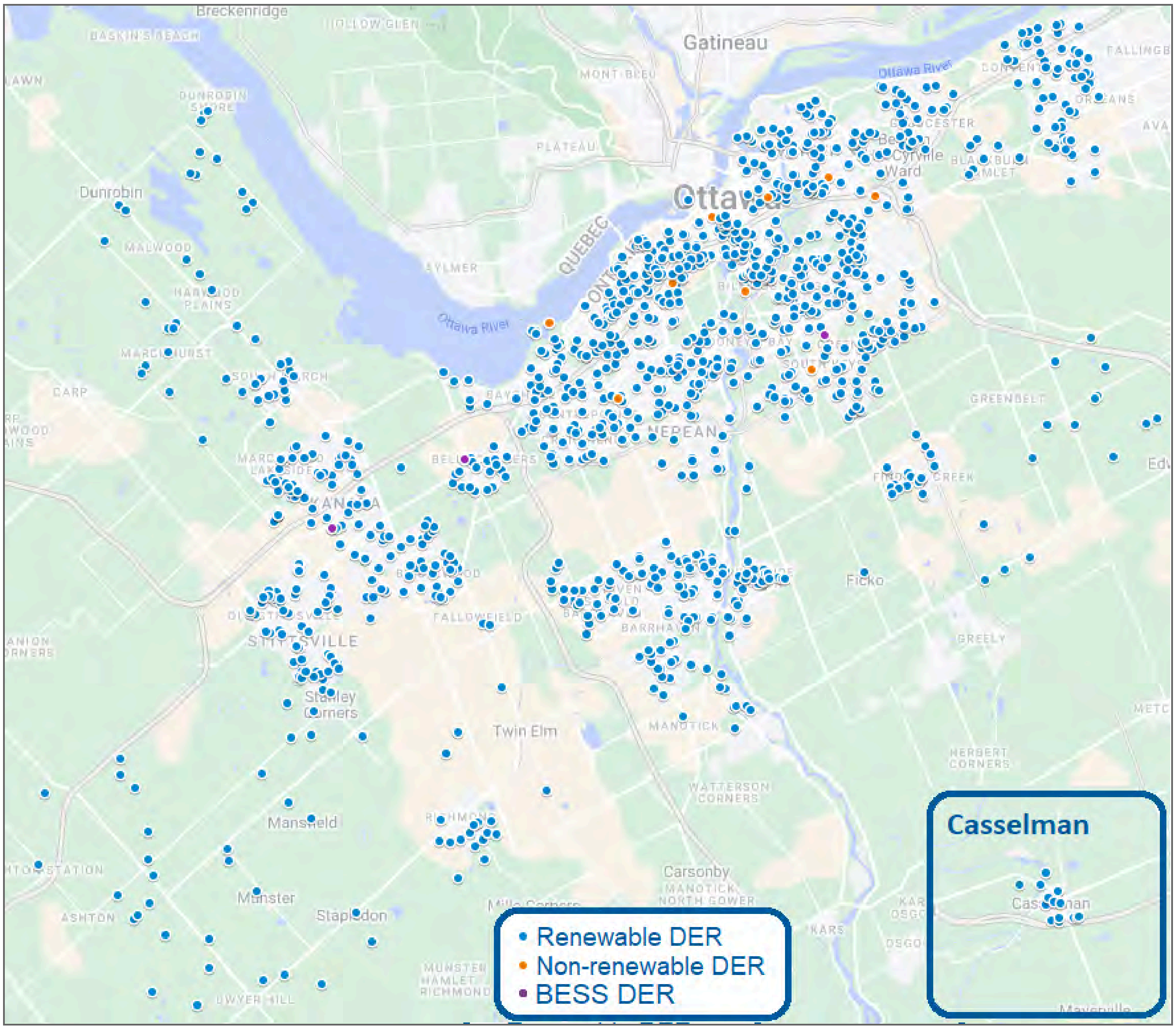


Figure 109 - Total System DER Count 2019-2023



The continuing success of DERs is visible in Figure 110, which maps the existing renewable and non-renewable DERs across the Hydro Ottawa service territory.

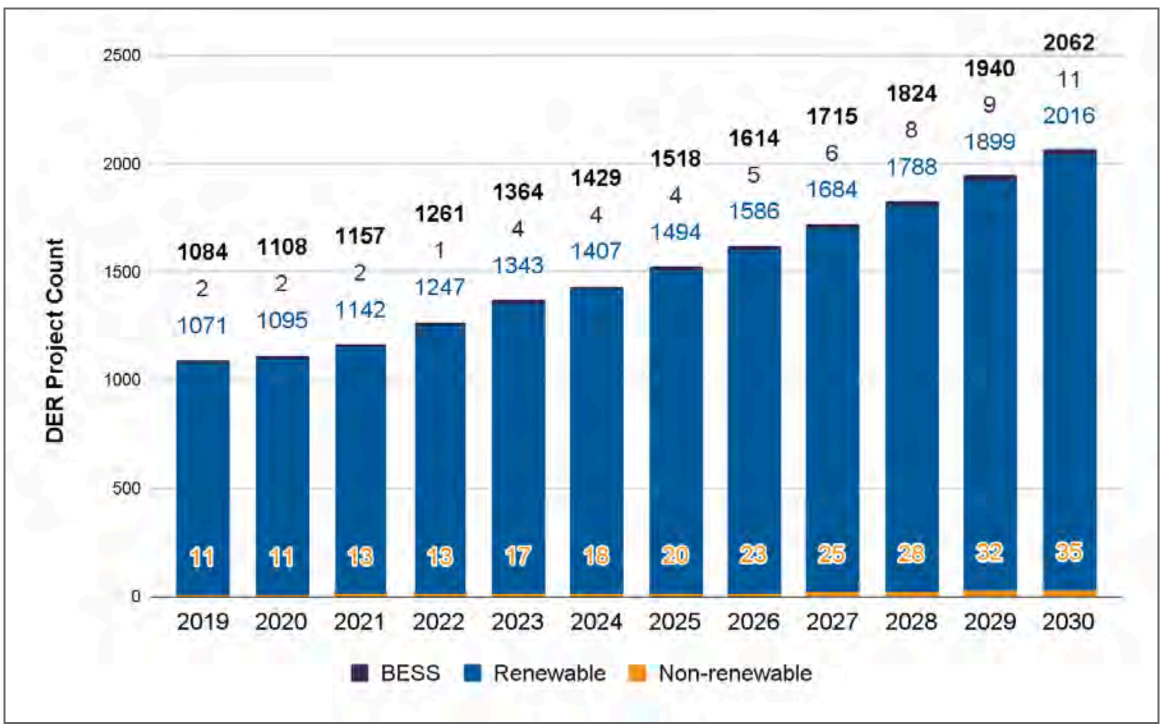
Figure 110 - Map of DER Projects in Hydro Ottawa Service Area



9.3.2 Generation Forecast

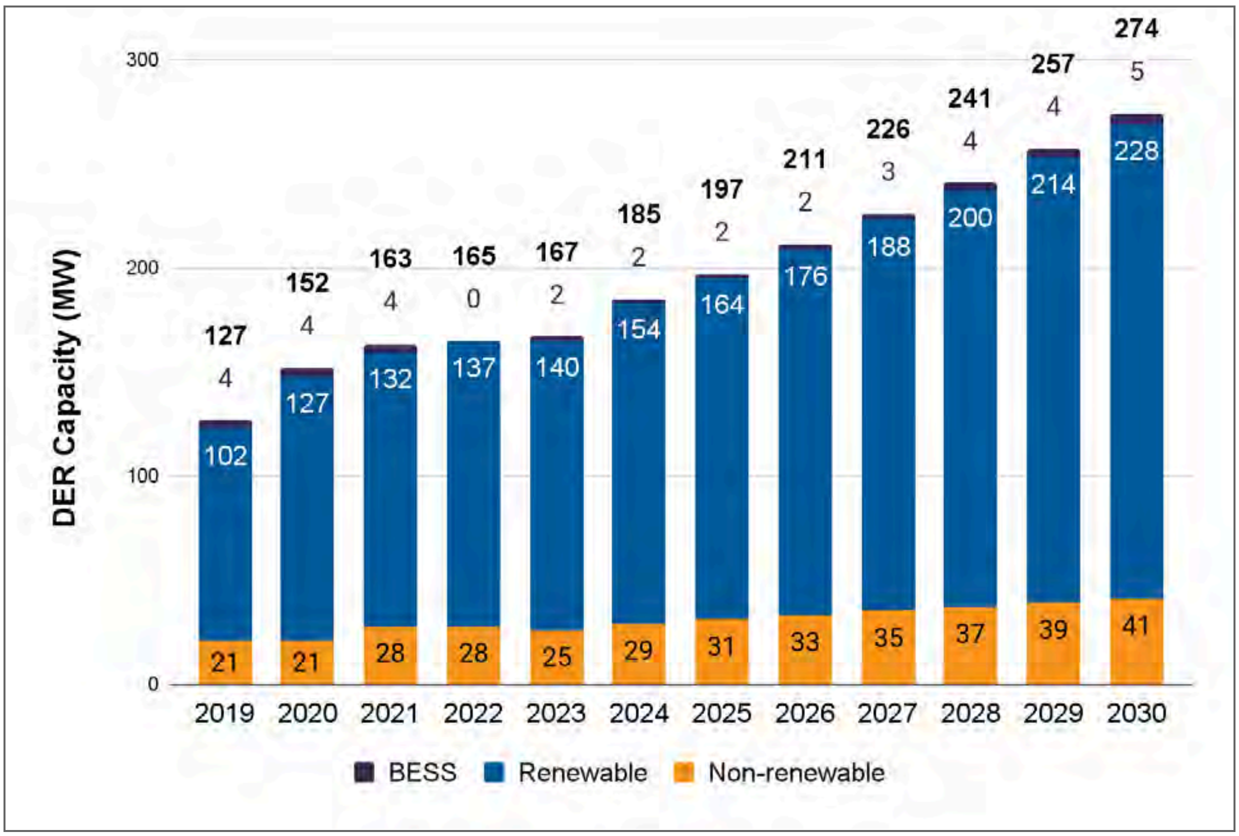
Hydro Ottawa's 2026-2030 DER forecast takes into account historical data, planned projects, current customer programs and the prevailing economic climate. Ultimately, customer choice fuels the demand for DERs and this demand is highly sensitive to policy influences, particularly the availability of funding and incentive programs. Predicting the precise timing, magnitude, and likelihood of customer adoption is challenging due to the numerous policy, economic, and technological variables at play - actual growth could deviate if new programs, incentives or technologies are introduced. The latest Hydro Ottawa forecast anticipates a total of 2,016 renewable projects by the end of 2030, in comparison to the 1,343 installed as of the end of December 2023. The forecast also anticipates 35 non-renewable and 11 BESS projects by the end of 2030, shown in Figure 111.

Figure 111 - Historical and Forecasted DER Projects



The forecast anticipates the cumulative installed renewable DER capacity to reach 228 MW by the end of 2030, as per Figure 112. The cumulative non-renewable DER capacity is projected to increase to 41 MW by the end of 2030, with BESS capacity increasing to 5 MW. With policy emphasis on decarbonization, it is expected that the number of renewable and energy storage DER projects will continue to increase beyond 2030.

Figure 112 - Historical and Forecasted DER Capacity



9.3.3. System Capability to Connect DER

Connecting new DERs to the distribution system requires careful evaluation of several key factors. Hydro Ottawa must ensure that the grid can safely and reliably accommodate the additional generation without compromising existing infrastructure or the quality of service to customers. This assessment includes analyzing the system's short-circuit capacity, thermal limits, and the potential impact of reverse power flow.

Furthermore, Hydro Ottawa must consider the effects of DERs on power quality. Maintaining stable voltage and frequency levels is crucial, and the connection of a DER should not introduce disturbances or create issues for other grid users. The potential for islanding, where a DER becomes isolated from the main grid but remains energized, also requires thorough investigation to prevent safety hazards. Each of these considerations is described in greater detail below as related to current system capacity and forecasted DER capacity from 2026-2030.

Short Circuit Capacity Constraints

Connection of DERs will increase the available current that flows through the distribution system during faults. The total available current during faults cannot exceed the equipment ratings. Currently Ellwood MTS is restricted due to short circuit capacity constraints. Consequently, substations fed from Ellwood MTS are also restricted - all Cahill AN feeders, Brookfield feeders AF02 through AF04, McCarthy AQ02 through AQ04, Albion feeders UA05 through UA07, and Walkley feeders UZ05 through UZ12. The Ellwood MTS short circuit constraint results in a total of 36 restricted feeders, as outlined in Table 37. More details on steps being taken by Hydro Ottawa to deal with the Ellwood MTS constraints is elaborated in Section 9.3.4 - Capacity Investments for DER Connections.

1 **Table 37 - Restricted Feeders and Number of Connected Customers**

Station Name	Feeder Designation	Restriction	# of Connected Customers
Ellwood	ELW01	Short Circuit Capacity	-
	ELW02	Short Circuit Capacity	64
	ELW03	Short Circuit Capacity	-
	ELW04	Short Circuit Capacity	1,038
	ELW05	Short Circuit Capacity	1,131
	ELW06	Short Circuit Capacity	5
	ELW07	Short Circuit Capacity	1,771
	ELW08	Short Circuit Capacity	1,149
	ELW09	Short Circuit Capacity	1,048
	ELW10	Short Circuit Capacity	973
	ELW11	Short Circuit Capacity	836
	ELW12	Short Circuit Capacity	673
	ELW13	Short Circuit Capacity	1,044
	ELW14	Short Circuit Capacity	808
Cahill	AN02	Short Circuit Capacity	-
	AN03	Short Circuit Capacity	-
	AN04	Short Circuit Capacity	365
	AN05	Short Circuit Capacity	399
	AN06	Short Circuit Capacity	251
	AN07	Short Circuit Capacity	-
	AN00	Short Circuit Capacity	-
Brookfield	AF02	Short Circuit Capacity	61
	AF03	Short Circuit Capacity	381
	AF04	Short Circuit Capacity	252
McCarthy	AQ02	Short Circuit Capacity	187
	AQ03	Short Circuit Capacity	453

Station Name	Feeder Designation	Restriction	# of Connected Customers
	AQ04	Short Circuit Capacity	330
Albion	UA05	Short Circuit Capacity	501
	UA06	Short Circuit Capacity	307
	UA07	Short Circuit Capacity	341
Walkley	UZ05	Short Circuit Capacity	382
	UZ06	Short Circuit Capacity	654
	UZ07	Short Circuit Capacity	241
	UZ10	Short Circuit Capacity	-
	UZ11	Short Circuit Capacity	665
	UZ12	Short Circuit Capacity	277
Lisgar	TL01	Thermal Capacity	6
	TL03	Thermal Capacity	-
	TL05	Thermal Capacity	755
	TL07	Thermal Capacity	-
	TL09	Thermal Capacity	215
	TL11	Thermal Capacity	-
	TL13	Thermal Capacity	2
	TL15	Thermal Capacity	-
	TL17	Thermal Capacity	-
	TL19	Thermal Capacity	674
	TL21	Thermal Capacity	364
	TL23	Thermal Capacity	31
	TL25	Thermal Capacity	424

Thermal Capacity Constraints

Exceeding the feeder ampacity rating results in overheating the conductors and connected equipment, thereby reducing the effective life of the asset or causing immediate equipment failure.

For DERs, the available thermal capacity is the full feeder ampacity rating, less the contingency loading. Lisgar TS currently has thermal constraints on T1, resulting in a total of 13 restricted feeders, as shown in Table 37. More details on steps being taken by Hydro Ottawa to deal with these constraints is elaborated in Section 9.3.4 - Capacity Investments for DER Connections.

Reverse Power Flow Considerations

When transformers are identified as having reverse flow capability as per manufacturer specification, the limiting factor is 60% of the top transformer rating plus minimum station load. For station transformers that have limited or no capability for reverse power flow, the limiting factor is the station minimum load. Only Lisgar TS is currently restricted by reverse power flow at the station.

Power Quality Considerations

There are various power quality concerns that are considered when connecting distributed generation on the system, including harmonics, phase imbalance, voltage instability, and flicker. Each of these factors is investigated as part of the connection impact assessment for proposed DERs.

Anti-islanding Considerations

DERs may introduce safety and power quality issues in the event of continued unsanctioned generation after the loss of distribution supply. The installation of transfer trip functionality and alternate anti-islanding methods such as reverse power flow protection may be used to mitigate the potential for the unsanctioned islanding of individual generators. Currently transfer-trip is required for generation connections equal to or larger than 500kW. Anti-islanding measures are investigated as part of the connection impact assessment for proposed DERs.

9.3.4. Capacity Investments for DER Connections

Hydro Ottawa currently has two stations in its distribution system with restrictions on generation connection. Ellwood MTS restrictions are due to short circuit limitations, while Lisgar TS is limited by minimum normal loading on the station bus, thus raising reverse power flow concerns should additional generation be installed.

Options are being assessed to remove short circuit limitations at Ellwood MTS. One of the alternatives being assessed is installing fast switching protective devices at the closed bus tie, thereby removing the short circuit constraint at the station and all downstream substations fed from Ellwood MTS. This solution is still at the planning stages and feasibility is left to be determined. In the interim, Hydro Ottawa is investigating the feasibility of operating Ellwood MTS with an open bus tie to temporarily remove the short circuit limitation until a permanent solution can be implemented.

Hydro One is addressing the constraint at Lisgar TS through the replacement of the T1 transformer to a unit that has reverse flow capability - the work will be completed by 2025. In addition, Hydro Ottawa is currently in discussions with Hydro One through the IRRP on timings to replace the T2 transformer at Lisgar TS with a larger unit to address future demand growth within the downtown area.

Hydro Ottawa is actively pursuing the solutions above to remove the short circuit restrictions on 36 feeders and the thermal restriction on 13 feeders, in order to accommodate new DERs. These initiatives demonstrate Hydro Ottawa's commitment to exploring and implementing feasible alternatives to enable DER connections even in areas with existing network constraints. This approach ensures that customers seeking to integrate DERs can be effectively accommodated wherever possible.

9.4. PLANNING LOAD FORECASTING

Hydro Ottawa's capacity planning process evaluates the distribution grid's ability to serve current and future customers safely and reliably, using the system load forecast as its foundation. The system load forecast was informed by two types of forecasts: Hydro Ottawa Planning Forecast and the IRRP Forecast. It is important to note that these forecasts are different from the revenue load forecast explained in detail in Section 9.4.3 - Planning Load Forecast vs. Revenue Load Forecast.

9.4.1. Hydro Ottawa Planning Forecast

Hydro Ottawa's Planning Forecast projects station-level load increases until 2030. It is guided by the City of Ottawa's Official Plan, City planning circulations, CDPs and consultations with developers and considers:

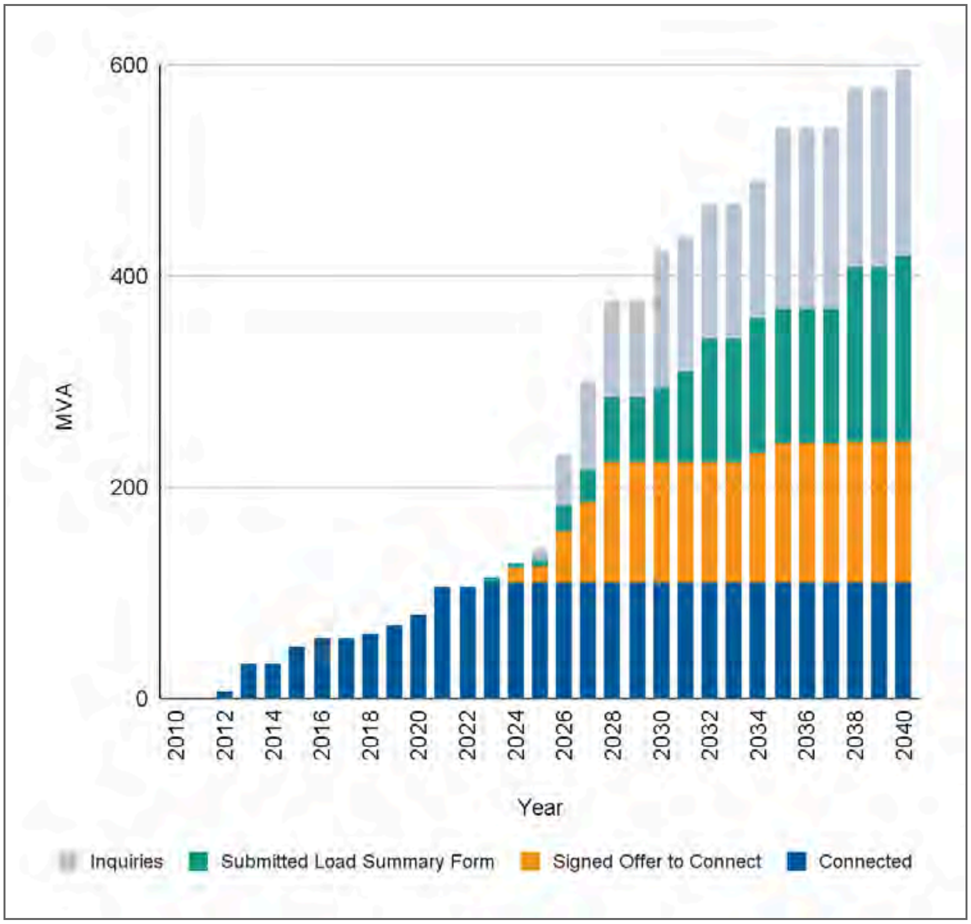
- Historical weather-normalized load from system coincident peak (currently summer) at the station level,
- Planned developments (residential, mixed-use, and employment)
- Known large load requests, see Section 9.4.1.1 - Large Load Request Trends and
- Customer requests in initial planning phases

While systemic impacts of space heating and transport electrification are not explicitly modeled, known large load requests, some of which are driven by electrification, are included. This detailed station-level approach is specifically used to inform near-term capacity needs across distribution subsystems, out to 2030.

9.4.1.1. Large Load Request Trends

Hydro Ottawa received large electrification load requests in the 2021-2025 period ranging from 5 MVA to 57 MVA. These requests encompass a variety of customers, from large institutions, like universities and hospitals, to technology companies and federal agencies. The main driver for the majority of large load requests was electrification of space heating, water heating, and transportation in order to align with municipal and federal decarbonization goals. The use of electric heat pumps, electric bus charging, and electric industrial water heating results in a significant increase in loading for large facilities, particularly when transitioning the entire facility to electric. The cumulative demand requests received through to January 1st 2025, with the respective energization timelines, are illustrated in Figure 113. Figure 113 highlights 110 MVA of large loads successfully integrated into the grid between 2010 and 2023 (blue), 113 MVA of confirmed customer commitments, secured through signed Offers to Connect and slated for completion by 2028 (orange), and a further 199 MVA of potential load requests, encompassing preliminary inquiries through to formal load summary submissions (grey and green). Should these potential requests materialize by 2030, Hydro Ottawa anticipates an unprecedented 312 MVA increase in its total load demand over the 6 year span of 2024-2030; a three-fold increase from the 110MVA connected in the previous 10 years.

Figure 113 - Cumulative MVA Large Load Requests



9.4.2. IRRP Forecast

The IRRP forecast submitted by Hydro Ottawa to the IESO for the regional planning process is built with a focus on the medium to long-term outlook (beyond 2030) that considers a sensitivity analysis due to effects of decarbonization goals. This is in alignment with the Regional Planning Process Advisory Group's (RPPAG) Load Forecasting Guideline.[44] Previously, mid to long-term forecasting relied on historical consumption patterns and projected growth rates based on observable past trends. However, with the introduction of decarbonization goals and the resulting electrification of

[44] RPPAG Load Forecasting Guideline-
https://www.oeb.ca/sites/default/files/Load-Forecast-Guidance-Document-RPPAG-20221013.pdf

buildings, water heating, and transportation, this methodology is no longer adequate to model the potential impacts these shifts have on electricity demand.

Hydro Ottawa leveraged the hourly system coincident peak forecasts from the Decarbonization Study's Reference Scenario, see details in Section 9.4.2.1 - Decarbonization Study to inform the IRRP forecast. This helps contextualize potential long-term impacts of decarbonization. Aligning with the Decarbonization Reference Scenario in the medium to long-term is required for the regional planning process as transmission level investments that add capacity to the provincial grid have longer lead times (> 5 years). This also allows Hydro Ottawa to validate that capacity investments for immediate needs (informed through Hydro Ottawa's planning forecast) strategically align with indications of long-term needs, ensuring efficient capital deployment and optimizing asset utilization.

9.4.2.1. Decarbonization Study

To support the transition to a more advanced forecasting methodology for medium to long-term system needs, Hydro Ottawa engaged Black & Veatch to conduct a Decarbonization Study to examine the impact of decarbonization initiatives on Hydro Ottawa's distribution system through 2050. Refer to Attachment 2-5-4(F) - Decarbonization Study for details on the study.

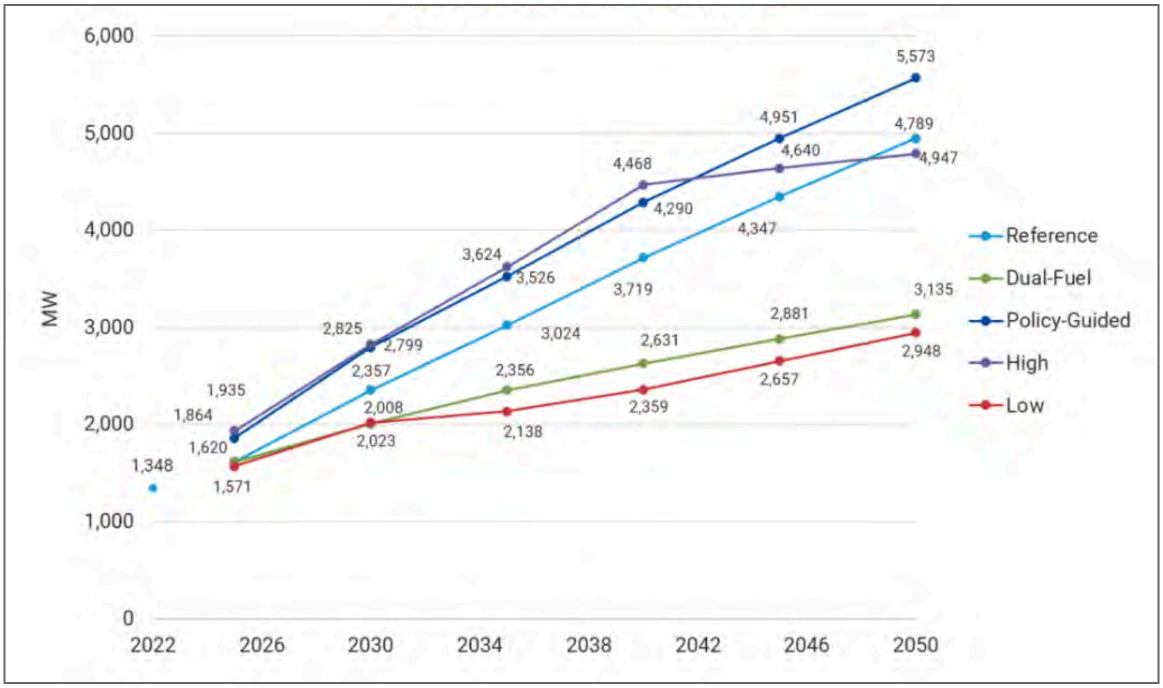
The Decarbonization Study outlines five scenarios that assess the impact of decarbonization initiatives on Hydro Ottawa's distribution system until 2050. Decarbonization levers such as population growth, energy efficiency, electric vehicle adoption, and building heating assumptions were adjusted within each scenario. Load modeling was divided into Baseline and New Electrification load categories. These scenarios illustrate potential impacts on Hydro Ottawa's load profiles. The five scenarios are outlined in Table 38 below.

Table 38 - Decarbonization Study Scenarios

Scenario	Description
Policy-Guided Scenario	• Models strict adherence to Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. • Assumes full electrification of buildings and transportation, representing an aggressive decarbonization pathway. • Provides insights into the potential challenges and infrastructure requirements under ambitious climate goals.
Reference Scenario	• Represents the most likely outcome based on current trends in Hydro Ottawa's load forecast. • Assumes a moderate pace of decarbonization, with increasing electrification in the mid-to-long term. • Serves as the primary basis for evaluating the distribution system impact and potential solutions.
Dual-Fuel Scenario	• Sensitivity analysis applied to the Reference Scenario, focusing on space heating and water heating. • Assumes a significant portion of buildings will adopt dual-fuel heating systems, using both electricity and low-carbon gas. • Helps assess the impact of continued gas use on peak demand during extreme cold temperature and overall load growth.
High Case Sensitivity	• Explores a more aggressive decarbonization and electrification pathway than the Policy-Guided Scenario. • Assumes accelerated adoption of electric vehicles (EVs) and higher efficiency gains in heating technologies. • Helps evaluate the potential for rapid load growth and the need for proactive grid investments.
Low Case Sensitivity	• Considers a less aggressive decarbonization and electrification pathway than the Policy-Guided Scenario. • Assumes slower EV adoption and a higher proportion of buildings continuing to rely on decarbonized gaseous fuels. • Provides insights into the potential for slower load growth and the implications for infrastructure planning.

Hydro Ottawa leveraged Black & Veatch projections for the Reference Scenario to inform its medium to long-term forecast that was submitted to the IESO as part of the regional planning process - the IRRP Forecast. The five scenarios are depicted in Figure 114.

Figure 114 - Decarbonization Scenario Peak by Year[45]



The Reference scenario is based on historical data and existing trends, and assumes increasing policy-driven decarbonization leading to electrification in the medium to long-term. This scenario was selected because in the Reference Scenario, the new electrification load forecast is characterized by a tempered pace of decarbonization in the short-term which meets Canada's 2030 Emissions Reduction Plan and Canada's wider 2050 decarbonization goals. Further, this scenario assumes full electrification of most buildings, with a minority continuing to utilize gas distribution networks by 2050. The Reference scenario sees the system transition to winter peaking by 2030, largely driven by projections on space heating, where electrification rates in buildings lead to spikes in space heating when temperatures are low and impact heating efficiency.

9.4.3. Planning Load Forecast vs. Revenue Load Forecast

The planning forecast serves as the foundation for evaluating the distribution system's capacity to

[45] Figure 38 in Attachment 2-5-4(F) - Decarbonization Study

accommodate future electricity demand. This forecast plays a pivotal role in identifying both the locations and the timing of necessary system upgrades. By considering factors at various levels of granularity—including the station and planning region—the planning forecast allows for a nuanced and targeted approach to system expansion. Its emphasis on location specificity and its incorporation of coincident peak demand requirements—the periods when electricity demand is at its highest—ensure that the distribution system remains robust and capable of meeting the needs of consumers, even during peak load periods. More details on justification for station capacity needs are available in Section 2.3.2 in Schedule 2-5-8 - System Service Investments.

In contrast, the revenue load forecast, outlined in Schedule 3-1-1 - Revenue Load and Customer Forecast, is primarily employed for financial planning and the determination of distribution rates and allocating revenue requirements. This forecast centers on billing consumption and billing demand rather than the locational coincident peak demand, measured in MWs. While the planning forecast is granular and location-specific, the revenue load forecast takes a more aggregated approach. It considers a broader array of factors, such as economic trends, population growth, energy efficiency initiatives, and the impacts of CDM programs. The development of the revenue load forecast typically relies on historical billing data, sophisticated econometric models, and customer class segmentation, enabling a comprehensive understanding of revenue requirements and informing the establishment of distribution rates.

In essence, the planning forecast and the revenue load forecast serve distinct yet complementary purposes within the electricity distribution system. Both forecasts use the same foundational considerations built upon shared core principles, influencing elements, and underlying assumptions on how energy consumption will evolve. However, the planning forecast ensures the system's physical capacity to meet future peak demand (the worst case scenario), while the revenue load forecast supports financial planning and rate setting through annual consumption. By recognizing the differences in their focus and level of aggregation, Hydro Ottawa leverages these forecasts effectively to optimize both the operational and financial performance of the electricity distribution system.

ea technology

CERTIFICATE OF CONFORMANCE

Certificate of Conformance

This is to certify that the Asset Management System of

Hydro Ottawa Limited

2711 Hunt Club Road, Ottawa, K1G 4G2, Canada

is in conformance with the requirements specified within the following Asset Management Standard:

ISO55001: 2014

The scope of the Asset Management System is applicable to:

- The electricity distribution and electrical energy supply assets owned, managed and operated by Hydro Ottawa Ltd. including:
  - All electricity distribution system assets.
    - This includes metering assets and communication systems between all applicable sets of assets.
    - This excludes fleet and IT businesses.
  - All core processes that are applicable to the Asset Management System, including internal resources and control of external service providers contributing to asset management.

This certificate is applicable to the following Hydro Ottawa Ltd. locations:

- Main Office & East Operations (2711 Hunt Club Road, Ottawa, K1G 4G2, Canada)
- Training Centre (4565 Bank Street, Gloucester, K1T 3W6, ON, Canada)
- West Operations (100 Maple Grove Road, Kanata, K2V 1B8, ON, Canada)
- Warehouse & South Operations (201 Dibblee Road, Nepean, K2R 1J2, ON, Canada)
- Central Operations (1275 Carling Avenue, Ottawa, K1Z 1A2, ON, Canada)

CERTIFICATE OF CONFORMANCE

Signed For EA Technology

A McHarrie: Head of Asset Management
Issued by: EA Technology Limited
Capenhurst Technology Park
Capenhurst
Chester. CH1 6ES

Certificate Number: EA2309001

Certification issue date: 18th September 2023

Certificate expiry date: 17th September 2026

IAM endorsed ASSESSOR

Stantec

Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan

FINAL REPORT

December 4, 2023

Prepared for:
Hydro Ottawa Limited

Prepared by:
Stantec

Project Number:
160925222

Limitations and Sign-off

The conclusions in the Report titled Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. This report should be read in conjunction with the original Distribution System Climate Risk and Vulnerability Assessment, 2019 and Hydro Ottawa Climate Change Adaptation Plan, 2019. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

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Prepared by: Rocard, Jennifer — Digitally signed by Rocard, Jennifer Date: 2023.12.04 17:06:51 -04'00'
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Climate Solutions Leader, Canada
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Executive Summary

Stantec Consulting Ltd. (Stantec) was retained to by Hydro Ottawa Limited (HOL) to conduct an update to the Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019. The main objective of the study was to identify if the climate adaptation and risk mitigation measures recommended in the 2019 adaptation plan are still appropriate for the existing risk levels and consequences. This study uses additional and updated climate projection data to estimate climate parameter probabilities and identifies whether these changes lead to materially different risk scores for Hydro Ottawa's infrastructure assets over the study period. The study involved updating the list of climate parameters to include additional high wind thresholds representative of recent extreme weather events, update climate parameter probabilities, impact severity (based on input from Hydro Ottawa personnel), and risk scores, completing a forensic analysis of the May 21, 2022 Derecho event; and a workshop with staff to evaluate adaptation plan progress and assess potential changes to consequence ratings from the 2019 risk assessment, updating where appropriate the adaptation and risk mitigation plan using input from the review workshop and where risk scores changed to medium-very high under current and future climate. For consistency, the same methods used in the 2019 report were also used in this reassessment.

Two additional high wind thresholds were established for this update based on updated Environment and Climate Change Canada (ECCC) criteria for severe thunderstorm winds and the damages observed by the Northern Tornadoes Project in surveys following the 2022 May Derecho event. The thresholds established included:

- Wind speeds > 130 km/h – Based on new ECCC severe thunderstorm winds and with 17% higher loading factor than the 120 km/h gust threshold used in the 2019 study.
- Wind speeds > 180 km/h (Derecho event equivalent) – based on consistent EF-2 style observed damage in Ottawa region and Doppler Radar near surface wind speed recordings.

The climate analysis completed for the 2019 study was based on Coupled Model Intercomparison Project Phase 5 (CMIP5) Global Climate Models (GCMs) climate projections. CMIP5 climate projections formed the basis of the *IPCC Fifth Assessment Report* (IPCC, 2013). The "Delta Approach" downscaling method was used to generate localised climate change projections from 37 CMIP5 GCMs. Projected frequencies of occurrence and likelihoods were assessed based on the multi-model ensemble projections under the RCP8.5 scenario.

Following the completion of the 2019 study, new climate projection data has become available. In 2020, the National Capital Commission and the City of Ottawa released climate projection data for the RCP4.5 and RCP8.5 scenarios for the National Capital Region (NCR). In 2021/2022, the Intergovernmental Panel on Climate Change (IPCC) released its *Sixth Assessment Report* (AR6) based on climate projections from the Coupled Model Intercomparison Project Phase 6 (CMIP6) and based on the new Shared Socio-economic Pathway (SSP) climate change scenarios. Where possible, the projected frequency of occurrence and probability of the selected climate parameters for the CRVA were updated based on these new climate projection data sources.

The climate parameter frequency of occurrence and probabilities were updated using, where possible, the downscaled National Capital Region projections and downscaled CMIP6 projections. Annual and/or 30-year probabilities for the 2050s (2041-2070) changed for the following climate parameters:

- Rain: 50 mm in 1 hr
- Invasive species: Emerald Ash Borer kill temperature (daily minimum temperature of -30°C or colder)
- Frost: Hard freeze-thaw cycles (daily Tmax/Tmin temperature fluctuation of ±4°C around 0°C)

While tornadoes have impacted the Ottawa region more frequently in the last decade, the probability rating for tornado occurrence has not changed. Probability ratings were established for two scenarios: 1) the likelihood of a single point within Hydro Ottawa's service area being struck by a tornado and 2) the likelihood of a tornado occurring anywhere within the service area. In the risk assessment, the higher likelihood was carried forward and used to estabilsh potential risk.

Frequency of occurrence and probabilities were also established for the new high wind thresholds of wind speeds > 130 km/hr and > 180 km/hr.

Risk scores increased due to higher consequence ratings for current and future climate for higher threshold wind speeds (120 km/hr) and for newly established thresholds (130 km/hr and 180 km/hr). However, for most risks, no risk level change was observed.

To handle additional risks from higher wind thresholds, the following risk adaptation measures should be considered:

- Consider a study on pole characteristics (i.e. age and guying locations) from the 2022 Derecho to determine potential vulnerability of pole tops.
- Consider the impact of climate change on recently (or future) hydro poles being grown (i.e. wood density and strength)
- Consider establishing additional supply capacity and storage for key components (e.g. poles) in the event that a major or catastrophic event impacts a large portion of the service area
- Consider real-time or automated monitoring system for severe weather events or creating a staff position for a meteorologist to handle coordination between utilities and monitoring potential upstream outages before they impact HOL service area
- Continue with planned adaptation planning actions already underway, including an undergrounding study, anti-cascading study and strategy, and asset hardening however, new risk should be utilized in decision making a cost/benefit studies underway.

Other risk mitigation measures developed in the 2019 study remain relevant based on the conversations conducted at the 2023 reaffirmation workshop.

Acronyms / Abbreviations

AEP	Annual Exceedance Probability
AR5	5th Assessment Report
AR6	6th Assessment Report
BCCAQv2	Bias Correction/Constructed Analogues with Quantile delta mapping reordering, version 2
CanDCS-U5	Canadian Downscaled Climate Scenarios – Univariate (CMIP5)
CanDCS-U6	Canadian Downscaled Climate Scenarios – Univariate (CMIP6)
CMIP5	Coupled Model Intercomparison Project 5
CMIP6	Coupled Model Intercomparison Project 6
ECCC	Environment and Climate Change Canada
EF	Enhanced Fujita Scale
GCM	Global Climate Model
IDF	Intensity-Duration-Frequency
IPCC	Intergovernmental Panel on Climate Change
NTP	Northern Tornadoes Project
PCIC	Pacific Climate Impacts Consortium
PIEVC	Public Infrastructure Engineering Vulnerability Committee
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
RSI	Risk Sciences International
SSP	Shared Socioeconomic Pathway

1 Introduction

Stantec Consulting Ltd. (Stantec) completed this scope of work to provide Hydro Ottawa Limited (HOL) with an Updated Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan, as appropriate, given some of the recent major weather events, specifically:

- September 21, 2018 – Tornadoes
- April 15, 2019 – Lightning storm and flooding
- July 5, 2019 – Windstorm
- June 14, 2021 – Summer/Lightning storm
- May 21, 2022 – Derecho storm
- December 23, 2022 – Winter storm

This update addresses only the revised risks and adaptation measures and should be read in conjunction with the original reports:

- Distribution System Climate Risk and Vulnerability Assessment, dated September 11, 2019 (Stantec, 2019a)
- Hydro Ottawa Climate Change Adaptation Plan, dated November 11, 2019 (Stantec, 2019b)

1.1 Background

A Climate Risk and Vulnerability Assessment (CRVA) and an Adaptation Plan was conducted was developed for HOL conducted by Stantec in 2019 (Stantec, 2019a-b) using:

- Available climate data for the region and their projection into the future using internationally accepted Intergovernmental Panel on Climate Change (IPCC) projection data, and
- Forensic analysis of three significant weather events that occurred in 2018 and resulted in widespread outages / costly recoveries, including a freezing rain event in April, a heavy wind event in May, and a series of tornados that touched down in September in the Ottawa region.

The climate data was used to conduct a climate risk assessment using Engineers Canada's Public Infrastructure Engineering Vulnerability Committee's (PIEVC) assessment protocol (Engineers Canada, 2011) and estimate the vulnerability and risk of Hydro Ottawa's electrical distribution system to climate change and extreme weather events.

The risk assessment included a workshop with Hydro Ottawa personnel, interviews with stakeholders, and an analysis of past climatic events to characterize the impacts and consequences of climate on Hydro Ottawa's assets. Risks were evaluated by combining the climate hazard likelihood with the consequence information. The results of the 2019 report were used to determine where infrastructure vulnerabilities to climate change were present and identify adaptation options to increase resilience.

1.2 Objective

The main objective of this update was to add new climate parameters for wind, utilize new climate data, revise risk based on more extreme weather events and establish new climate risk scores and risk mitigation measures as part of the update to the climate risk and adaptation plans. The outcome of the project is to identify revised climate risk scoring and whether there are any additional climate adaptation and risk mitigation measures required as a result of the revised assessment.

1.3 Scope

The following scope of work has been completed as part of this assessment.

1. **Climate Parameter Probability Update:** Assessment of past and recent weather events looking for new and more accurate climate data that has been available since the most recent assessment. Revision of likelihood scores for the Hydro Ottawa service area where necessary.
2. **Risk Assessment Update:** Evaluating the possible changes to the consequence ratings for any events, in particular focusing on the high and very high risks from the 2019 report.
3. Incorporation of an evaluation of the six weather related events into the impact rating and adding layers of wind speeds between 80 and 180 km/hr with the representative frequency data (for the same current and future scenarios developed in the 2019 report).
4. Provision of a forensic evaluation of the Derecho event that occurred on May 21, 2022. For this task, Stantec included the services of a subconsultant form the University of Western Ontario Northern Tornadoes Project (NTP), the foremost severe weather experts in Canada. This task included access to data from the NTP collected past event, leveraging extensive damage survey, impacts data, and mapping as well as engagement during the risk assessment workshops and executive board presentation. The primary resource from NTP were also part of the 2019 report, which allows for continuity with service delivery between Stantec, NTP, and Hydro Ottawa.
5. Identification of the impacts of various wind events across the additional laminations identified and rank the impacts / consequences (i.e., probability x impact) to provide overall risk levels in accordance with the Enterprise Risk Management rating system.
6. **Adaptation Plan Update:** Review of the status of climate adaptation and risk mitigation measures from the 2019 report using input from a review workshop to determine appropriateness based on updated risk levels and hazards.
7. **Addendum Report and Presentation of Results:** Provide an addendum report for both the 2019 Climate Risk and Vulnerability Assessment and Climate Change Adaptation plan based on the to reflect the new findings. Prepare and deliver an executive summary presentation to senior management, including an overview of the Derecho event and findings from the forensic study.

2 Climate Analysis Update

This section describes the data and methods used to update climate parameter frequencies of occurrence and probabilities, followed by a discussion on the climate parameters with adjusted probability scores based on the updated climate projection data reviewed. The climate parameters investigated, and methods used to estimate probabilities align with the 2019 report, except where otherwise noted.

2.1 Methodology

2.1.1 Climate Data

The climate analysis completed for the 2019 study was based on Coupled Model Intercomparison Project Phase 5 (CMIP5) Global Climate Models (GCMs) climate projections. CMIP5 climate projections formed the basis of the *IPCC Fifth Assessment Report* (IPCC, 2013). The “Delta Approach” downscaling method was used to generate localised climate change projections from 37 CMIP5 GCMs. Projected frequencies of occurrence and likelihoods were assessed based on the multi-model ensemble projections under the RCP8.5 scenario.

Since the completion of the 2019 study new climate projection data has become available. In 2020, the National Capital Commission and the City of Ottawa released climate projection data for the RCP4.5 and RCP8.5 scenarios for the National Capital Region (NCR). In 2021/2022, the Intergovernmental Panel on Climate Change (IPCC) released its *Sixth Assessment Report* (AR6) based on climate projections from the Coupled Model Intercomparison Project Phase 6 (CMIP6) and based on the new Shared Socio-economic Pathway (SSP) climate change scenarios. Where possible, the projected frequency of occurrence and probability of the selected climate parameters for the CRVA were updated based on these new climate projection data sources.

2.1.1.1 NCR Projections

The National Capital Commission (NCC) and the City of Ottawa have released a comprehensive climate change projection study for the National Capital Region (NCR). The NCR projections were developed using a collaborative and impacts driven approach and relying on ECCC and various GCMs and Regional Climate Model (RCM) datasets (City of Ottawa, 2020). The downscaled NCR climate projections have a high spatial resolution (10 km) and output numerous climate variables and indices for the RCP4.5 and RCP8.5 scenarios over the period of 2011-2100.

The primary source of climate projections for the NCR projections was high -resolution (~10 km) downscaled climate projections for Canada from 24 CMIP5 GCMs, referred to as the Canadian Downscaled Climate Scenarios – Univariate (CMIP5) (CanDCS-U5). The Pacific Climate Impacts Consortium (PCIC) has produced the CanDCS-U5 projections using the hybrid BCCAQv2 (Bias Correction/Constructed Analogues with Quantile delta mapping reordering, version 2) downscaling method (Cannon, 2015; Cannon et al., 2015). Additional climate projection data used for the NCR projections came from RCMs include CORDEX/UQAM, CanRCM4 (ECCC), INRS/Ouranos, and the University of PEI.

2.1.1.2 Shared Socio-economic Pathways

The IPCC's *Sixth Assessment Report* presents the latest global and regional assessments of climate change and its impacts using a set of five new illustrative emissions scenarios, referred to as Shared Socioeconomic Pathways (SSPs). The SSPs are based on five narratives describing alternative socioeconomic developments, including "sustainable development" (SSP1), "middle-of-the-road development" (SSP2), "regional rivalry" (SSP3), "inequality" (SSP4), and "fossil-fueled development" (SSP5) (see Table 2 in Riahi et al., 2017 for detailed descriptions). SSP5-8.5 represents a scenario with very high GHG emissions, with CO2 emissions that roughly double from current levels by 2050.

The climate analysis in the 2019 report used climate projections for the high emissions Representative Concentration Pathway – RCP8.5. The radiative forcing trajectories in RCP8.5 and SSP5 generally correspond (Riahi et al., 2017) and represent similar climate projection scenarios. Of the RCP and SSP scenarios, the RCP8.5 and SSP5 trajectories more closely match historical emissions, respectively, and therefore represent plausible emissions tracks into the future (Smith and Myers, 2018; Schwalm et al., 2020; Mohanty and Simonovic, 2021). Therefore, to provide a conservatively high estimate of projected climate change and its associated impacts, the CVRA focuses on the RCP8.5 and SSP5 emissions scenarios.

2.1.1.3 CanDCS-U6 Projections

Recently, global climate models (GCMs) driven by the SSPs have contributed to CMIP Phase 6 (Eyring et al., 2016), which forms the basis of the IPCC *Sixth Assessment Report* (IPCC, 2021). Downscaling methods are often used to produce finer spatial resolution projections from these GCMs. PCIC has produced high-resolution (~10 km) downscaled climate projections for Canada for 26 CMIP6 GCMs for three Shared Socioeconomic Pathway (SSP) projection scenarios, referred to as the Canadian Downscaled Climate Scenarios – Univariate (CMIP6) (CanDCS-U6). PCIC produced the downscaled projections for the simulated period of 1950-2100 using the hybrid BCCAQv2 downscaling method.

2.1.1.4 Levels of Confidence in Projections

Future climate conditions presented in this climate profile are retrieved from climate projections produced by downscaled GCMs, specialized literature, and professional judgement of Stantec's climate scientists. Some climate variables can be projected into the future with more confidence than others. The level of confidence in climate projections is dependent on the understanding of the processes involved in the climate phenomena, ability of climate models to simulate the phenomena, degree of agreement among the climate models (e.g., range of uncertainty), and the supporting evidence (e.g., theory, specialized literature, expert judgement, etc.). For example, projections based on GCMs and downscaling of such models are considered:

- Adequate (high confidence) for general temperature and precipitation projections,
- Less adequate (moderate confidence) for extreme parameters, and
- Inadequate for combined events (low confidence) such as freezing rain.

Combined or complex climate variables are normally inferred from other climate variables and result in lower confidence for projections. For example, freezing rain is a complex process and the projected prevalence of freezing rain events under future climate conditions is not as well understood as other variables such as temperatures.

All climate models have inherent shortcomings in fully and accurately representing the real climate system. Therefore, it is not recommended to rely only on one or two climate models to estimate future climate. Instead, an average of several climate models (a multi-model mean) tends to give a more reliable estimate of future climate (IPCC, 2013; 2021). The use of ensembles and multi-model means is common in climate science and is strongly encouraged as "best practice" (IPCC, 2013; 2021). Using ensembles and multi-model means provide insight into uncertainties in climate model projections. Therefore, the ensemble mean of the 26 CMIP6 GCMs is presented in this assessment.

2.1.2 Derecho Event May 21, 2022 Forensic Analysis

As part of the reaffirmation study, Stantec included the expertise of meteorologists from Western University's Northern Tornadoes Project (NTP) and Northern Hail Project (NHP) to provide expert advice and analysis in the form of a forensic assessment of the May 21, 2022, severe windstorm. Termed a "derecho", this storm severely impacted Hydro Ottawa's infrastructure.

Doctor David Sills, Executive Director of the Northern Tornadoes Project (NTP), and Simon Eng, Research Meteorologist with the Northern Hail Project (NHP) and former consulting meteorologist on the original 2019 study, were asked to support the Hydro Ottawa reaffirmation study to address the following questions and concerns:

- *Significant concern regarding impacts associated with 120 km/h winds:* A peak wind gust reading of 120 km/h was recorded at Ottawa International Airport during the event. Wind speeds of this magnitude were included in the original climate risk assessment (Stantec 2019) but the May 21, 2022, storm generated impacts far greater than had been anticipated for winds of this magnitude.
- *The number and severity of weather-related outage events in recent years:* Several very high impact severe weather events have affected Hydro Ottawa's system since the late-2010s. This has triggered concerns that these events are increasing in frequency to such an extent that their effects may not be manageable.
  - In particular, the southern-portion of the City has been severely affected by both the 2022 Derecho event and one of the September 2018 tornadoes: This raised concerns that this specific region within Hydro Ottawa's service area was particularly vulnerable to severe thunderstorm-related wind events.
- *The May 21, 2022, storm indicated the need for identifying additional damage thresholds:* To help support future planning and continued efforts to increase resilience to current and future climate impacts, the risk assessment framework required the identification of additional, higher wind speed thresholds than had been previously identified in the original 2019 risk assessment (Stantec 2019).

Evidence using damage-based wind speed estimates, coupled with a review of Doppler radar wind velocity information, as well as evidence from other locations along the Derecho path, strongly indicates that the 120 km/hr wind gust measured at Ottawa International Airport was *not* representative of the wind speeds experienced during the event in the most severely impacted portions of Hydro Ottawa's system.

These pieces of evidence generally indicate much stronger winds which likely reached 180-195 km/h. As a result, additional wind thresholds were established and are further described in Section 2.1.3. Further information from the forensic analysis of the Derecho event can be found in Appendix C.

2.1.3 Additional High Wind Thresholds

Initial wind thresholds for the 2019 study included high wind gusts of 120 km/h and easterly winds of 60 km/h and 80 km/h at seasonal and annual time periods. Two additional high wind thresholds were established for this update based on updated Environment and Climate Change Canada (ECCC) criteria for severe thunderstorm winds and the damages observed by the Northern Tornadoes Project in surveys following the 2022 May Derecho event. The thresholds established included:

- Wind speeds > 130 km/h – Based on new ECCC severe thunderstorm winds and with 17% higher loading factor than the 120 km/h gust threshold used in the 2019 study
- Wind speeds > 180 km/h (Derecho event equivalent) – based on consistent EF-2 style observed damage in Ottawa region and Doppler Radar near surface wind speed recordings

2.1.4 Climate Parameter Probabilities

Climate parameter frequency of occurrence and probability were based on either the NCR projections, CanDCS-U6 projections, or literature review (which included specialized studies, climate analogues, and professional judgement). The climate projections data sources used for each climate parameter, for the 2019 study and the 2023 update, are presented in Table 1. The baseline probabilities from the 2019 report are maintained in this study because their calculation relied on high-quality measurements obtained from the Ottawa Macdonald-Cartier International Airport weather station.

Annual probabilities were calculated for the baseline period (1981-2010) and the 2050s (2041-2070) for each climate parameter. The annual probabilities were then translated to study period probabilities by estimating the likelihood of occurrence over a 30-year period.

Table 1: Climate Projections Data Sources used in the 2019 Report and the 2023 Update

Climate Parameter	Threshold(s)	Climate Projections Data Source	
		2019 Report	2023 Update
Temperature – Extreme Heat	Tmax ≥ 25°C; Tmax ≥ 35°C	CMIP5 Projections Downscaled with Delta Approach	NCR Projections
	Tmax ≥ 30°C; Tmax ≥ 40°C; Tmean ≥ 30°C; Heat waves	CMIP5 Projections Downscaled with Delta Approach	CanDCS-U6 Projections
Temperature – Extreme Cold	Tmin ≤ -35°C	CMIP5 Projections Downscaled with Delta Approach	CanDCS-U6 Projections

Climate Parameter	Threshold(s)	Climate Projections Data Source	
		2019 Report	2023 Update
Rain (Short Intensity – High Duration)	50 mm in 1 hr	Historic IDF data adjusted using Clausius-Clapeyron rate	NCR Projections
Freezing Rain & Ice Storms	Ice accumulation of 25 mm; 40 mm	Literature	Literature
Snow	≥ 5 cm in 24 hrs; ≥ 30 cm in 24 hrs	Literature	Literature
	≥ 10 cm in 24 hrs	Literature	NCR Projections
High Winds	Wind speeds of 60 km/hr; 80 km/hr; 90 km/hr; 120 km/hr	Literature	Literature
High Winds	Wind speeds of 130 km/hr; 180 km/hr	N/A	Literature
Lightning	Flash density	Literature	Literature
Tornadoes	EF1+	Literature	Literature
Invasive Species	Emerald Ash Borer (kill temperature); Giant Hogweed (germination temperature requirement)	CMIP5 Projections Downscaled with Delta Approach	CanDCS-U6 Projections
Fog	≥ 50 fog days (Nov.-March)	Literature	Literature
Frost	Freeze-thaw cycles (Tmax Tmin fluctuation around 0°C)	CMIP5 Projections Downscaled with Delta Approach	NCR Projections
	Hard freeze-thaw cycles (Tmax Tmin fluctuation of ±4°C around 0°C)	CMIP5 Projections Downscaled with Delta Approach	CanDCS-U6 Projections

Climate parameter probabilities were assigned using the five-point scoring scale used in Hydro Ottawa's Asset Management System Risk Procedures (Table 2). This five-point probability scoring scale was used in the 2019 study and, therefore, maintains consistency and allows comparability between the 2019 study and the 2023 update.

Table 2: Probability Scoring Scaled Used in Hydro Ottawa's Asset Management System Risk Procedures

Probability Score	Descriptor	Detailed Description	Probability Range
1	Rare	May only occur in time period under exceptional circumstances	p ≤ 5%
2	Unlikely	Could occur in time period	5% < p ≤ 35%
3	Possible	Might occur in time period	35% < p ≤ 65%
4	Likely	Will probably occur in time period	65% < p ≤ 95%
5	Almost Certain	Is expected to occur	95% < p

2.2 Results

Updated projected frequency of occurrence, annual and 30-year probabilities, for each climate parameter assessed in the 2019 study, as well as baseline (1981-2010) and 1991-2020 data, are provided in Appendix A. Climate parameters for which the annual and/or 30-year probability changed as well as for the additional high wind thresholds (laminations) are presented in Table 3. Probabilities for any parameters from the 2019 study that did not change remain with the same ratings as were previously calculated. While tornadoes have impacted the Ottawa region more frequently in the last decade, the probability rating for tornado occurrence has not changed. Probability ratings were established for two scenarios: 1) the likelihood of a single point within Hydro Ottawa's service area being struck by a tornado and 2) the likelihood of a tornado occurring anywhere within the service area. In the risk assessment, the higher likelihood was carried forward and used to establish potential risk.

Table 3: Changes in Climate Parameter Probabilities and Additional Wind Threshold Probabilities

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Rain	50 mm in 1 hr	4.5% (< 1 yr^{-1})	1	75%	4	32% (< 1 yr^{-1})	2	> 99%	5
Invasive Species: Emerald Ash Borer	Daily min. temp. of -30°C or colder (kill temp.)	3% (< 1 yr^{-1})	1	60%	3	4% (< 1 yr^{-1})	1	71%	4
Frost	Hard freeze-thaw cycles (Daily Tmax Tmin temp. fluctuation of ±4°C around 0°C) (30 cycles)	38% (< 1 yr^{-1})	3	> 99%	5	18% (< 1 yr^{-1})	2	> 99%	5
High Wind	Wind speeds > 130 km/hr	N/A	N/A	N/A	N/A	2.90% (<1 yr^{-1})	1	58%	3
	Wind speeds > 180 km/hr	N/A	N/A	N/A	N/A	1.25% (<1 yr^{-1})	1	31%	2

3 Review Workshop and Prioritizing Actions

Stantec organized an in-person (with a virtual option) climate risks and adaptation plan working session with Hydro Ottawa personnel on May 3, 2023. The workshop included a summary of the 2022 Derecho event forensic evaluation, the introduction of two additional thresholds for the high wind climate parameter, and a review of the consequence / risk scores. Additionally, Stantec sought input from attendees to determine the status of the 2019 climate adaptation and risk mitigation measures from the 2019 reports (Stantec, 2019a-b), and to determine their appropriateness for existing risk levels.

Revised consequence scores, where a change occurred, are presented in Section 4.2. Section 4 presents the updated adaptation recommendations for medium to very high risks, where a change has occurred.

4 Updates to Risk Assessment

4.1 2023 Methods

Each combination of climate parameter and infrastructure asset class is referred to as an interaction. To assess material changes in risk, Stantec calculated risk for the baseline (1981-2010) and 2050s (2041-2070) time horizons for each interaction. Risk is calculated following the approach outlined in the 2019 report, where ***Risk Score = Probability Score x Severity Score*** (Engineers Canada, 2011). Updated risk scores were only calculated for the following interactions:

- Interactions with climate parameters with a changed 2050s probability score,
- Interactions with the new high wind thresholds, or
- Interactions with updated consequence scores.

Consequence scores were assigned using a 1- to 25-point severity scale and performance descriptors extracted directly from Hydro Ottawa's Asset Management System Risk Procedures. The resulting risk matrix is presented in Table 4.

Table 4: Severity Ratings used in the Risk Assessment

Severity Score and Descriptor		Infrastructure Performance and Severity Rating			
		Level of Service: System Accessibility	Level of Service: Service Quality	Resource Efficiency	Asset Value - Financial
Insignificant	**1**	N/A	Service interruption resulting in <10,000 customer minutes interrupted. Service quality resulting in customer complaint, but meets CSA standards	Requires <10 hours of overtime to complete O&M work or undergo training. Requires <100 hours of overtime to complete capital work.	Financial risk resulting in an O&M expense of <$1k. Financial risk resulting in a capital expense of <$10k.
Minor	**4**	N/A	Service interruption resulting in >10,000 customer minutes interrupted. Service quality resulting in customer escalation, but meets CSA standards	Requires >10 hours of overtime to complete O&M work or undergo training. Requires >100 hours of overtime to complete capital work.	Financial risk resulting in an O&M expense of >$1k. Financial risk resulting in a capital expense of >$10k.
Moderate	**9**	Load demand/generation is exceeding planning limits.	Service interruption resulting in >500,000 customer minutes interrupted.	Requires >250 hours of overtime to complete O&M work or undergo training. Requires >2,500 hours of overtime to complete capital work.	Financial risk resulting in an O&M expense of >$50k. Financial risk resulting in a capital expense of >$500k.

Severity Score and Descriptor		Infrastructure Performance and Severity Rating			
		Level of Service: System Accessibility	**Level of Service: Service Quality**	**Resource Efficiency**	**Asset Value - Financial**
Extensive	**16**	Load demand/generation is exceeding thermal limits.	Service interruption resulting in >3,000,000 customer minutes interrupted.	Requires >1,500 hours of overtime to complete O&M work or undergo training. Requires >15,000 hours of overtime to complete capital work.	Financial risk resulting in an O&M expense of >$300k. Financial risk resulting in a capital expense of >$3M.
Significant	**25**	Unable to service new load/ERFs	Service interruption resulting in >10,000,000 customer minutes interrupted. Service quality resulting in not meeting CSA standards.	Unable to complete work with internal and/or external resources due to volume or skill gap.	Financial risk resulting in an O&M expense of >$1M. Financial risk resulting in a capital expense of >$10M.

Table 5: Hydro Ottawa Asset Management Risk Procedure Matrix

			Impact				
			1	4	9	16	25
			Insignificant	Minor	Moderate	Extensive	Significant
Likelihood	1	Rare	1	4	9	16	25
	2	Unlikely	2	8	18	32	50
	3	Possible	3	12	27	48	75
	4	Likely	4	16	36	64	100
	5	Almost Certain	5	20	45	80	125

Risk Score	Risk Rating
Low	≤10
Medium	11-30
High	31-60
Very High	≥60

Risk ratings for individual components were taken by summing the total consequence across all evaluated columns and multiplying by the event likelihood. For example, if consequence of 9 was assigned for all for categories for an event with a probability rating of 3, the resultant total cumulative risk would be calculated as:

Table 6: Sample Consequence and Cumulative Risk Rating Calculation

Level of Service: System Accessibility	Level of Service: Service Quality	Resource Efficiency	Asset Value - Financial	Likelihood of Event	Cumulative Risk
9	9	9	9	3	**108**

4.2 2023 Consequence and Risk Score Updates and Additions

Updates and additions to consequence scores occurred for the following parameters:

- For the wind threshold of 120 km/hr, consequence score updates included revising upward the consequence score of the Asset Value – Financial from a 9 to a 16 for Power Distribution – Overhead (N-S and E-W orientations) due to recent extreme wind experienced by Hydro Ottawa that led to more operational and capital expenses than previously rated in the 2019 study. During the workshop it was felt that the initial rating should be raised to reflect consequences reflective of extreme wind impacts that had not been felt by Hydro Ottawa prior to the derecho event.
- For the new wind threshold of 130 km/hr, consequence scores mirror the updated values for the 120 km/hr threshold. While there is a 17% increase in overall force, it was felt that the increase in consequence score for the 120 km/hr threshold would also be felt under a 130 km/hr event occurring in the service area.
- For the new 180 km/hr wind threshold, developed based upon the findings by UWO in the analysis of damage for the 2022 Derecho event, consequence scores of a 16 were assigned for system accessibility, service quality, and resource efficiency for Power Distribution lines and poles (N-S and E-W orientations). For financial, consequence scores were assigned a 25 due to the damage experienced by Hydro Ottawa in the 2022 Derecho event. These scores are reflective of severe damage and demand posed on Hydro Ottawa during and following the event, including challenges to restore power and the duration of the major event.
- For freezing rain, with ice accumulation of 25 mm, the consequence score for Asset Value – Financial was revised from a 4 to a 9 for Power Distribution – Overhead (N-S and E-W orientations), due to the impacts of recent freezing rain events that led to more operational and capital expenses than previously rated in the 2019 study.

A summary of the updated consequence scores and associated 2050s risk scores are presented in Table 7.

Table 7: Summary of Changes and Additions to Consequence and Risk Scores

Climate Parameter: Threshold	Infrastructure Performance Category	Consequence Update	2019 Study		2023 Update	
			Consequence Score	2050s Cumulative Risk Score	Consequence Score	2050s Cumulative Risk Score
High wind: 120 km/hr	Asset Value - Financial score for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Increased consequence scores from 9 to 16 due to recent extreme wind experienced by Hydro Ottawa that led to more operational and capital expenses	9	81	16	102
High wind: 130 km/hr	All categories	Consequence scores mirror those of the 120 km/hr threshold	N/A	N/A	16	102
High wind: 180 km/hr	System accessibility, service quality, and resource efficiency for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Consequence scores assigned a 16 based on UWO's analysis of damage for the 2022 Derecho event	N/A	N/A	16	114
	Financial for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Consequence scores assigned a 25 due to damage experienced by Hydro Ottawa in the 2022 Derecho event	N/A	N/A	25	
Freezing rain: Ice accumulation of 25 mm	Financial for Power Distribution - Overhead (N-S and E-W orientations) Lines	Increased consequence scores for 4 to 9 due to due to recent freezing rain events experienced by Hydro Ottawa that led to more operational and capital expenses	4	16	9	26

5 Updates to Adaptation Plan

This section presents additional recommendations to mitigate climate risk where a risk level has changed since the original scope of work. The recommendations in this section are made to supplement the original recommendations (Stantec, 2019b).

5.1 2019 Scope of Work

The development of the 2019 Adaptation Plan consisted of the following steps (Stantec, 2019b):

1. Validation of medium to very high risks to infrastructure and operations as well as the impacts in a workshop with Hydro Ottawa staff.
2. Selection of risk mitigation or adaptation measures to reduce the impacts of medium to very high future climate risks; developed through the workshop with Hydro Ottawa.
3. Prioritization of actions based on the risk levels, change in risk (current to future) and Hydro Ottawa's Asset Management System Risk Procedures.
4. Assignment of responsibilities and the development of indicators to track and monitor progress in the Enterprise Risk Management System (ERMS).

5.2 2023 Results

5.2.1 Executed Adaptation Actions

Hydro Ottawa has made significant progress on implementing the risk recommendations from the Adaptation Plan (Stantec, 2019b). A summary of work that was completed, the status update and next steps as provided by HOL is included in Appendix B.

5.2.2 Additional Suggested Adaptation Measures

Hydro Ottawa is progressing and moving forward on implementing climate change adaptation measures to build resilience from extreme events. It is recommended that HOL work to continue addressing climate change risk through ongoing work and consider additional adaptation measures brought forward during the review workshop to specifically address new climate and accelerating related risks. All new adaptation recommendations were related to the pole line systems and new measures are provided in Table 8. No additional recommendations for operations, underground systems or substations.

5.2.2.1 Pole Line System

Table 8: Updated Impacts and Adaptation Measures

Climate Parameter	System / Component Affected	Description of Impact	Current Risk Score	Future Risk Score	2023 Update to Future Risk Score	New Adaptation Recommendations
New Wind Thresholds from Derecho Event and Extreme Wind Speeds						• Consider a study on pole characteristics (i.e. age and guying locations) from the 2022 Derecho to determine potential vulnerability of pole tops. • Consider the impact of climate change on recently (or future) hydro poles being grown (i.e. wood density and strength) • Consider establishing additional supply capacity and storage for key components (e.g. poles) in the event that a major or catastrophic event impacts a large portion of the service area • Consider real-time or automated monitoring system for severe weather events or creating a staff position for a meteorologist to handle coordination between utilities and monitoring potential upstream outages before they impact HOL service area • Continue with planned adaptation planning actions already underway, including an undergrounding study, anti-cascading study and strategy, and asset hardening however, new risk should be utilized in decision making a cost/benefit studies underway. • Consider establishing a shared resource MoU with other utilities (e.g. Hydro One, Hydro Quebec) to work toward open data sharing of risks, opportunities, and best practices for handling extreme events. Other risk mitigation measures developed in the 2019 study remain relevant based on the conversations conducted at the 2023 reaffirmation workshop.
Annual wind speeds of 180 km/hr or higher (30-year occurrence)	Power Distribution: East-West lines and poles	Damage to poles and lines from high wind events.	114	114	114	
Annual wind speeds of 180 km/hr or higher (30-year occurrence)	Power Distribution: East-West lines and poles	Risk of damages from falling trees, broken tree limbs or flying debris.	114	114	114	
Annual wind speeds of 180 km/hr or higher (30-year occurrence)	Power Distribution: North-South lines and poles	Damage to poles and lines from high wind events.	132	146	146	
Annual wind speeds of 180 km/hr or higher (30-year occurrence)	Power Distribution: North-South lines and poles	Risk of damages from falling trees, broken tree limbs or flying debris.	132	146	146	
Annual wind speeds of 130 km/hr or higher (30-year occurrence)	Power Distribution: East-West lines and poles	Damage to poles and lines from high wind events.	102	102	102	
Annual wind speeds of 130 km/hr or higher (30-year occurrence)	Power Distribution: East-West lines and poles	Risk of damages from falling trees, broken tree limbs or flying debris.	102	102	102	
Annual wind speeds of 130 km/hr or higher (30-year occurrence)	Power Distribution: North-South lines and poles	Damage to poles and lines from high wind events.	129	129	129	
Annual wind speeds of 130 km/hr or higher (30-year occurrence)	Power Distribution: North-South lines and poles	Risk of damages from falling trees, broken tree limbs or flying debris.	129	129	129	
Revised Risk Scores Based on New Consequence Scoring						
Annual wind speeds of 120 km/hr or higher (30-year occurrence)	Power Distribution: East-West lines and poles	Damage to poles and lines from high wind events.	81	81	**102**	
Annual wind speeds of 120 km/hr or higher (30-year occurrence)	Power Distribution: East-West lines and poles	Risk of damages from falling trees, broken tree limbs or flying debris.	81	81	**102**	
Annual wind speeds of 120 km/hr or higher (30-year occurrence)	Power Distribution: North-South lines and poles	Damage to poles and lines from high wind events.	108	108	**129**	
Annual wind speeds of 120 km/hr or higher (30-year occurrence)	Power Distribution: North-South lines and poles	Risk of damages from falling trees, broken tree limbs or flying debris.	108	108	**129**	

Climate Parameter	System / Component Affected	Description of Impact	Current Risk Score	Future Risk Score	2023 Update to Future Risk Score	New Adaptation Recommendations
Ice accumulation (25 mm)	Power Distribution: North-South lines and poles	Damage from increased weight on overhead lines. Ice accretion on lines in excess of 12.5 mm (0.5 inches) accompanied by a 90km/h wind could result in structural failure and uneven ice accretion could cause swinging or 'galloping' in the lines Damages to lines from fallen trees or broken tree limbs. Damage to poles and other surface equipment from vehicles losing control on icy roads.	10	13	26	Complete an inventory of switches for critical equipment and consider looking at alternatives for implementing measures to prevent freezing.
Ice accumulation (25 mm)	Power Distribution: North-South lines and poles	Damages to lines from fallen trees or broken tree limbs.	8	16	26	

6 Limitations

The findings in this report are subject to several limitations. Section 2 discusses specific uncertainties associated with each climate parameter. Some overarching limitations are noted below.

Climate data is inherently uncertain. The climate parameter probabilities provided should be considered as high-level estimates of future conditions. The primary source of uncertainty in climate projections is the estimate of greenhouse gas emissions that will be observed over the current century. Additional sources of uncertainty include (but are not limited to) climate model parameterization, bias, and resolution.

Some of the climate parameters investigated are associated with very high degrees of uncertainty, because they are difficult to constrain using the outputs from climate models. Stantec has reviewed recently published scientific literature and guidance to provide an estimate of likely future conditions.

7 Conclusion

This Update to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan was conducted by Stantec to provide Hydro Ottawa Limited (HOL) with updated climate parameter probabilities, consequence scores, risk levels, and adaptation plan. Recent extreme weather resulting in major weather events, specifically:

- September 21, 2018 – Tornadoes
- April 15, 2019 – Lightning storm and flooding
- July 5, 2019 – Windstorm
- June 14, 2021 – Summer/Lightning storm
- May 21, 2022 – Derecho storm
- December 23, 2022 – Winter storm

The findings in this report are based on the evaluation of impacts from the recent major weather-related events, a forensic analysis of the May 2022 Derecho event, and input from the review workshop.

The two main tasks completed within this study were to (1) update the list of climate parameters to include additional high wind thresholds representative of recent extreme weather events, update climate parameter probabilities, impact severity (based on input from Hydro Ottawa personnel), and risk scores, as well as completing a forensic analysis of the May 21, 2022 Derecho event; and (2) update where appropriate the adaptation and risk mitigation plan using input from the review workshop and where risk scores changed to medium-very high under current and future climate. For consistency, the same methods used in the 2019 report were also used in this reassessment.

Two additional high wind thresholds were established for this update based on updated Environment and Climate Change Canada (ECCC) criteria for severe thunderstorm winds and the damages observed by the Northern Tornadoes Project in surveys following the 2022 May Derecho event. The thresholds established included:

- Wind speeds > 130 km/h – Based on new ECCC severe thunderstorm winds and with 17% higher loading factor than the 120 km/h gust threshold used in the 2019 study
- Wind speeds > 180 km/h (Derecho event equivalent) – based on consistent EF-2 style observed damage in Ottawa region and Doppler Radar near surface wind speed recordings

Risk scores increased due to higher consequence ratings for current and future climate for higher threshold wind speeds (120 km/hr) and for newly established thresholds (130 km/hr and 180 km/hr). However, for most risks, no risk level change was observed.

To handle additional risks from higher wind thresholds, the following risk adaptation measures should be considered:

- Consider a study on pole characteristics (i.e. age and guying locations) from the 2022 Derecho to determine potential vulnerability of pole tops.
- Consider the impact of climate change on recently (or future) hydro poles being grown (i.e. wood density and strength)
- Consider establishing additional supply capacity and storage for key components (e.g. poles) in the event that a major or catastrophic event impacts a large portion of the service area
- Consider real-time or automated monitoring system for severe weather events or creating a staff position for a meteorologist to handle coordination between utilities and monitoring potential upstream outages before they impact HOL service area.
- Continue with planned adaptation planning actions already underway, including an undergrounding study, anti-cascading study and strategy, and asset hardening however, new risk should be utilized in decision making a cost/benefit studies underway.

Other risk mitigation measures developed in the 2019 study remain relevant based on the conversations conducted at the 2023 reaffirmation workshop.

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Appendices

Appendix A 2023 Climate Parameter Probability Update

Table A-1: Climate Parameter Probabilities and Additional Wind Threshold Probabilities in the Historical Baselines (1981-2010 and 1991-2020)

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Temperature – Extreme Heat	Daily max. temp. of 25°C or higher	100% (~62-63 yr^{-1})	5	100%	5	100% (~68-69 yr^{-1})	5	100%	5
	Daily max. temp. of 30°C or higher	100% (~14-15 yr^{-1})	5	100%	5	100% (~15-16 yr^{-1})	5	100%	5
	Daily max. temp. of 35°C or higher	50% (<1 yr^{-1})	3	>99%	5	80% (<1 yr^{-1})	3	100%	5
	Daily max. temp. of 40°C or higher	6% (<1 yr^{-1})	2	84%	4	6% (<1 yr^{-1})	2	84%	4
	Daily avg. temp. of 30°C or higher	3% (<1 yr^{-1})	1	60%	3	3% (<1 yr^{-1})	1	60%	3
	Heat waves: Consecutive days with max temp ≥ 30°C and min temp ≥ 23°C	7% (<1 yr^{-1})	2	89%	4	7% (<1 yr^{-1})	2	89%	4
	Heat waves: Consecutive days with max temp ≥ 30°C and min temp ≥ 25°C	~0% (~0 yr^{-1})	1	~0%	1	~0% (~0 yr^{-1})	1	~0%	1

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Temperature – Extreme Cold	Daily min. temp. of -35°C or colder	3% (<1 yr^{-1})	1	60%	3	~0% (rare)	1	~0%	1
Rain (Short Intensity – High Duration)	50 mm in 1 hr	1% (<1 yr^{-1})	1	~25%	2	1% (<1 yr^{-1})	1	~25%	2
Freezing Rain & Ice Storms	Ice accumulation of 25 mm	5% (<1 yr^{-1})	1	79%	4	5% (<1 yr^{-1})	1	79%	4
	Ice accumulation of 40 mm	2.5% (<1 yr^{-1})	1	>50%	3	2.5% (<1 yr^{-1})	1	>50%	3
Snow	Days with 5 cm of more of snowfall	100% (~15 yr^{-1})	5	100%	5	100% (~15 yr^{-1})	5	100%	5
	Days with 10 cm of more of snowfall	100% (~5-6 yr^{-1})	5	100%	5	100% (~5-6 yr^{-1})	5	100%	5
	Days with 30 cm of more of snowfall	13% (<1 yr^{-1})	2	98%	5	17% (<1 yr^{-1})	2	>99%	5
High Winds	Annual wind speeds of 60 km/hr	100% (~14-15 yr^{-1})	5	100%	5	100% (~15-16 yr^{-1})	5	100%	5
	Easterly winds of 60 km/hr or higher (warm season [April-September])	28.9% (<1 yr^{-1})	2	100%	5	47% (<1 yr^{-1})	2	>99%	5
	Easterly winds of 60 km/hr or higher	2.6% (<1 yr^{-1})	1	55%	3	3% (<1 yr^{-1})	1	60%	3

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
	(summer [June-August])								
	Annual wind speeds of 80 km/hr	100% (~1-2 yr^{-1})	5	100%	5	100% (~1-2 yr^{-1})	5	100%	5
	Easterly winds of 80 km/hr or higher (cool season [October - March])	5.3% (<1 yr^{-1})	2	80%	5	5.3% (<1 yr^{-1})	2	80%	5
	Easterly winds of 80 km/hr or higher (winter [December - February])	2.6% (<1 yr^{-1})	1	55%	3	2.6% (<1 yr^{-1})	1	55%	3
	Annual wind speeds of 90 km/hr	23% (<1 yr^{-1})	2	>99%	5	23% (<1 yr^{-1})	2	>99%	5
	Annual wind speeds of 120 km/hr	2.5% (<1 yr^{-1})	1	53%	3	3.10% (<1 yr^{-1})	1	53%	3
	Annual wind speeds of 130 km/hr	2.5% (<1 yr^{-1})	1	53% (rare)	3	3.10% (<1 yr^{-1})	1	>60% (rare)	3
	Annual wind speeds of 180 km/hr	1.25% (<1 yr^{-1})	1	31% (rare)	2	1.25% (<1 yr^{-1})	1	31% (rare)	2
Lightning	Strikes near infrastructure (flashes/ km^2/ year)	1.1% (<1 yr^{-1})	1	28%	2	1.1% (<1 yr^{-1})	1	28%	2

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Tornadoes	EF1+ in Hydro Ottawa service area (City of Ottawa)	14.6% (<1 yr^{-1})	2	>99%	5	14.6% (<1 yr^{-1})	2	>99%	5
	EF1+ point probability (i.e., striking a specific asset in City of Ottawa service area)	0.02% (rare)	1	0.6%	1	0.02% (rare)	1	0.6%	1
Invasive Species: Emerald Ash Borer	Emerald Ash Borer (Daily min. temp. of -30°C or colder [kill temp.])	53% (<1 yr^{-1})	3	>99%	5	47% (<1 yr^{-1})	3	>99%	5
	Giant Hogweed (3 consecutive days of -8°C or colder [gemination requirement])	100% (25 yr^{-1})	5	100%	5	100% (9 yr^{-1})	5	100%	5
Fog	Season with ≥ 50 fog days (Nov.-March)	37% (~3-4 yr^{-1}	3	100%	5	37% (~3-4 yr^{-1})	3	>99%	5

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Frost	Freeze-thaw cycles – (Daily Tmax Tmin temp. fluctuation of ±1°C around 0°C) (30 cycles)	100% (~2-3 yr^{-1})	5	100%	5	100% (~2-3 yr^{-1})	5	100%	5
	Hard freeze-thaw cycles (Daily Tmax Tmin temp. fluctuation of ±4°C around 0°C) (30 cycles)	30% (<1 yr^{-1})	2	>99%	5	30% (<1 yr^{-1})	2	>99%	5

Table A-2: Climate Parameter Probabilities and Additional Wind Threshold Probabilities in the 2050s from the 2019 Study and the 2023 Update

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Temperature – Extreme Heat	Daily max. temp. of 25°C or higher	100% (~99 yr^{-1})	5	100%	5	100% (~105 yr^{-1})	5	100%	5
	Daily max. temp. of 30°C or higher	100% (~42 yr^{-1})	5	100%	5	100% (~48 yr^{-1})	5	100%	5
	Daily max. temp. of 35°C or higher	100% (~6 yr^{-1})	5	100%	5	100% (~9 yr^{-1})	5	100%	5
	Daily max. temp. of 40°C or higher	100% (~1-2 yr^{-1})	5	100%	5	100% (~1-2 yr^{-1})	5	100%	5
	Daily avg. temp. of 30°C or higher	100% (~1-2 yr^{-1})	5	100%	5	100% (~4 yr^{-1})	5	100%	5
	Heat waves: Consecutive days with max temp ≥ 30°C and min temp ≥ 23°C	100% (~2 yr^{-1})	5	100%	5	100% (~3 yr^{-1})	5	100%	5
	Heat waves: Consecutive days with max temp ≥ 30°C and min temp ≥ 25°C	37% (<1 yr^{-1})	3	>99%	5	37% (<1 yr^{-1})	3	>99%	5
Temperature – Extreme Cold	Daily min. temp. of -35°C or colder	0.1% (rare)	1	3%	1	0.1% (rare)	1	3%	1

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Rain (Short Intensity – High Duration)	50 mm in 1 hr	4.5% (<1 yr^{-1})	1	75%	4	32.0% (<1 yr^{-1})	2	>99%	5
Freezing Rain & Ice Storms	Ice accumulation of 25 mm	6% (<1 yr^{-1})	2	84%	4	6% (<1 yr^{-1})	2	84%	4
	Ice accumulation of 40 mm	3.8% (<1 yr^{-1})	1	~70%	4	3.8% (<1 yr^{-1})	1	~70%	4
Snow	Days with 5 cm of more of snowfall	100% (~15 yr^{-1})	5	100%	5	100% (~15 yr^{-1})	5	100%	5
	Days with 10 cm of more of snowfall	100% (~5 yr^{-1})	5	100%	5	100% (~4 yr^{-1})	5	100%	5
	Days with 30 cm of more of snowfall	10% (<1 yr^{-1})	2	>95%	5	10% (<1 yr^{-1})	2	>95%	5
High Winds	Annual wind speeds of 60 km/hr	100% (~16 yr^{-1})	5	100%	5	100% (~16 yr^{-1})	5	100%	5
	Easterly winds of 60 km/hr or higher (warm season [April-September])	32.4% (<1 yr^{-1})	2	>99%	5	32.4% (<1 yr^{-1})	2	>99%	5
	Easterly winds of 60 km/hr or higher (summer [June-August])	2.9% (<1 yr^{-1})	1	~60%	3	2.9% (<1 yr^{-1})	1	~60%	3

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
	Annual wind speeds of 80 km/hr	100% (~1-2 yr^{-1})	5	100%	5	100% (~1-2 yr^{-1})	5	100%	5
	Easterly winds of 80 km/hr or higher (cool season [October - March])	6.3% (<1 yr^{-1})	2	85%	4	6.3% (<1 yr^{-1})	2	85%	4
	Easterly winds of 80 km/hr or higher (winter [December - February])	3.2% (<1 yr^{-1})	1	>60%	3	3.2% (<1 yr^{-1})	1	>60%	3
	Annual wind speeds of 90 km/hr	29% (<1 yr^{-1})	2	>99%	5	29% (<1 yr^{-1})	2	>99%	5
	Annual wind speeds of 120 km/hr	3.1% (<1 yr^{-1})	1	61%	3	3.1% (<1 yr^{-1})	1	61%	3
	Annual wind speeds of 130 km/hr	N/A	N/A	N/A	N/A	2.90% (<1 yr^{-1})	1	58%	3
	Annual wind speeds of 180 km/hr	N/A	N/A	N/A	N/A	1.25% (<1 yr^{-1})	1	31%	2
Lightning	Strikes near infrastructure (flashes/ km^2/ year)	1.5% (<1 yr^{-1})	1	36%	3	1.56% (<1 yr^{-1})	1	38%	3
Tornadoes	EF1+ in Hydro Ottawa service	18.2% (<1 yr^{-1})	2	>99%	5	18.2% (<1 yr^{-1})	2	>99%	5

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
	area (City of Ottawa)								
	EF1+ point probability (i.e., striking a specific asset in City of Ottawa service area)	0.02% (rare)	1	0.7%	1	0.02% (rare)	1	0.7%	1
Invasive Species: Emerald Ash Borer	Emerald Ash Borer (Daily min. temp. of -30°C or colder [kill temp.])	3% (<1 yr^{-1})	1	60%	3	4% (<1 yr^{-1})	1	71%	4
	Giant Hogweed (3 consecutive days of -8°C or colder [gemination requirement])	100% (17 yr^{-1})	5	100%	5	100% (3 yr^{-1})	5	100%	5
Fog	Season with ≥ 50 fog days (Nov.-March)	Likely increase	4	100%	5	Likely increase	4	100%	5

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Frost	Freeze-thaw cycles – (Daily Tmax Tmin temp. fluctuation of ±1°C around 0°C) (30 cycles)	100% (~2 yr^{-1})	5	100%	5	100% (~2-3 yr^{-1})	5	100%	5
	Hard freeze-thaw cycles (Daily Tmax Tmin temp. fluctuation of ±4°C around 0°C) (30 cycles)	38% (<1 yr^{-1})	3	>99%	5	18% (<1 yr^{-1})	2	>99%	5

Appendix B 2023 Adaptation Status, Next Steps, and Barriers

Forensic Analysis of the May 21, 2022 Derecho for the Ottawa Area

Following the announcement of the reaffirmation study – consisting of an update of the 2019 Hydro Ottawa Climate Risk Assessment (Stantec, 2019), meteorologists from Western University's Northern Tornadoes Project (NTP) and Northern Hail Project (NHP) were retained to provide expert advice and analysis in the form of a forensic assessment of the May 21, 2022, severe windstorm. Termed a "derecho", this storm severely impacted Hydro Ottawa's infrastructure.

Doctor David Sills, Executive Director of the Northern Tornadoes Project (NTP), and Simon Eng, Research Meteorologist with the Northern Hail Project (NHP) and former consulting meteorologist on the original 2019 study, were asked to support the Hydro Ottawa reaffirmation study to address the following questions and concerns:

- *Significant concern regarding impacts associated with 120 km/h winds:* A peak wind gust reading of 120 km/h was recorded at Ottawa International Airport during the event. Wind speeds of this magnitude were included in the original climate risk assessment (Stantec 2019) but the May 21, 2022, storm generated impacts far greater than had been anticipated for winds of this magnitude.
- *The number and severity of weather-related outage events in recent years:* Several very high impact severe weather events have affected Hydro Ottawa's system since the late-2010s. This has triggered concerns that these events are increasing in frequency to such an extent that their effects may not be manageable.
    - *In particular, the southern-portion of the City has been severely affected by both the 2022 Derecho event and one of the September 2018 tornadoes:* This raised concerns that this specific region within Hydro Ottawa's service area was particularly vulnerable to severe thunderstorm-related wind events.
- *The May 21, 2022, storm indicated the need for identifying additional damage thresholds:* To help support future planning and continued efforts to increase resilience to current and future climate impacts, the risk assessment framework required the identification of additional, higher wind speed thresholds than had been previously identified in the original 2019 risk assessment (Stantec 2019).

Key **findings** from the NTP/NHP analysis are the following:

Evidence using damage-based wind speed estimates, coupled with a review of Doppler radar wind velocity information, as well as evidence from other locations

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along the derecho's path, strongly indicates that the 120 km/hr wind gust measured at Ottawa International Airport was *not* representative of the wind speeds experienced during the event in the most severely impacted portions of Hydro Ottawa's system. These pieces of evidence generally indicate much stronger winds which likely reached 180-195 km/h.

- Peak wind speed estimates obtained through damage assessment of buildings and trees using the Canadian version of the "Enhanced Fujita Scale" (EF-Scale; ECCC 2018) consistently indicated peak wind velocities in extreme south-eastern portions of the City of Ottawa were in the 180-195 km/h range – i.e., the lower-end of the "EF-2" range on the Enhanced-Fujita Scale.
- Winds of this magnitude were consistent with Doppler weather radar indicated values (Ibrahim et al., 2023), which showed winds in the area exceeding 160 km/h.
- Evidence also indicates that other locations along the storm's path that reported similar or higher instrumented wind gust measurements did *not* exhibit damage of the severity seen in the Ottawa area, either to electrical overhead systems or more broadly to buildings, infrastructure, and trees. These include:
    - Kitchener-Waterloo area – An initial peak gust of 131 km/h was recorded at Kitchener-Waterloo International Airport – while power outages and tree damage were reported in the area, damage to buildings, critical infrastructure and trees did not approach the magnitude of the impacts in the Ottawa area.
    - Toronto Pearson International Airport – A peak gust of 121 km/h was reported at Pearson International Airport, but damage to buildings and overhead systems in this region was again of much lesser magnitude then what had occurred in the Ottawa area. A ground survey of this area was conducted within hours of the event by one of the authors (S.Eng) and although notable damage to urban trees was documented, as well as the failure of a medium-voltage electrical distribution line near Lisgar GO Transit station, again damage was of much lower intensity than had been documented in the Ottawa area.
- For this reaffirmation study, *new* recommended wind gust thresholds of *130 km/h* and *180 km/h* were developed, corresponding to Environment and Climate Change Canada's (ECCC) "extreme" thunderstorm warning criteria, and the lower bound of EF2 damage, respectively.
- The direction of storm motion and damage to specific areas within the City of Ottawa should not be taken as indications that the motion and impact area of storms will be similar in future events. Historical events have shown that both the direction of storm motion and locations impacted will differ depending on specific weather conditions.
    - However, the preliminary historical assessment of derecho events indicates that storm motion will mostly likely have an eastward component, with storms approaching from the SSW through to the NNW.

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Note that the NTP conducted a thorough, multi-month study of the entire length of the derecho's track, which included numerous detailed ground surveys, satellite image review, and social and news media monitoring, documentation, and follow-up. Areas suffering similar (i.e., up to EF2 intensity) damage were indeed detected in other parts of the derecho damage path but did not include the regions near or around Kitchener-Waterloo and Toronto Pearson Airports.

Methodology and Definitions

Due to their highly localised and characteristically high intensity, specialised methods are needed to obtain wind speed estimates for severe thunderstorm winds (i.e., tornadoes, derechos, microbursts, etc.). This assessment used two methods in addition to instrumented measurements, to obtain wind speed estimates:

1) The Enhance Fujita or "EF" Scale uses damage to buildings, trees, and other infrastructure and objects to estimate wind speeds (ECCC 2018). Wind speeds are classified into 6 categories, from EF0 to EF5, of increasing intensity (Table 1). Consistency is achieved through comparing damage to adjacent objects and assets to determine if they indicated similar wind speeds. It is also achieved through careful inspection of the age, type, and quality of building construction.

Table 1 - Canadian EF-Scale and Associated Wind Speed (Gust) Ranges

EF-Scale Rating	Associated Wind Speed Range (Equivalent 3-second gust; km/h)
EF0	90 to 130
EF1	135 to 175
EF2	180 to 220
EF3	225 to 265
EF4	270 to 310
EF5	315 +

2) The EF-scale estimated wind speeds were supplemented through a Doppler weather radar analysis. The Franktown (CASFT) radar is located close to the Ottawa area and was used to assess wind speeds near the surface during the event.

3) Finally, instrumented measurements from anemometers – instruments used to measure wind speed – were also consulted. However, we note that measurements from such instruments may be missing or suppressed due to power failures, mechanical issues, debris impacts or obstructions, and other causes. The data they generate is also subject to errors in data capture and computer archiving.

The storm that produced the severe wind damage in the Ottawa area (and indeed across southern Ontario and western and southern Québec) is a special class of

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severe thunderstorm wind event referred to as a “derecho”. A derecho is defined as a long-lived “convectively” (i.e., thunderstorm) driven windstorm. “Damage must be incurred either continuously or intermittently over a swath of at least 650 km (~400 mi) and a width of approximately 100 km (~60 mi) or more.” (AMS, 2023)

Historical Derecho Climatology and Climate Change

A historical database of Canadian derechos is currently in development but is only in its infancy (see **Figure 1**). To properly assess the historical frequency and characteristics (e.g., path length, intensity, direction of motion) of derechos in Canada, the historical database needs to first be completed. Similarly, for a climate change projection of potential future changes in derecho activity, the historical baseline is first needed.

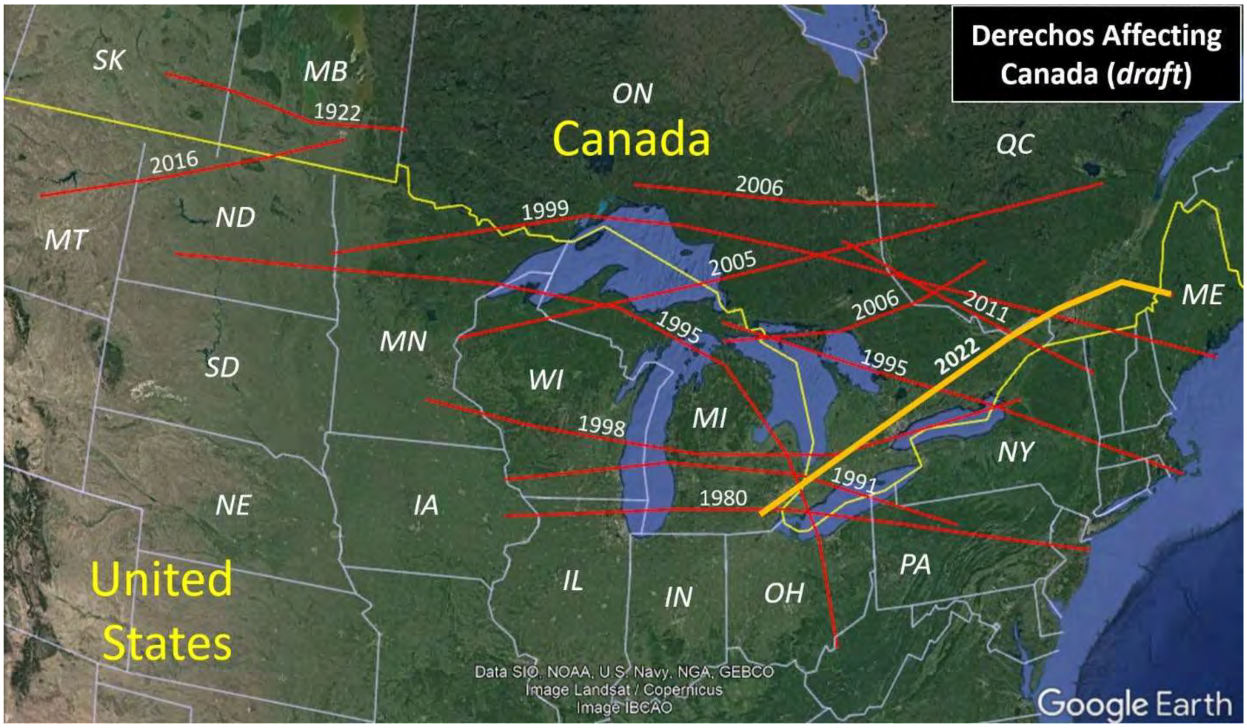

Figure 1 - Draft climatology of derechos affecting Canada (1922 to 2022).

Historical Events: July 17, 2011, Ottawa River Valley Derecho

The most recent derecho event preceding the 2022 storm affecting the Ottawa area occurred on July 17, 2011. The 2011 derecho event began at 2:45 PM in the Upper Ottawa Valley, affecting Allumette Island and Petawawa/Pembroke are before impacting the City of Ottawa at around 7:20 PM (CBC 2011). This storm resulted in four (4) injuries (including one serious) after it triggered a stage collapse at the

Ottawa Blues Festival (CBC 2011), as well as one fatality at Ferme-Neuve, Québec. The storm continued to the southeast, affecting portions of Ontario, Québec, New York, and Vermont, ending at ~10:10 PM in Vermont. Unfortunately, no reliable wind speed estimates could be readily developed for this event in the Ottawa area. Ottawa International Airport reported a gust of “96E km/h”, with the letter “E” indicating the archived wind gust value is estimated and not an instrumented recording. No reliable wind speed estimate could be obtained from the stage collapse, either, since while the design wind speed for the stage should have been 80 km/h, subsequent investigations of the structure indicated it was not properly constructed and could easily have failed at a lower wind speed than the design requirement (CBC 2021). However, the storm did produce two instrumented measurements of gusts reaching 120 km/h, one at Pembroke, Ontario, the other at Chapeau, Québec.

Literature Assessment of Climate Change Effects on Derecho Activity

While no tailored climate change projection studies of derecho activity exist, the following considerations suggest that an increase is indeed possible:

- Climate change studies of the “storm track” – the boundary between air masses that generally represents where both the boundary between warm, moist air to the south and cooler arctic air to the north – and where large-scale low-pressure systems tend to travel, are shifting poleward (i.e., north in the northern hemisphere, e.g., Harvey et al., 2014).
    - Studies of derecho activity in the United States (e.g., Coniglio et al. 2004) have consistently indicated an area of maximum activity located immediate south of the Canadian border. Any poleward shift in this track would result in an increase in derecho events affecting southern Canada, especially in the Great Lakes basin.
- Derecho events tend to occur along the poleward side (i.e., northern fringe in the Northern Hemisphere) of so-called “heat domes”. These are features which result in extended extreme heat events for regions located underneath these domes. The frequency and intensity of heat events are projected to increase substantially, and therefore it is possible that severe thunderstorm events which favour the periphery of these extreme heat events will also increase in frequency and severity.

Engineering Risk Considerations

As is indicated on the preliminary map of historical Canadian derechos (Figure 1), the path of the May 2022 event was indeed anomalous. The 2011 storm impacted the City from the northwest, while other storms in the region resulted in paths with other directions, even changing direction in different segments. While the direction of motion will have an eastward component, this means that the *exact* direction of motion of the next event cannot be reliably anticipated.

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Summary of Findings

- Wind producing the worst impacts in southern and south-eastern portions of Hydro Ottawa's service area were due to winds in the 180-195 km/h range.
    - Indications from EF-scale damage analysis and Doppler radar derived winds strongly indicate that the wind gust measurement at Ottawa International Airport is not representative of winds which produced the most severe damage.
- A review of historical events indicates that the City of Ottawa has previously been affected by derecho events, and that the direction of motion and specific areas impacted have differed from the 2022 event. Therefore, the specific locations affected and the direction of storm motion experienced in the 2022 storm should not be explicitly relied upon as indicators of future events.
- While no derecho-specific climate change projection studies are available – for Canada or elsewhere – there are several indicators that suggest that derecho activity may increase in frequency for southern Canada under climate warming.

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Appendix C Forensic Analysis Derecho Event May 21, 2022

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
PLS-1	Pole Line System	Develop anti-cascading strategies and standards for hardening of pole line systems to protect against wind and ice accumulation events, including: •Introducing break or stress points into the distribution lines. •Anchoring. •type of pole. Complete a cost-benefit review of the strategies at critical areas and/or strategic timelines (end of life).	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Wind, ice accumulation	Monitor power outages from cascading events year over year and track by climate event.
PLS-2	Pole Line System	Consider further updates to the vegetation management plan to account for the climate impacts and risks of increased invasive species and their potential to damage infrastructure or injure personnel during wind and ice events. Noting past program augmentations made in response to past storm events, evaluate feasibility of further augmentation with: •Trimming trees more often/aggressively or include heritage trees. •Include trees in the fall zone outside of Hydro Ottawa right away if condition assessment indicates vulnerability. •Working with the City of Ottawa and the Village of Casselman to choose tree species that will be more resistant to future climate.	Forestry Asset Planning	Vegetation Management Plan	Wind, ice accumulation	Review outage report as a result of tree damage on an annual basis and adjust Vegetation Management Plan as required.
PLS-3	Pole Line System	Complete a technology review and feasibility study of technology that may use reduce ice build-up through pulsing or vibration of distribution lines to prevent ice build-up and galloping of lines.	Standards	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Ice accumulation	Line and pole damage and ice accumulation.
PLS-4	Pole Line System	Complete a study/analysis of potential methods to increase detection capabilities for downed lines to increase response time to repair damaged pole line system after damage from wind and/or ice accumulation.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Wind, ice accumulation	Monitor power restoration response time to event.
PLS-5	Pole Line System	While likely cost prohibitive, where it may be warranted, complete a cost/benefit analysis to converting overhead lines to underground infrastructure when major damage has occurred, or when the infrastructure is nearing its end of life. Underground distribution lines and infrastructure would mitigate risk from wind, ice accumulation and fog.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Wind, ice accumulation, fog	Outage reports for weather events and cost of damage estimates.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
PLS-6	Pole Line System	Consider the feasibility of further increasing the frequency of pole washing and cost/benefit based on risk level (current/future) to prevent increase risk of fires related to an increase in anticipated fog days.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Fog	Monitor pole fires and fog days on a year over year basis.
PLS-7	Pole Line System	Complete a cost/benefit analysis of expedited replacement of insulators and fused cut-outs with porcelain to prevent increase risk of fires related to an increase in anticipated fog days.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Fog	Monitor pole fires and fog days on a year over year basis.
PLS-8 [1]	Pole Line System	Complete an inventory of switches for critical equipment and consider looking at alternatives for implementing measures to prevent freezing.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Ice accumulation	Incidents and/or inability to correct issues related to immobile switches as a result of freezing rain.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
ULS-1	Underground Line System	Complete an engineering review to identify if there are locations vulnerable to overheating (via a detailed assessment of locations that could be vulnerable to temperatures higher than 40°C) and complete a cost-benefit analysis for mitigation options, which may include: •Institute either operational constraints on how much power can be conveyed through cables to limit overheating of cables. •Cool ducts either actively or passively, for example, with thermal fill (a clay slurry).	Asset Planning Standards	Asset Management Plan UG Cable R0	Maximum Temperatures	Temperature runs within prescribed levels. Premature cable failure events and occurrences of 40°C days.
ULS-2	Underground Line System	Identify new technologies and processes through research and feasibility or pilot studies to reduce freeze thaw impacts. These may include: •Exploring the use of different materials for manholes instead of concrete that are less susceptible to freeze-thaw (e.g. fiber glass). •Redesign civil structure collars to move with the heading (e.g. telescopic collars).	Asset Planning Standards	Asset Management Plan - Civil Structures	Freeze-thaw events	Track freeze-thaw damage and annual freeze-thaw days.
SUB-1	Substations	Review additional requirements for sanding and gritting prior to site access.	Facilities	Maintenance Procedures	Ice accumulation	Delays due to inaccessibility.
SUB-2	Substations	Develop a policy to monitor and inspect substation building and structural components after an ice event to mitigate the risk of structural damage and loss of assets as a result of ice damage to substations.	Facilities Stations	Maintenance Procedures	Ice accumulation	Number of leaks or damages. Track maintenance costs.
SUB-3	Substations	Complete a cost-benefit analysis of installing protective covers on small exterior equipment, where feasible, to prevent damage/failure as a result of ice accumulation.	Facilities	Asset Management Plans	Ice accumulation	Number of failures of attached equipment due to ice.
SUB-4	Substations	Create an inventory of all critical equipment (e.g. switches) that could be impacted by ice accumulation, prioritize by criticality, and assess feasibility or practicality of covering with permanent or temporary covers without creating additional hazards [1].	System Operations Asset Planning Standards	Asset Management Plan - Station Switchgear and Breakers	Ice accumulation	Number of operational failures due to ice.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
OPS-1	Operations	Refine and establish a policy on wind conditions when a lift bucket should not be used and when work should not be completed to mitigate the risk of injury related to wind.	Distribution Operations Health and Safety	Health and Safety Policy/Practice	Wind	Monitoring of the number of wind-related events and health and safety incidents associated with wind and lift buckets.
OPS-2	Operations	Consider a review of policies surrounding heat stress on outdoor workers and revise to include projected climate changes to mitigate the impacts of heat stress. Policies to consider should including: •A policy on work redistribution (scheduling) to avoid outdoor work during peak heat hours. •Where feasible and risk assessment permits, consider a policy around the adoption and use of modified PPE to improve cooling / ventilation.	Distribution Operations Health and Safety	Health and Safety Policy/Practice	Heat events	Monitor the number of heat-related incidents and daily max temperatures in excess of 35 °C and 40°C.
OPS-3	Operations	Work with Hydro One, and provincial regulators to ensure supply design and standards are aligned with climate risks.	Asset Planning System Operations	Various	Ice accumulation, wind	Track the frequency and scale of outages resulting from Hydro One service disruption.
OPS-4	Operations	Consider the cost-benefit of the following measures to reduce the risk of employee injuries related to ice accumulation events: •Review, and consider revising policy for requiring installation of winter tires on Hydro-owned vehicles to prevent injuries to personnel rather than through a request/approval process. •Installation and use of additional automated devices to limit need to travel during inclement conditions. •Introducing policies to include heated steps or walkways on Hydro Ottawa properties versus continued salting/sanding.	Fleet & Facilities Asset Planning	Health and Safety Policy/Practice	Ice accumulation	Monitor the number of ice-related incidents (near miss, incidents).
OPS-5	Operations	Develop a policy to monitor and inspect building and roofs after an ice event.	Facilities	Maintenance Procedures	Ice accumulation	Tracking of damage by weather event (if known). Track maintenance costs.
OPS-6	Operations	Consider updating the work from home policy to eliminate or reduce commuting during extreme weather events and hazardous road conditions, particularly ice accumulation.	Human Resources	Human Resources Policy	Ice accumulation	Safety bulletin for tracking number of slips, falls, and other ice-related incidents.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
OPS-7	Operations	Consider future climate projections at end of life of current system when deciding to replace or rehabilitate building HVAC systems. Integrate requirement into Procurement Policy to size and design based on climate projections (heating and cooling requirements) in conjunction with critical needs (IT server requirements). By integrating future needs into procurement, the risk that cooling is not adequate during 40°C is minimized.	Facilities	Procurement Policy	Heat event	Monitor the efficiency and service requirements of the building's HVAC system and environmental controls.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

HATCH

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10/24/2024

Pranav Pattabi, P.Eng
Supervisor, Maintenance and Reliability
Hydro Ottawa Ltd.
2711 Hunt Club Rd, Ottawa, ON

Subject: Hydro Ottawa Asset Condition Assessment Framework

Dear Pranav,

Hatch was engaged by Hydro Ottawa Ltd. (HOL) to review their Asset condition assessment (ACA) framework. The primary objective of this exercise is to validate the framework's calculation and methodology, providing suggestion on its alignment with HOL's broader asset management (AM) strategy and relevant standards. The ACA framework is employed by HOL to derive Asset Health Indices (HI), supporting efforts to enhance system reliability, optimize customer satisfaction, and improve operational efficiency. This approach integrates data from various maintenance programs such as visual inspections, testing and monitoring activities.

Hatch's review was structured into two aspects: 1) Examination of the provided information, including summaries of methodologies and raw data, to validate the ACA framework results for the assets in scope; 2) Evaluation of the ACA framework to ensure alignment with HOL's AM philosophy.

Hatch's review of HOL's ACA framework led to the following conclusions:

1. **Desktop Review and Validation of Framework Results**

Hatch has found HOL's ACA framework to be comprehensive, reflected by HOL's efforts to capture and utilize available data. The methodology document largely demonstrates transparency, consistency and alignment with the calculation model. Despite the volume of assets being assessed, the methodology ensures that data from different source is translated into meaningful metrics.

Hatch identified minor calculation gaps with minimal impact to the overall asset portfolio. HOL currently uses Microsoft Excel (Excel) for Health Index calculations. Some of the identified discrepancies rise from the manual handling of multiple Excel files. While Excel offers ease of use and flexibility, it is also prone to errors due to the intensive manual processes involved in managing and processing data. The reliance on manual data transfer, formula adjustments, and file imports increases the risk of human error, which can compromise the accuracy of health index calculations. Even minor mistakes, such as incorrect cell references or data misplacement, can potentially cascade into larger issues, leading to unreliable outputs. Additionally, the lack of built-in automation or advanced error-checking mechanisms within Excel makes it challenging to maintain consistency across large datasets. As data volumes grow, the effort required to validate entries and formulas manually becomes more time-consuming and error-prone. This increases the potential for inconsistencies, especially when multiple users are involved in updating and modifying asset data.

When Hatch identified this minor gap, HOL, acknowledges the challenges associated with Excel's manual processes and their impact on data accuracy. In response, HOL shared that they are actively exploring more streamlined solutions to address this limitation. Their goal is to implement a system that minimizes reliance on manual processes, offers analytics and dashboard capabilities, and has the potential to integrate with other enterprise solutions.

Hatch worked with HOL to identify the gaps and to find mitigation solutions, ultimately resulting in addressing all the calculation gaps a result of the project.

2. Assessment of Alignment with AM Philosophy and Relevant Standards:

Hatch has found HOL's ACA framework as overall comprehensive giving the limitation with available data. The framework also shows HOL's effort to balance complexity with practicality.

A key strength of HOL's ACA framework lies in its HI validation step, which ensures the integrity and robustness of all results. This step assesses if a sufficient number of parameters is available for each asset before proceeding with the ACA calculation, ensuring that the analysis is not only thorough but also meaningful. By setting this threshold, the framework prevents incomplete or unreliable assessments, maintaining consistency and precision across all evaluated assets.

Hatch proposed that additional criteria be incorporated for certain asset classes to provide a more comprehensive representation of the overall Health Index. HOL acknowledged the value of this suggestion and expressed agreement, noting that they are already in the process of gathering more data to support this enhancement. HOL confirmed that with this expanded dataset, they plan to implement some of the suggested criteria in the near future, further enhancing their ACA framework.

Hatch further recommended adopting a non-linear approach that can be closer aligned with HOL's Asset Management principles, emphasizing a shift from traditional linear models to more dynamic, data-driven methodologies. HOL has acknowledged the value of this suggestion and confirmed that they are actively exploring solutions to enhance their capabilities in advanced analytics. Their objective is to adopt a platform that offers better scalability, reduces reliance on manual processes, and minimizes the potential for human error inherent in Excel-based management. By moving toward a more automated and integrated system, HOL aims to streamline operations, improve data accuracy and ensure consistency across asset condition assessment as the framework evolves.

These efforts reflect HOL's commitment to continuous improvement, balancing the need for immediate enhancements with long-term strategies for operational efficiency. Their dual focus on expanding data collection and upgrading technology ensures that future phases will not only incorporate more robust criteria but also benefit from more reliable and scalable processes.

Key Takeaway

Hatch has reviewed HOL's Asset Condition Assessment calculations and methodologies. Hatch confirmed that the calculations are aligned with the methodologies and that the methodologies are generally aligned with industry best practices. Minor gaps were identified in the calculations, which HOL has acknowledged and addressed. Hatch also provided suggestions for enhancing the methodologies, which HOL recognized as valuable. HOL confirmed that they are in the process of gathering additional data and exploring solutions to support advanced analytics and meet evolving data requirements.

Yours faithfully,

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Distribution Asset Failure Curves

August 15, 2024

Hydro Ottawa Failure Curves

Hydro Ottawa

HATCH

Hatch Project H372826

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Agenda

Executive Summary

Overview

Hydro Ottawa Limited ("HOL") is looking to advance their asset failure curve intelligence to improve the risk- and value-based asset management processes. The overall objective of the project was to advance the existing failure curves from industry consensus-based to data-driven evidence based.

Through this project, Hatch has reviewed existing failure curves, provided data-driven failure curves and augmented HOL's current age-condition decay curves based on available asset records. Various data scenarios and methodologies were considered and verified by Hatch's SMEs to arrive at most accurate data-driven representation of the system. The purpose of this exercise was reviewing data availability, data quality, selecting the appropriate methodology and providing future recommendations.

This analysis was performed for 30 asset types across 9 asset classes:

- ✓ Transformers
- ✓ Poles
- ✓ Switches, Reclosers, Switchgear
- ✓ Cables, Relays, Maintenance Holes, Batteries

Evaluated Assets

Click on asset class to view detailed results

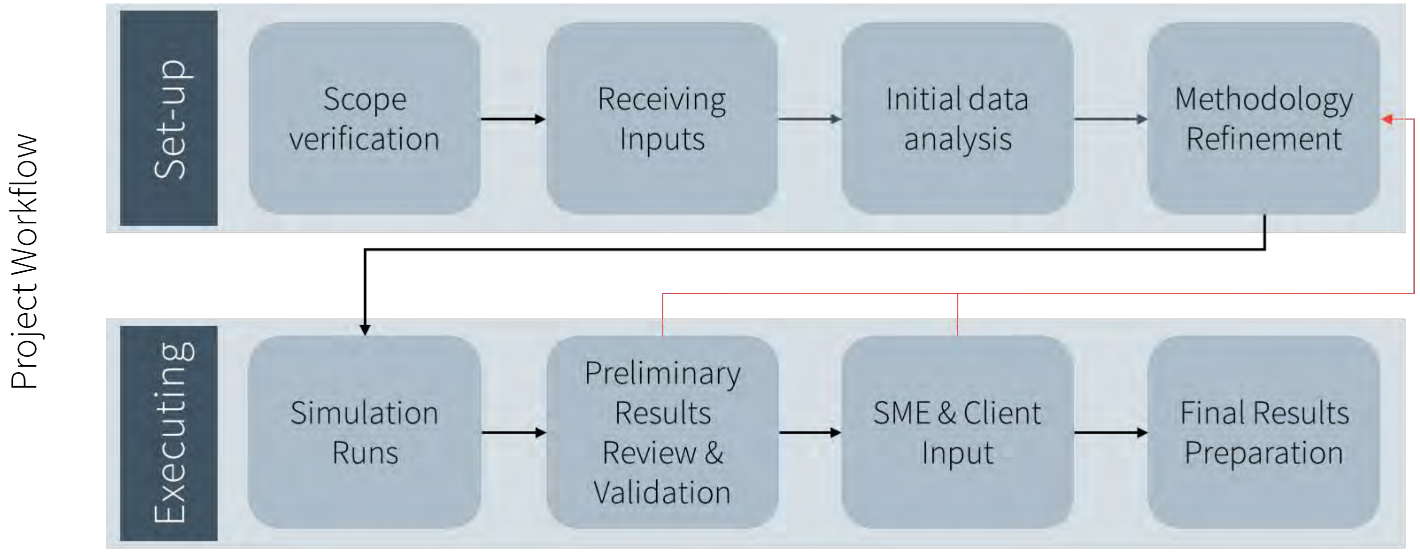
Transformers	1	Station Transformers
	2	Polemount Transformers
	3	Vault Transformers
	4	UG Transformers
	5	Station Tap Changers
Poles	6	Wood Poles
	7	Concrete Poles
	8	Metal Poles
	9	Composite Poles
Switches/Reclosers	10	Station HV SF6 Breakers
	11-A	Station Metalclad Air Breakers
	11-B	Station Metalclad Vacuum Breakers
	11-C	Station Metalclad Oil Breakers
	11-D	Station Metalclad SF6 Breakers

Switches/Reclosers	12-A	UG Switchgear Air
	12-B	UG Switchgear SF6
	13-A	OH Manual Loadbreak Switch
	13-B	OH SCADA Loadbreak Switch
	14	OH Distribution Reclosers
	15	Station Outdoor Reclosers
	16	Station HV Circuit Switchers
Cables	17-A	UG Primary Cables – EPR
	17-B	UG Primary Cables – XLPE
	17-C	UG Primary Cables – PILC
Other	18	Protective Relays [EM, Electronic, Microprocessor]
	19	Maintenance Holes
	20-A	Station Batteries [VLA]
	20-B	Station Batteries [VRLA]

HydroOttawa HATCH

Highlights

- The team utilized an iterative process to examine the applicability of different reliability engineering methodologies and techniques to HOL's data, building upon Hatch's extensive experience in implementing reliability engineering methodologies within the T&D domain.
- Overall process flow was developed to address HOL-specific challenges and leverage different available inputs
- Continuous efforts were made to compare the results with industry and HOL Typical Useful Life values. The results were reviewed with SMEs for verification and further optimization of each step of the process.



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Methodology

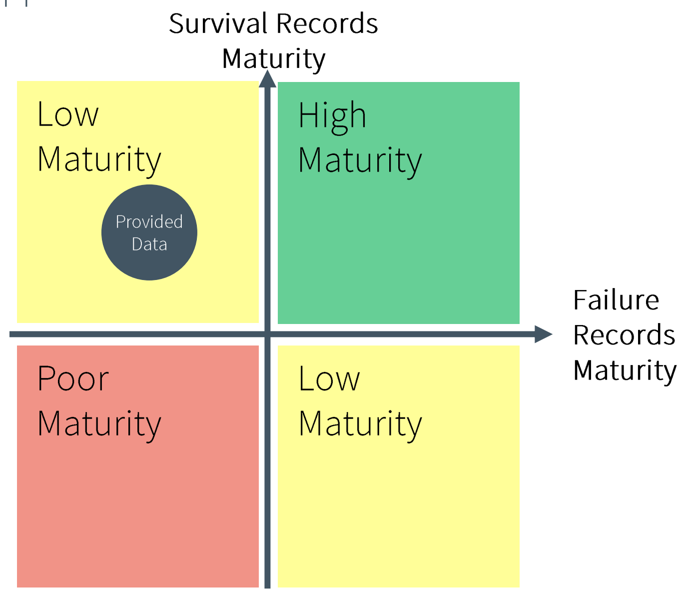
Data Driven Reliability Engineering

The accuracy of data-driven reliability engineering relies on the quality of existing data. The following are some of the data challenges within the reliability engineering for transmission and distribution utilities:

- General lack of survival and/or failure data.
- Minimal failure data compared to in-service assets. This leads to higher right censoring effect.
- Shorter data collection duration compared to the early assets' installation year and the overall study period. This leads to longer missing data duration and higher left truncation effect.

Based on these challenges, the data provided for this exercise would qualify on the second quadrant of the following reliability engineering maturity matrix. This highlights the fact that for the majority of asset classes, the data-driven results should be verified with internal SMEs before being applied.

The lack of asset failure data is the biggest challenge within the transmission and distribution asset management domain. This challenge, among other challenges, were addressed by utilizing extensive scenario-based simulations and probabilistic approaches to address the missing data.



Executive Summary | Methodology | Results Overview | Recommendations | Appendices

Asset Simulation Methodology

Poisson bootstrapping and synthetic simulations

HOL Inputs

① Asset Registry (no failures)

Estimated/actual install years for survivals

Health Index data where applicable

② Corrective Renewal Data

# of corrective renewals due to failures for years 2016 to 2022

Analysis Set-up

Asset Registry Distribution

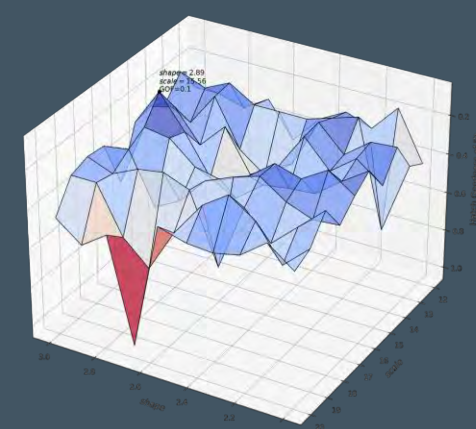
TUL Estimates

SME Input

Weibull Parameters
- Matrix of possible shape and scale values

Asset Simulation

Statistical analysis leveraging available data to arrive at best representative Weibull curve



Refine Boundary Conditions and Parameters if result is not satisfactory

Review Results

Synthetic Asset Registries
- Including Failures & Survivals

- ➢ Compare synthetic survival distribution to current asset registry
- ➢ Compare synthetic failure to replacement records
- ➢ Compare fitted Weibull distribution to TUL and SME inputs

Best Synthetic Registry & corresponding Weibull Curve ★

Result Review and Application

Simulation methodologies are designed to create simulated populations of assets under various initial conditions, including the probabilistic failure characteristics of these assets.

The outcome is then evaluated to ensure that the simulated population closely matches the current asset registry. If the simulated results consistently approach the distribution of the current asset registry, the simulation is considered to be converging. This convergence indicates that the methodology is reaching a stable state that accurately represents the current asset class population.

Converging at such a stable state is a common challenge when simulation methods are employed in management of utility assets. Various factors such as poor data quality can prevent a simulation from converging. In this exercise, the shape and scale parameters of a Weibull distribution were simulated across past several decades to arrive at virtual population of assets that shows maximum similarity to the current asset registry.

For 18 out of 30 asset classes (60% of the studied asset classes) the model did converge successfully. For the remaining 12 assets classes (40% of the studied asset classes) the model did not converge to specific stable results.

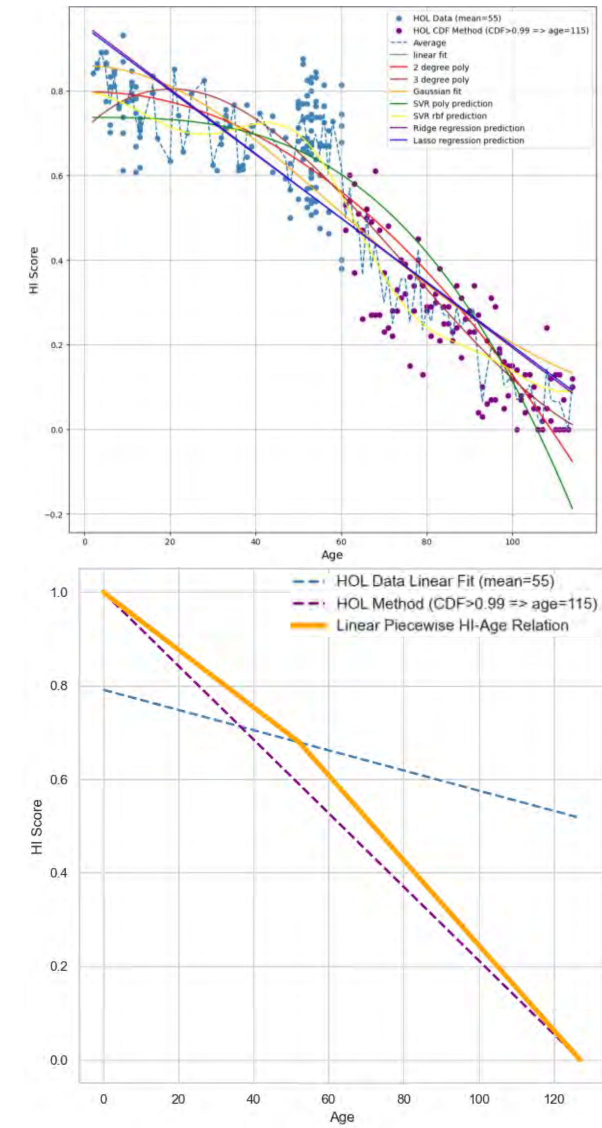
Three sets of results are reported for each asset class where applicable.

- Data Driven Results: The simulation results that most closely match the distribution of the asset registry are reported as data-driven results.
- TUL Adjusted Results: When data-driven results deviate from the industry's TULs, the similarity criterion is relaxed to include the top 10% of matches most closely resembling the current asset registry. From this selection, the results closest to the industry TUL are then provided.
- TUL Based Results are developed using industry recognized TUL, HOL specific historical TUL, and expert judgement.

When the simulation model did not converge, the corresponding cells within result tables for Data Driven Results and TUL Adjusted Results are gray shaded. Since the provided data is considered to be in the Low Maturity category, the simulation results for non-converging asset classes do not reflect their actual survival pattern. For these cases, SME verified shape was used to produce TUL Based results.

Age-Condition Degradation Curve

- Multiple statistical and machine learning methods were tested to model the health index degradation with time (including Linear, Polynomial, Sigmoid, Gaussian and Support Vector Machine regressions).
- The quality of data across all different asset classes would not allow for consistent regression model to work in majority of cases.
- The following criteria for a linear piecewise model was developed and proved robust based on data of 17 asset classes.
    - A segmented linear piecewise relationship was built to incorporate Health Index records where data shows less degradation than the current HOL health index degradation methodology.
    - First segment connects new assets with HOL health index data trend.
    - The fitted average useful life was used as inflection point.
    - Second segment connects inflection point to asset end of life as per the current HOL methodology.

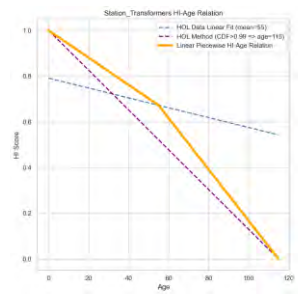


Station Transformers Age Condition Degradation

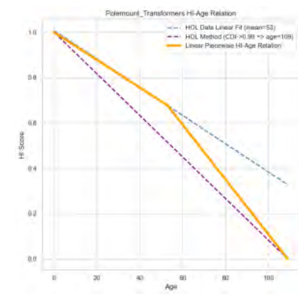
Results Overview
Age-Condition Degradation Curves

Results Overview: Age-Condition Degradation Curve

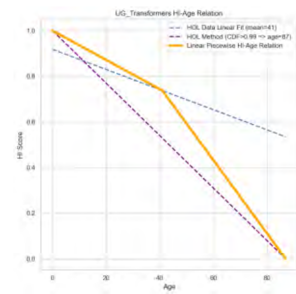
Station Transformers



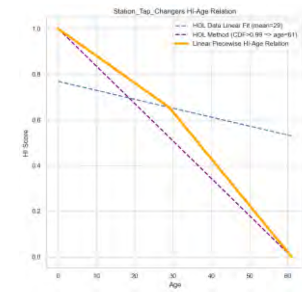
Polemount Transformers



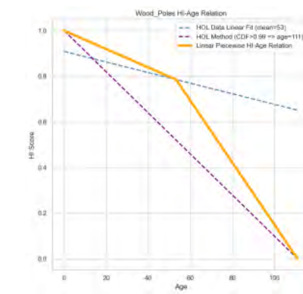
UG Transformers



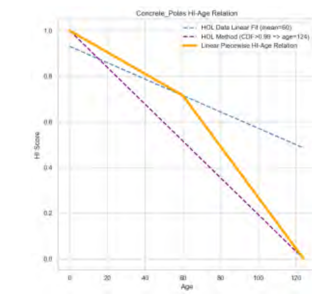
Station Tap Changer



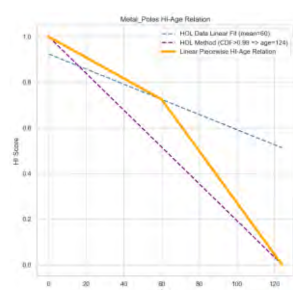
Wood Poles



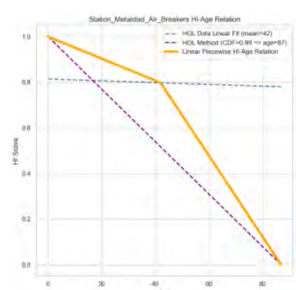
Concrete Poles



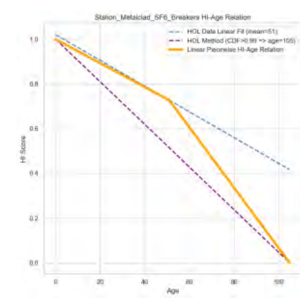
Metal Poles



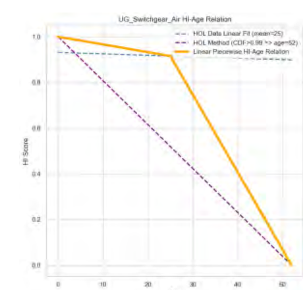
Metalclad Breakers - Air



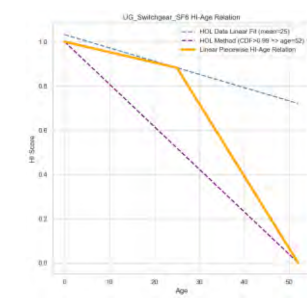
Metalclad Breakers – SF6



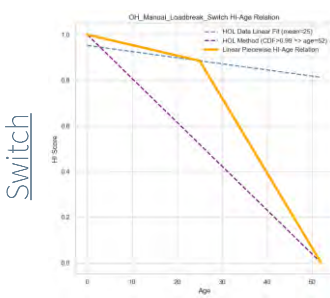
UG Switchgear Air



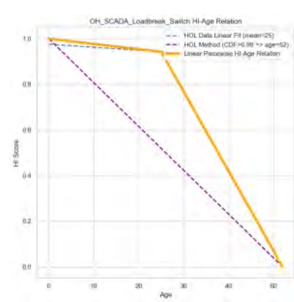
UG Switchgear SF6



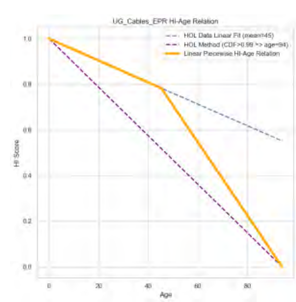
OH Manual Loadbreak Switch



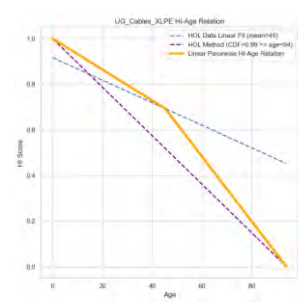
OH SCADA Loadbreak Switch



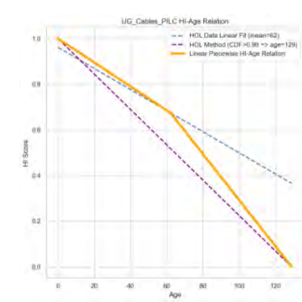
UG EPR Cables



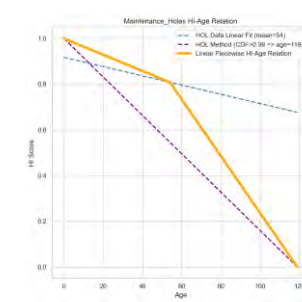
UG XLPE Cables



UG PILC Cables



Maintenance Holes



Results Overview – Failure Curves Data Driven Results

Results Overview - Transformers

#	Asset	Data Driven			TUL Adjusted			TUL Based			Typical Useful Life (TUL)	*Comments*
		Shape	Scale	Mean	Shape	Scale	Mean	Shape	Scale	Mean		
1	Station Transformers	2.1	53	47	2.1	59	52	2.5	62	55	55	*Model converged successfully*
2	Polemount Transformers	3.2	76	68	3.7	59	53	2.5	59	53	53	*Model **did not** converge to a specific shape/scale combination*
3	Vault Transformers	2.6	69	61	2.3	60	53	2.5	59	53	53	*Model **did not** converge to a specific shape/scale combination*
4	UG Transformers	2.4	46	41	--	--	--	2.5	46	40	40	*Model converged successfully*
5	Station Tap Changers	2.0	27	24	2.4	32	29	2.5	34	30	30	*Model converged successfully*

Note: The red-highlighted results are recommended values confirmed during a workshop between HOL and Hatch SMEs. These recommendations were based on the convergence of the simulation model, the maturity of input data, and industry experience.

Results Overview - Poles

#	Asset	Data Driven			TUL Adjusted			TUL Based			Typical Useful Life (TUL)	*Comments*
		Shape	Scale	Mean	Shape	Scale	Mean	Shape	Scale	Mean		
6	Wood Poles	3	72	**64**	2.5	69	**61**	2.5	60	53	53	*Model **did not** converge to a specific shape/scale combination*
7	Concrete Poles	3.0	67	**60**	--	--	--	2.5	67	60	60	*Model **did not** converge to a specific shape/scale combination*
8	Metal Poles	2.6	69	**62**	2.0	67	**60**	2.5	67	60	60	*Model **did not** converge to a specific shape/scale combination*
9	Composite Poles	2.7	86	**76**	2.9	90	**80**	2.5	90	80	80	*Model **did not** converge to a specific shape/scale combination*

Note: The red-highlighted results are recommended values confirmed during a workshop between HOL and Hatch SMEs. These recommendations were based on the convergence of the simulation model, the maturity of input data, and industry experience.

Results Overview – Switches/Reclosers

#	Asset	Data Driven			TUL Adjusted			TUL Based			Typical Useful Life (TUL)	*Comments*
		Shape	Scale	Mean	Shape	Scale	Mean	Shape	Scale	Mean		
10	Station HV SF6 Breakers	3.0	50	45	--	--	--	2.5	51	45	45	*Model **did not** converge to a specific shape/scale combination*
11-A	Station Metalclad Air Breakers	2.2	52	46	2.2	45	40	2.5	47	42	42	*Model converged successfully*
11-B	Station Metalclad Vacuum Breakers	2.9	54	48	3.0	53	47	2.5	52	46	46	*Model converged successfully*
11-C	Station Metalclad Oil Breakers	2.7	45	40	2.6	58	51	2.5	62	55	55	*Model converged successfully*
11-D	Station Metalclad SF6 Breakers	2.4	53	47	2.9	60	53	2.5	57	51	51	*Model converged successfully*
12-A	UG Switchgear Air	3.0	26	23	2.9	38	34	2.5	28	25	25	*Model converged successfully*
12-B	UG Switchgear SF6	2.9	39	35	3.0	28	25	2.5	28	25	25	*Model **did not** converge to a specific shape/scale combination*

Note: The red-highlighted results are recommended values confirmed during a workshop between HOL and Hatch SMEs. These recommendations were based on the convergence of the simulation model, the maturity of input data, and industry experience.

Results Overview - Switches/Reclosers

#	Asset	Data Driven			TUL Adjusted			TUL Based			Typical Useful Life (TUL)	*Comments*
		Shape	Scale	Mean	Shape	Scale	Mean	Shape	Scale	Mean		
13-A	OH Manual Loadbreak Switch	2.3	39	**35**	2.0	36	**32**	2.5	28	**25**	25	*Model converged successfully*
13-B	OH SCADA Loadbreak Switch	2.6	41	**37**	2.3	31	**27**	2.5	28	**25**	25	*Model converged successfully*
14	OH Distribution Reclosers	2.6	44	**39**	3.0	44	**40**	2.5	45	**40**	40	*Model **did not** converge to a specific shape/scale combination*
15	Station Outdoor Reclosers	2.4	43	**38**	2.4	44	**39**	2.5	45	**40**	40	*Model **did not** converge to a specific shape/scale combination*
16	Station HV Circuit Switchers	2.2	58	**51**	--	--	--	2.5	57	**50**	50	*Model **did not** converge to a specific shape/scale combination*

Note: The red-highlighted results are recommended values confirmed during a workshop between HOL and Hatch SMEs. These recommendations were based on the convergence of the simulation model, the maturity of input data, and industry experience.

Results Overview - Cables

#	Asset	Data Driven			TUL Adjusted			TUL Based			Typical Useful Life (TUL)	*Comments*
		Shape	Scale	Mean	Shape	Scale	Mean	Shape	Scale	Mean		
17-A	UG Primary Cables – EPR	2.3	29	26	2.9	49	43	2.5	51	45	45	*Model converged successfully*
17-B	UG Primary Cables – XLPE	2.5	54	48	2.5	52	46	2.5	51	45	45	*Model converged successfully*
17-C	UG Primary Cables – PILC	2.0	67	60	2.6	69	62	2.5	70	62	62	*Model converged successfully*

Note: The red-highlighted results are recommended values confirmed during a workshop between HOL and Hatch SMEs. These recommendations were based on the convergence of the simulation model, the maturity of input data, and industry experience.

Results Overview - Other

#	Asset	Data Driven			TUL Adjusted			TUL Based			Typical Useful Life (TUL)	*Comments*
		Shape	Scale	Mean	Shape	Scale	Mean	Shape	Scale	Mean		
18-A	Protective Relays - EM	2.3	43	**38**	2.8	46	**41**	2.5	45	**40**	40	*Model converged successfully*
18-B	Protective Relays - Electronic	2.8	45	**40**	2.0	33	**30**	2.8	17	**15**	15	*Model converged successfully*
18-C	Protective Relays - Microprocessor	2.3	23	**21**	2.3	28	**25**	2.5	28	**25**	25	*Model **did not** converge to a specific shape/scale combination*
19	Maintenance Holes	2.3	61	**54**	2.6	67	**60**	2.5	68	**60**	60	*Model converged successfully*
20-A	Station Batteries [VLA]	2.9	16	**14**	2.3	19	**17**	2.5	28	**25**	25	*Model converged successfully*
20-B	Station Batteries [VRLA]	2.9	18	**16**	2.7	17	**15**	2.5	17	**15**	15	*Model converged successfully*

Note: The red-highlighted results are recommended values confirmed during a workshop between HOL and Hatch SMEs. These recommendations were based on the convergence of the simulation model, the maturity of input data, and industry experience.

Recommendations & Discussions

Summary and Recommendation

Project Highlights

- Utility companies face various data challenges in tracking and recording asset performance.
- It is instrumental to leverage any available information when data is not comprehensive.
- Available HOL information was utilized to developed a custom approach to address HOL-specific challenges

Recommendations

- Continue to improve failure data tracking and collection
  - Continue to track count of failures and renewals per year, in addition to replaced asset information, such as install year, age at renewal, and health index
  - For cables, continue to track failures/replacements by segment and feeder
- Continue to implement asset health index tracking
  - Continue to track and record asset health index information based on predetermined parameters

Confidential

Resilience Investment Business Case Report

Hydro Ottawa

Hydro Ottawa Resilience Investment Business Case Assessment
Project No. 156002

3/27/2024

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
ANL	Argonne National Laboratory
BCR	Benefit Cost Ratio
C&I	Commercial & Industrial
CIS	Customer Information System
CMI	Customer Minutes Interrupted
COF	Consequence of Failure
Con Ed	Consolidated Edison
DC	District of Columbia
DOE	Department of Energy
Dominion	Dominion Energy
FPL	Florida Power & Light
FPSC	Florida Public Service Commission
GHG	Green House Gas
GIS	Geographic Information System
HILP	High impact lower probability
ICE	Interruption Cost Estimator
IEEE	Institute of Electrical and Electronics Engineers
LOF	Likelihood of Failure
MED	Major Event Day
NARUC	National Association of Regulatory Commissioners
NASEO	National Association of State Energy Officials
NIAC	National Infrastructure Advisory Council
NOAA	National Oceanic and Atmospheric Administration
OH	Overhead
OMS	Outage Management System

Abbreviation	Term/Phrase/Name
PC44	Public Conference 44
Pepco	Potomac Electric Power Company
PNNL	Pacific Northwest National Laboratory
PSEG	Public Service Electric and Gas
ROW	Right-of-Way
SQ	Status Quo
T&D	Transmission and Distribution
TECO	Tampa Electric Company
UG	Underground

1.0 EXECUTIVE SUMMARY

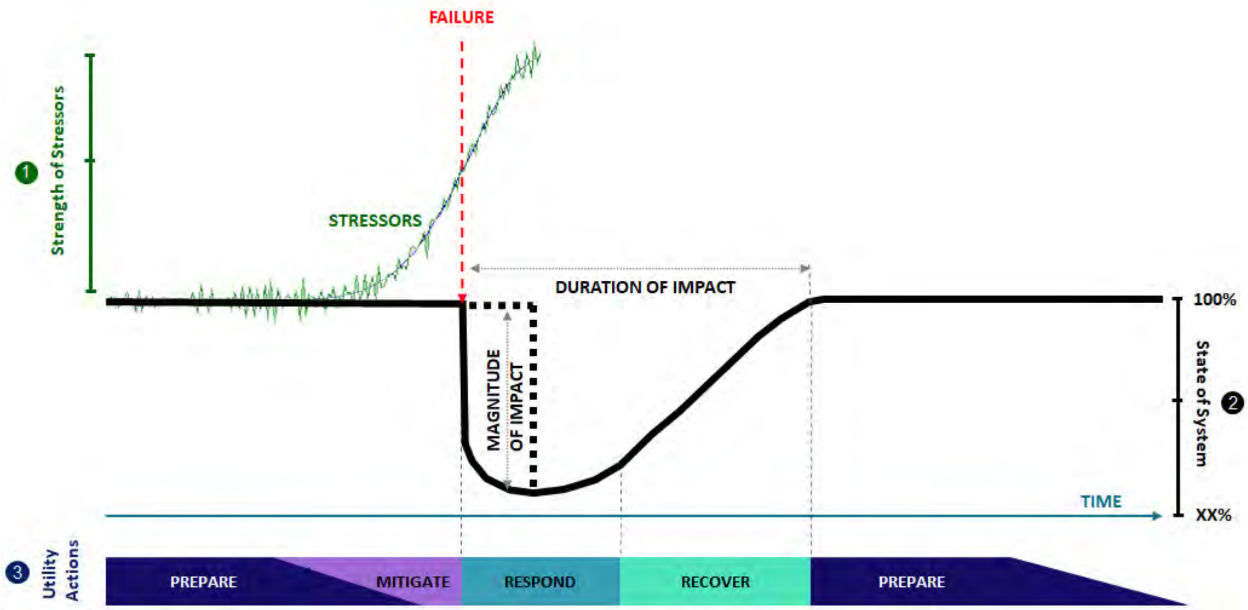
Resilience and its quantification within the utility industry, amongst others, is increasingly the topic of conversation for many electric grid stakeholders from commissions to planning engineers, from boardrooms to utility operations and beyond.

A utility's system resilience is a function of many factors but the two main functions are the frequency and types of events to impact the system, and the characteristics of the infrastructure. Obviously, more frequent and more intense events make grid resilience challenging. Second, the unique characteristics of a utility's system will change the overall outcome of the major events. The following are examples of key characteristics or vulnerabilities that will impact the resilience of the grid:

- Vegetation density
- Quantity of exposed infrastructure (Overhead vs Underground)
- Age and condition of exposed infrastructure
- Level of system sectionalization (Size of circuits, i.e. no. of customers fed off of each circuit)
- Mix of downstream customers

The combination of events and vulnerabilities provides additional challenges for grid resilience. 1898 & Co. utilizes a conceptual resilience framework to understand both of these factors (events and vulnerabilities) and how improvements to the grid can be executed to improve system resilience. Figure 1-1 represents this conceptual view of resilience. The framework is broken up into three components (stressor, state of the system, and utility actions). These three components of the framework are discussed in more detail in Section 2 of the report.

Figure 1-1: Conceptual Resilience Framework



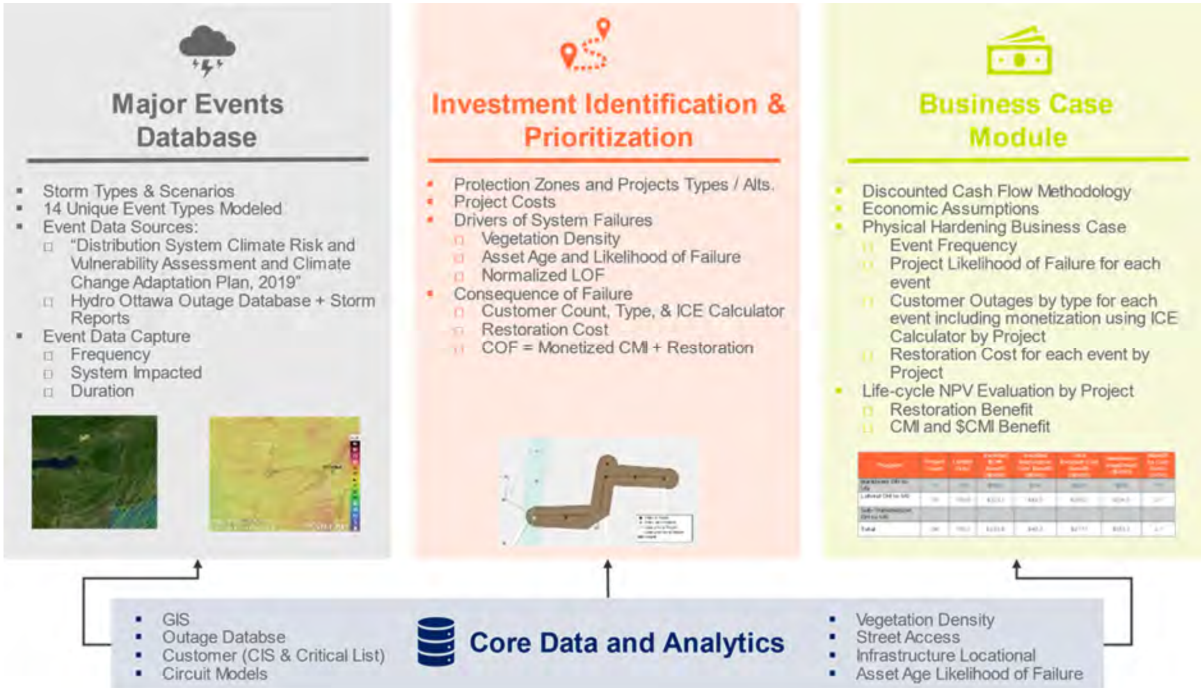
The conceptual frameworks are used throughout this report to:

- Make the case for how resilience investments benefit Hydro Ottawa's customers.
  - Impact to Customers: Outages - Section 3.2
  - Stressors - Section 3.3
  - Impact to Customers: Restoration Costs - Section 3.4
  - Elevated Safety Risks – Section 3.5
- Understand the benefits resilience investments have in avoiding or mitigating disruptive events.
- Anchor the resilience investment business case providing 'line-of-sight' from the theory to practice.

1.1 Resilience Investment Model Overview

Figure 1-2 provides an overview of the Resilience Investment Model to identify and prioritize hardening investments and calculate their customer centric business case.

Figure 1-2: Resilience Investment Model Overview



The Resilience Investment Model is foundationally data centric. It utilizes Hydro Ottawa enterprise data sources as well as external sources. From an internal enterprise perspective, the model utilizes Hydro Ottawa's Geospatial Information System (GIS) for the collection of assets and their attributes (age, type, etc.). This allows the resilience-based planning approach to be asset-centric. The model also utilizes Hydro Ottawa's Outage Database to understand the relationships between protection devices and the types of outage events, particularly larger events. The third core enterprise data set includes information from the Customer Information System (CIS). The fourth core dataset includes Hydro Ottawa distribution circuit models. 1898 & Co. linked these datasets to create the relationship between assets and customers and customer types. This allows the resilience-based planning approach to be customer-centric.

1898 & Co. also leveraged external data sources for the evaluation linking them to the internal data sources. The external data sources included satellite tree canopy for vegetation density analysis, and age deterioration analytics from 1898 & Co. own proprietary modeling. These external sources provided valuable information in identifying infrastructure that would more likely fail during events. Full details of the Resilience model are provided in Section 6.0

1.2 Resilience Investment Results

Hydro Ottawa and 1898 & Co. utilized a resilience-based planning approach to identify, prioritize, and justify o verhead to underground resilience investments in Hydro Ottawa's distribution system. Project benefits are shown in terms of the:

1. Decrease in the Storm Restoration Costs

2. Decrease in the customers impacted and the duration of the overall outage, calculated as CMI.

Additionally, the results are presented assuming monetization of the CMI using the DOE ICE Calculator, modified for resilience. The ICE Calculator is discussed in Section 6.2. The monetization of the CMI in conjunction with the storm restoration costs allows for the calculation of a benefit cost ratio for each potential overhead to underground project.

The resilience projects are prioritized based on the benefit cost ratio of each potential project. Figure 1-3 shows the resulting project resilience ranking, BCR per project cost, for all potential projects included in the evaluation with a historical baseline storm forecast.

Figure 1-3: **Project Resilience Ranking by BCR for Historical Baseline Storm Forecast**

As the figure shows approximately 1 percent of the overhead to underground projects evaluated show a resilience benefit cost ratio value of more than one (28 million dollars). This metric is used to identify the most vulnerable parts of the system that yield the greatest return per dollar spent.

Figure 1-4 shows the resulting project resilience ranking, BCR per project cost, for all potential projects included in the evaluation with climate change storm forecast.

Figure 1-4: **Project Resilience Ranking by BCR for Climate Change Forecast**

As the figure shows approximately 1 percent of the projects evaluated show a resilience benefit cost ratio value of more than one (57 million dollars). This metric is used to identify the most vulnerable parts of the system that yield the greatest return per dollar spent.

1.3 Conclusions

The following include the conclusions of this resilience evaluation for Hydro Ottawa:

- The resilience of the grid is becoming increasingly important. The case for selective overhead to underground resilience investment is sound for Hydro Ottawa; resilience is at the cross section of major events, the modern customer and integrated society. The impact of major events to today's customer and society are much greater than in the past.
- There is opportunity to improve the resilience of Hydro Ottawa's grid for the benefit of customers over the long-term with strategic overhead to underground projects that have quantified benefits that outweigh the costs.
  - Approximately fifty million in total investment that will benefit customers depending on the event forecast assumed.
  - Over Twelve km of resilience circuit investment.
  - 17-26 of potential beneficial overhead to underground projects.
- The development of a Resilience Investment Strategy using the Resilience Investment Model results provides confidence to Hydro Ottawa grid stakeholders. The model provides confidence for the following reasons:
  - **Event-Based –** each project is evaluated against its event performance for 14 different weather events types that are based in the historical record and also climate forecasts with similar conclusions.
  - **Asset and Root-Caused Focused –** each project includes the relationship to their underlying assets. Asset likelihood of failures are based on the assets age and surrounding vegetation.
  - **Data-Centric –** the model utilizes Hydro Ottawa's GIS, OMS, CIS, distribution circuit models, and critical customer information.
  - **Customer-Centric –** the model links each asset to the impacted customer count and type.

- **Granular -** the granularity at the asset and project levels allows Hydro Ottawa to invest in portions of the system that provide the most value to customers from both a restoration cost reduction and avoided CMI perspective.
- **Comprehensive -** The approach is comprehensive and evaluates nearly all of the assets on Hydro Ottawa's overhead distribution systems.
- **Business Case Foundations -** The output of the model is the life-cycle resilience benefit and benefit cost ratio in financial terms.
- **Consistency**: The model calculates benefits consistently for all potential projects.

The assessment and modeling approach drives prudency for the comprehensive overhead to underground hardening evaluation on two main levels. First, the granularity of potential resilience projects allows Hydro Ottawa to target investment in the portions of the system that provide the most value to customers. Secondly, the customer-centric financial justification of project investments allows Hydro Ottawa to prioritize investments that provide significant customer 'bang for buck'.

The focus of this study was underground of overhead infrastructure, that is not the only resilience investment strategy available to mitigate the impact of future events. As Hydro Ottawa finalizes their resilience plan, other resilience investments could supplement the investment identified in this study.

2.0 RESILIENCE FRAMEWORK

Resilience and its quantification within the utility industry, amongst others, is increasingly the topic of conversation for many electric grid stakeholders from commissions to planning engineers, from boardrooms to utility operations and beyond. Following this industry movement, the Institute of Electrical Electronics Engineers (IEEE) has a working group committee focused on supporting the utility industry to develop metrics for measuring and normalizing resilience. These stakeholders recognize that major events are impacting critical infrastructure and disrupting our interconnected society with increasing consequences and devastation. Stakeholders also recognize that the impact of major events cannot be fully mitigated, but efforts can be made to decrease the overall impact and time for the grid to return to normal operations. Currently, measuring resilience for grid stakeholders is still evolving, as it is not a simple concept, and has many factors to consider. Section 2.0 of the report discusses the following resilience topics:

- Provides various definitions as a foundation for understanding resilience
- Offers a framework to understand resilience, the various factors related to it, and how it will be measured within this evaluation and report

2.1 Resilience Definition

The Merriam-Webster dictionary defines resilience as

> "1 : the capability of a strained body to recover its size and shape after deformation caused especially by compressive stress.
> 2 : an ability to recover from or adjust easily to misfortune or change."

Merriam-Webster elaborates on the definition, taking it from a "physics" definition and applying it more personally. It says:

> "In physics, resilience is the ability of an elastic material (such as rubber or animal tissue) to absorb energy (such as from a blow) and release that energy as it springs back to its original shape. The recovery that occurs in this phenomenon can be viewed as analogous to a person's ability to bounce back from a jarring setback."

Merriam-Webster also provides an etymology for resilience:

> "The word *resilience* derives from the present participle of the Latin verb *resilire,* meaning to "to jump back" or "to recoil". The base of *resilire* is *salire*, a verb meaning "to leap" that also pops up in the etymologies of such sprightly words as sally and somersault."

The definitions from Merriam-Webster provide a baseline for understanding resilience from a "physics" and "person" perspective, but additional exploration is needed for its application to infrastructure and electric grids specifically. While there is general agreement within the industry around the major elements of resilience, the definitions are not identical. Other definitions of resilience from grid stakeholders are:

- IEEE PES PES-TR83 Report—Resilience Framework, Methods, and Metrics for the Electricity Sector: "The ability to protect against and recover from any event that would significantly impact the grid."
- CIGRE WG C4.47: "Power system resilience is the ability to limit the extent, severity, and duration of system degradation following an extreme event."
- FERC: "The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such event."
- DOE: "The ability of a power system and its components to withstand and adapt to disruptions and rapidly recover from them."

In a 2013 paper, the National Association of Regulatory Utility Commissioners (NARUC) offered its own definition of resilience in a manner that is simple and easy to understand.

> *"Robustness and recovery characteristics of utility infrastructure operations, which avoid or minimize interruptions of service during an extraordinary and hazardous event. In other words, it's the gear, the people and the way the people operate the gear immediately before, during and after a bad day that keeps everything going and minimizes the scale and duration of any interruptions."*

Before that, the National Infrastructure Advisory Council (NIAC) provided a definition that is often quoted, and which includes elements used in many other definitions. It states that resilience is the following:

> *"The ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event."*

The NIAC definition includes a system's ability to absorb and adapt. These important characteristics were also used by Argonne National Laboratory (ANL) in its work on state and social resilience and were incorporated into Pacific Northwest National Laboratory's (PNNL) work on the resilience impacts of transactive energy systems. The ANL approach can be used to break resilience into four phases that also align with NARUC's elegantly simple description – the difference being that ANL explicitly includes the ability of the system to recognize and mitigate potential failures before they happen. These four phases are described below:

- Prepare (Before)
  The grid is running normally but the system and its operators are preparing for potential disruptions.
- Mitigate (Before)
  The grid resists and absorbs the event until, if unsuccessful, the event causes a disruption.
- Respond (During)
  The grid responds to the immediate and cascading impacts of the event. The system is in a state of flux, and fixes are being made while new impacts are felt. This stage is largely reactionary (even if using prepared actions).
- Recover (After)
  The state of flux is over, and the grid is stabilized at low functionality. Enough is known about the current and desired (normal) states to create and initiate a plan to restore normal operations.

Sub-definitions include:

- *Vulnerability analysis*
  - *Lessons learned*
  - *Continued improvement*
- *Adaptability*
  - *To grid stresses*
  - *Switching flexibility/design*
  - *Robustness to absorb shocks and keep stable*
- *Changing conditions*
  - *Customer expectations*
  - *Climate change*
  - *Heavy distributed energy resources (DER) penetration*
- *Recovery*
  - *Includes preparedness like mutual assistance, SRP, spare inventory, etc.*
- *Extreme event*
  - *System Average Interruption Frequency Index (SAIFI) and Customer Average Interruption Duration Index (CAIDI) exclusions*
  - *Recordable storm*
- *Deliberate attacks*
  - *Cyber*
  - *Physical*
- *Accidents*
  - *Human performance*
  - *External*

Comparison of definitions to each other show significant alignment with respect to 1) disruptive events, 2) minimizing events, and 3) prepare, adapt, and recover.

For 1898 & Co. these definitions of resilience above can be used to form a conceptual framework in which to better understand and evaluate initiatives to improve grid resilience. This is discussed in the following sub-section.

2.2 Resilience Conceptual Framework

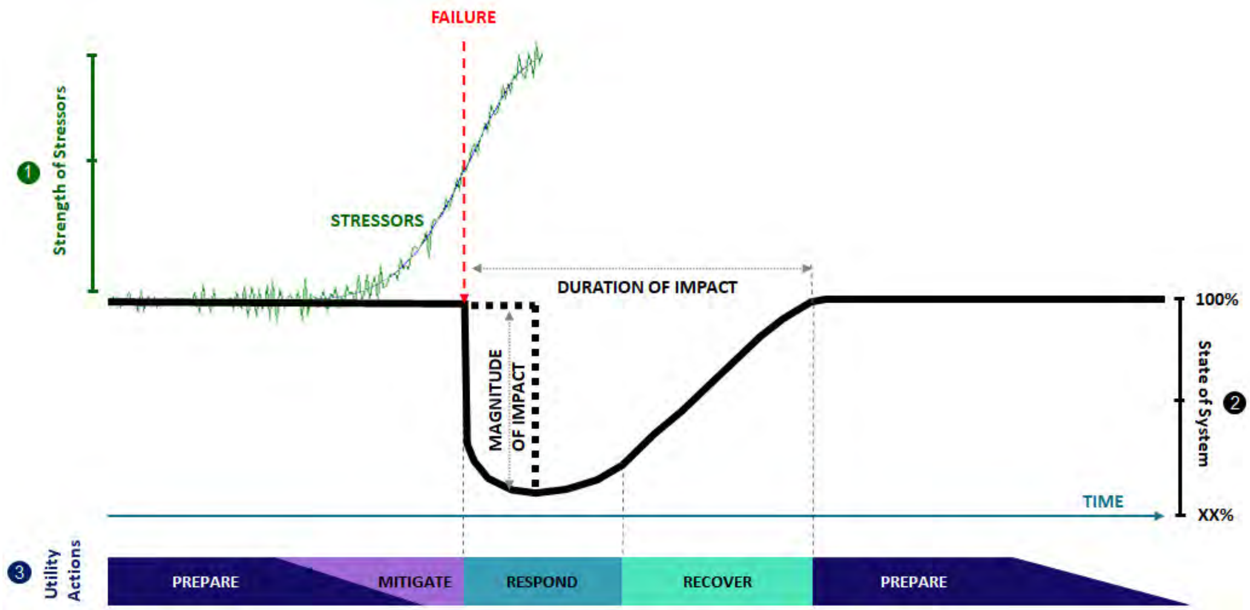
A utility's system resilience is a function of many factors but the two main functions are the frequency and types of events to impact the system, and the characteristics of the infrastructure. Obviously, more frequent and more intense events make grid resilience challenging. Second, the unique characteristics of a utility's system will change the overall outcome of the major events. The following are examples of key characteristics or vulnerabilities that will impact the resilience of the grid:

- Vegetation density
- Quantity of exposed infrastructure (Overhead vs Underground)
- Age and condition of exposed infrastructure
- Level of system sectionalization (Size of circuits, i.e. no. of customers fed off of each circuit)
- Mix of downstream customers

The combination of events and vulnerabilities provides additional challenges for grid resilience. Weather events by their nature are chaotic and do not impact an area evenly. Grid stakeholders could be 'lucky' or 'unlucky' depending on how weather events impact the grid. The power system will have a different resilience response to a thunderstorm with pockets of high winds in older, vegetation dense neighborhoods as opposed to newer neighborhoods which are typically underground (more likely in the suburbs). If a major event is more localized to the suburban area the grid may 'show' to be resilient, but should the event move 10 miles in a different direction it could cause significant outages in the older, vegetation dense neighborhood. The combination of these two factors - events and vulnerabilities - have profound impacts on a grid's measured resilience.

1898 & Co. utilizes a conceptual resilience framework to understand both of these factors (events and vulnerabilities) and how improvements to the grid can be executed to improve system resilience. Figure 2-1 represents this conceptual view of resilience. The framework is broken up into three components.

Figure 2-1: Conceptual Resilience Framework



The first component is the relative strength of a 'Stressor' or major event. The green line represents the underlying issue that is stressing the grid, which increases in magnitude until it reaches a point where it impacts the operation of the grid and causes an outage. The origin of the stress may be due to a failing component, or external due to storms or other events. Section 3.3 includes additional discussion on 'Stressors' and why investment is needed. Section 8.0 provides the application of 'Stressors' within this resilience framework for modeling resilience investment benefits. Each 'stressor' has a different expected frequency of occurrence and relative strength.

The second component is the 'State of System', represented by the black line. The line shows the status of the entire system or parts of the system (e.g., distribution circuits or substations). The "pit" depicted after the event occurs represents the impact on a system in terms of the magnitude of impact (vertical) and the duration (horizontal). For utilities this should be measured from a customer-centric perspective, mainly in the number of customer outages and the cost to restore the system to 'steady state'. The 'State of System' is driven by grid characteristics or vulnerabilities as outlined above. For utility overhead circuit infrastructure, the more aged and vegetation exposed assets with high downstream customer counts will cause a system to be less resilient against events.

The third component of the resilience framework is the utility actions as they prepare, mitigate, respond, and recover from the stressors that caused major disruptions to the grid. Within this third component, the utility has the ability to minimize the disruptions to the state of the system. The ‘prepare’ phase can be immediately before an event or well in advance of an event. In the case of immediately before an event, grid owners and operators may mobilize foreign utility crews and stage equipment to enable faster response during the event. Well before an event, grid owners and operators may invest in grid hardening initiatives to mitigate events. The focus of this report is on this prepare phase and the hardening investments that could be made to mitigate the impact of events. However, it should be noted that additional operation focused activities also impact major disruptions minimization but are not discussed as part of this evaluation. Additionally, technologies could be implemented to better understand the strain on the system to point grid operators to where failures could occur. For instance, utilizing enhanced weather prediction models against the system could identify likely areas of failure on the system. This would enable grid operators to reduce the time to respond. In the ‘respond’ phase grid operators are assessing damage and prioritizing response. This phase is often unpredictable, as efforts to assess the full impact can be delayed for safety reasons. In the ‘recover’ phase, grid operators understand the state of the system and how to restore it to normal operations. Section 8.0 outlines the resilience investment in the ‘prepare’ phase to decrease the impact of grid disruptions on customers.

Note that whether this is a specific or overall depiction of resilience, there is no quantification of time. Events may be measured in hours, or days, depending on the duration of the event.

The conceptual framework can be used to depict a specific distribution circuit, the whole distribution system, or the entire grid. If the figure is used to represent a specific distribution circuit, it represents the impact of the event on only that circuit. If the figure is used to represent the impact on the whole Hydro Ottawa system, it represents the aggregated impacts of the event (storm) and the outages that result from it.

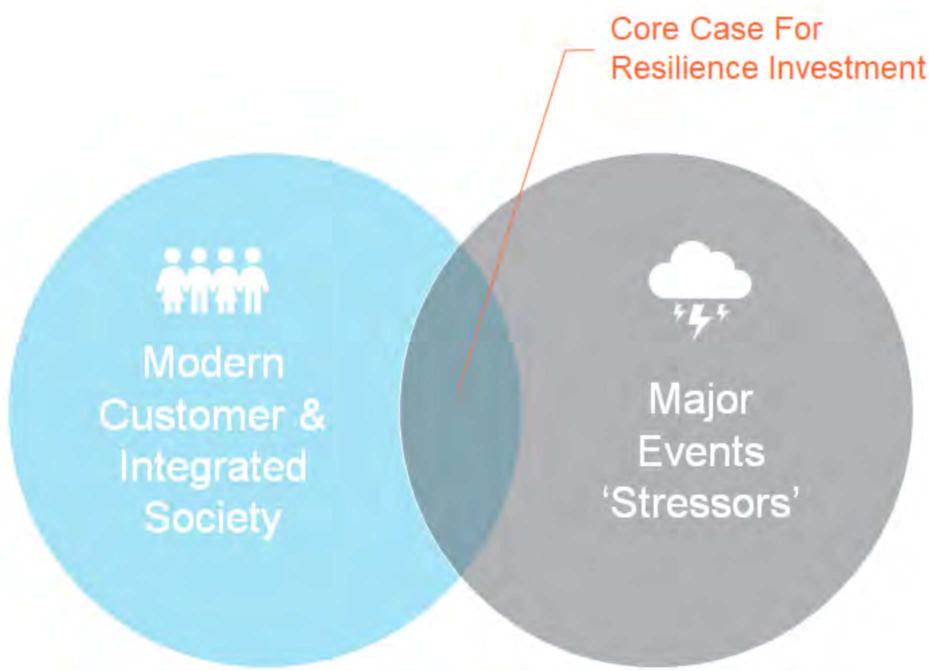
The conceptual frameworks are used throughout this report to:

- Make the case for how resilience investments benefit Hydro Ottawa's customers.
  - Impact to Customers: Outages - Section 3.2
  - Stressors - Section 3.3
  - Impact to Customers: Restoration Costs - Section 3.4
  - Elevated Safety Risks – Section 3.5
- Understand the benefits resilience investments have in avoiding or mitigating disruptive events.
- Anchor the resilience investment business case providing 'line-of-sight' from the theory to practice.

3.0 CASE FOR RESILIENCE

The case for resilience infrastructure improvements is where the modern customer and integrated society intersect with major events. This is depicted in Figure 3-1. While there are many factors, these two are the core case for improving grid resilience.

Figure 3-1: Core Case for Resilience Investment



The customer of today is much different than the customer of 25 years ago. Decades ago, grid outages were seen as inconveniences for customers. Today, these outages can cause real economic harm and stress, especially on society's most vulnerable. Additionally, today's society is far more integrated than in the past. The recent supply chain disruptions following the global pandemic have revealed to us just how interconnected our society and global economy has become.

The customer of today depends on the electric grid being consistently available for these reasons. Compounding the challenge is the expected trend toward more dependence on the grid with the acceleration of electrification such as home heating, commercial fleet electrification, transportation, electric vehicle adoption, to name a few. Additionally, distributed energy resources (DERs) are being contemplated by the customer base. The Canadian Net-Zero Emissions Accountability Act, which became law on June 29, 2021, enshrines in legislation Canada's commitment to achieve net-zero emissions by 2050. Electrification is seen as a key tool to achieve this goal. The acceleration of society's grid reliance due to electrification further establishes the need for the grid to be resilient. Delaying resilience investment will cause additional grid vulnerabilities as electrification accelerates to meet GHG targets.

History often shows that the catalyst for action is a major event that causes significant economic harm and/or stress for customers and society, while also placing societies most vulnerable at risk. A resilience focused and proactive organization considers these potential major events and the impact to customers and invests to mitigate their impact. As the modern customer and integrated society continue to rely more and more on the grid, it is important that grid stakeholders take proactive action to mitigate the impact of more regular events, as well as the major 1 in 100 year or 1 in 50-year type events.

The case for resilience starts by first exploring recent historical events that have impacted Hydro Ottawa customers, including memorable events, historical restoration costs, and historical customer outages. Second, the case for resilience provides additional context about the modern customer and expectations for grid reliance. The third element for the case for resilience is exploring major events outside recent memory to include the '1 in 100 hundred' year type events. As described above, the second and third items are the core case for resilience. While not always the primary focus of resilience investment, the high costs of system restoration and the increased levels of safety risk to society and crews of failed infrastructure during these events are also reasons to improve system resilience. These are also discussed in the following sub-sections. The sub-sections also show how these components fit into the resilience conceptual framework.

3.1 Historical Events Impacting Hydro Ottawa Customers

3.1.1 Recent Events of Note

The following are notable events that have impacted Hydro Ottawa's territory and left an impact on Hydro Ottawa and stakeholders. The review will include storms of note in 2022 and also recap some high impact storms over the last 25 years.

3.1.1.1 May 2022 Derecho

On May 21, 2022 a historic derecho swept through Hydro Ottawa's service territory. This derecho was one of the most destructive storms in Canadian history with winds up to 190 km/h.[1] The storm resulted in over 400 poles that needed to be replaced. In addition, approximately 180,000 customers lost power. Approximately 50 percent of these customers were without power for multiple days. Some customers were without power for over two weeks. The restoration efforts included utilization of 335 contractors[2]. The storm impacted the entire service territory with wind equivalent to either an EF1 (138-177 km/h) or EF2 (178-217 km/h)winds.

[1] Northern Tornadoes Project: https://ntpopendata-westernu.opendata.arcgis.com/apps/westernu::on-qc-derecho-may-21-2022-event-summary-map/about
[2] Derecho: Our biggest storm yet | Hydro Ottawa

Figure 3-2: May 2022 Derecho[3][4]

Storm Name:
May 2022 Derecho

Year: 2022

Top Wind Speed:
190 km/h

Outage Duration:
7+ days

Customers Impacted:
~180,000

Time to restore 50% of Customers: 48 hours

System Damage:
Poles Replaced – 400

3.1.1.2 December 23, 2022 Winter Storm

Before the storm hit Ottawa, the northeastern United States faced down wild weather with blizzards, damaging winds and freezing temperatures causing havoc for holiday travelers. Thousands of flights were cancelled and highways were closed with stranded motorists and multi-vehicle pile-ups.

Customers with email addresses on file received Weather Watch notification in their inbox the afternoon of Wednesday, December 21, warning them that fierce winds and power outages were expected due to the severity of the incoming storm. As predicted, the storm arrived late Thursday evening.

The storm impacted Hydro Ottawa's distribution system starting on December 23 with the first outage taking place at 1:01 a.m. A total of 67,710 customers sustained interruptions. Ninety percent of the customers were restored within 12.5 hours.[5]

[3] https://www.uwo.ca/ntp/blog/2022/ntp_extends_may_21st_ottawaarea_ef2_downburst_eastward.html
[4] https://hydroottawa.com/en/blog/what-year-top-five-outages-2022
[5] https://hydroottawa.com/en/about-us/regulatory-affairs/major-events/december-23-2022

Figure 3-3: December 23, 2022 Winter Storm[6]

Storm Name:
Dec 23, 2022 Winter Storm

Year: 2022

Outage Duration:
2 days

Customers Impacted:
~67,710

Time to restore 90% of Customers: 12.5 hours

3.1.1.3 Sept 2018 Tornados

On Sept 21, 2018 multiple tornados impacted Hydro Ottawa's service territory. These tornados were destructive with winds at 265 km/h. The storm resulted in 88 poles that needed to be replaced as well as 4 km of powerlines that needed to be replaced. In addition, approximately 165,000 customers were without power. Approximately 95 percent of these customers were restored within 72 hours. The restoration efforts included utilization of 86 contractors[7].

[6] https://hydroottawa.com/en/blog/what-year-top-five-outages-2022
[7] https://hydroottawa.com/en/blog/weathering-storm-look-back-september-2018-tornadoes

Figure 3-4: Sept 2018 Tornadoes[8]

Storm Name:
Sept 2018 Tornadoes

Year: 2018

Top Wind Speed:
265 km/h

Outage Duration:
7+ days

Customers Impacted:
~165,000

Time to restore 50% of Customers: 36 hours

System Damage:
Poles Replaced – 88
Powerlines – 4km

Several poles collapsed along Greenbank Road and Hunt Club Road after a tornado hit Ottawa on Sept. 22, 2018. (Leah Hansen/CBC)

3.1.1.4 Great Ice Storm of 1998

While this was approximately 25 years ago, it give insights into resiliency planning. On January 5, 1998, ice started forming and ice thickness up to 85 mm were measured with unofficial report of up to 100 mm were reported. The storm was very large in extent with considerable damage throughout Ontario and Quebec. Employees from Gloucester Hydro, Goulbourn Hydro, Kanata Hydro, Nepean Hydro and Ottawa Hydro come together as one team to repair the extensive damage. Overall, Environment Canada estimates "the storm claims as many as 35 lives, downs millions of trees, 1,000 transmission towers, 30,000 utility poles and enough wires and cable to stretch around the world three times.[9]

[8] https://www.cbc.ca/news/canada/ottawa/tornadoes-one-year-anniversary-city-response-1.5291134
[9] https://hydroottawa.com/en/about-us/our-company/our-history

Figure 3-5: Great Ice Storm of 1998[10,11,12]

Storm Name:
Great Ice Storm of 1998

Year: 1998

Maximum Ice Thickness:
85 mm

Customers Impacted (Ontario):
~1,500,000

Time to restore 95% of Customers: ~48 hours

Last Customer Restored:
33 days

Total Storm Damage (Ontario):
Poles Replaced – 300,000
Powerlines – >100,000km

Ice storm in Ottawa. Postmedia

3.1.1.5 Other Major Events

The following table summarizes other weather Events:

Table 3-1: Other Major Weather Event Summary[13]

Start Date	Storm Description	Total Customers Interrupted	Time to restore 90% of Customers
July 1, 2016	Thunderstorm	32,934	2 hours
January 4, 2017	Freezing Rain	19,130	11.3 hours
September 27, 2017	Thunderstorm	14,051	24 hours
April 16, 2018	Freezing Rain/Wind	56,146	36 hours
May 4, 2018	High Wind	60,811	12 hours
July 5, 2019	Thunderstorm	70,069	6.5 hours
November 1, 2019	High Winds	14,228	6 hours
June 14, 2021	Thunderstorm	17,441	8.5 hours
April 5, 2023	Freezing Rain	163,448	40.5 hours

10 https://www.cbc.ca/news/canada/ottawa/ice-storm-ottawa-20-years-later-1.4470067
11 https://ottawacitizen.com/news/local-news/the-great-ice-storm-of-1998-by-the-numbers
12 https://hydroottawa.com/en/about-us/our-company/our-history
13 https://hydroottawa.com/en/about-us/regulatory-affairs/major-events

3.1.2 Historical Restoration Costs

Table 3-2 shows the historical Hydro Ottawa storm costs for major storms. The table shows the costs in the dollars of the day (nominal) and then escalated to 2023. The values were provided by Hydro Ottawa. The average major storm cost is approximately $7.6 million per storm in 2023 dollars. These costs are eventually passed on to customers.

Table 3-2: Hydro Ottawa Historical Storm Costs

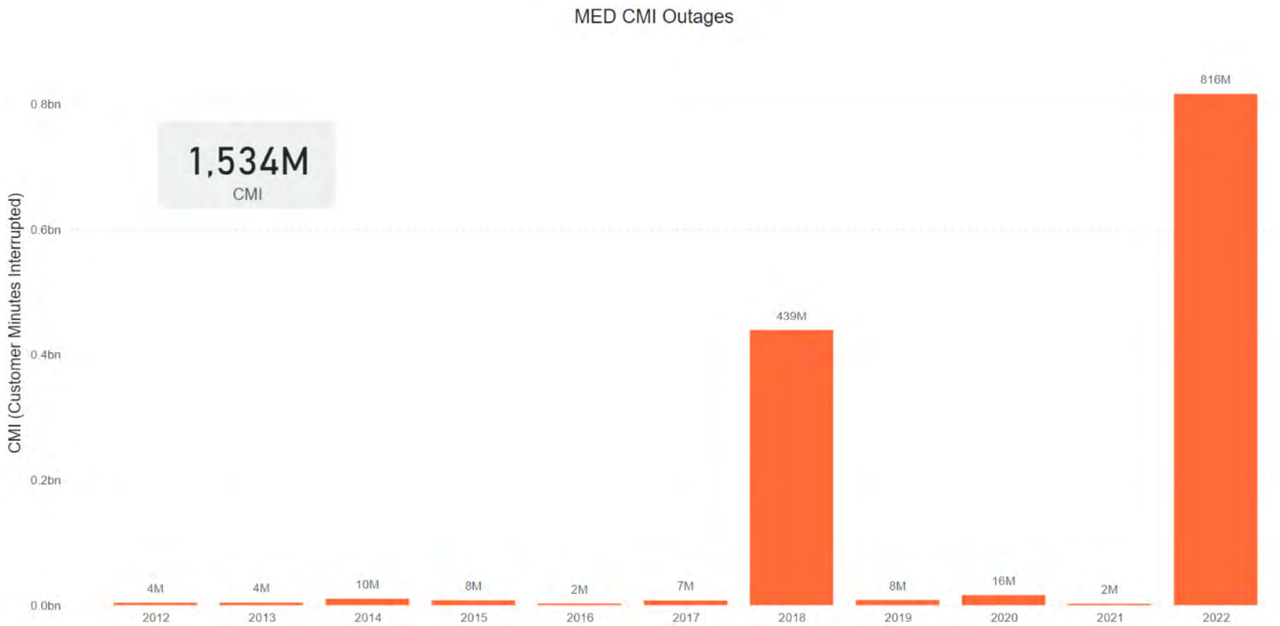
Date	Strom Type	O&M (Nominal$)	Capital (Nominal$)	Total (Nominal$)	Total (2023$)[14]
2018-04-15	Ice Storm	$400,000	$900,000	$1,300,000	$1,579,572
2018-05-04	Wind Storm	$100,000	$800,000	$900,000	$993,673
2018-09-21	Tornado	$800,000	$2,300,000	$3,100,000	$3,422,650
2022-05-21	Derecho	$8,700,000	$15,300,000	$24,000,000	$24,480,000

3.1.3 Historical Major Event Day Customer Outages

Figure 3-6 shows the historical Hydro Ottawa major event (Major Event Day)[15] customer minutes interrupted (CMI) from July 2012 through February 2023. This information was captured from Hydro Ottawa outage database. The figure shows a total 11-year CMI of 1.53 billion, with an annual average of 128 million CMI. This means each customer was without electrical service an average of 366 minutes per year over the 11-year time horizon. The figure also shows that a single event can impact an 11-year time horizon significantly as the May 2022 Derecho 816 million CMI comprise a significant portion of the 11-year total CMI.

[14] Inflation Calculator | Find US Dollar's Value from 1913-2022 (usinflationcalculator.com)
[15] A Major Event Day (MED) is a day where the impacts on system reliability have exceeded a threshold which is no longer considered business as usual. Definitions vary by jurisdiction, but typically adhere to some variation of the 2.5-β method defined in IEEE 1366-2022. MED outages are typically excluded from reporting to help compare reliability performance between utilities.

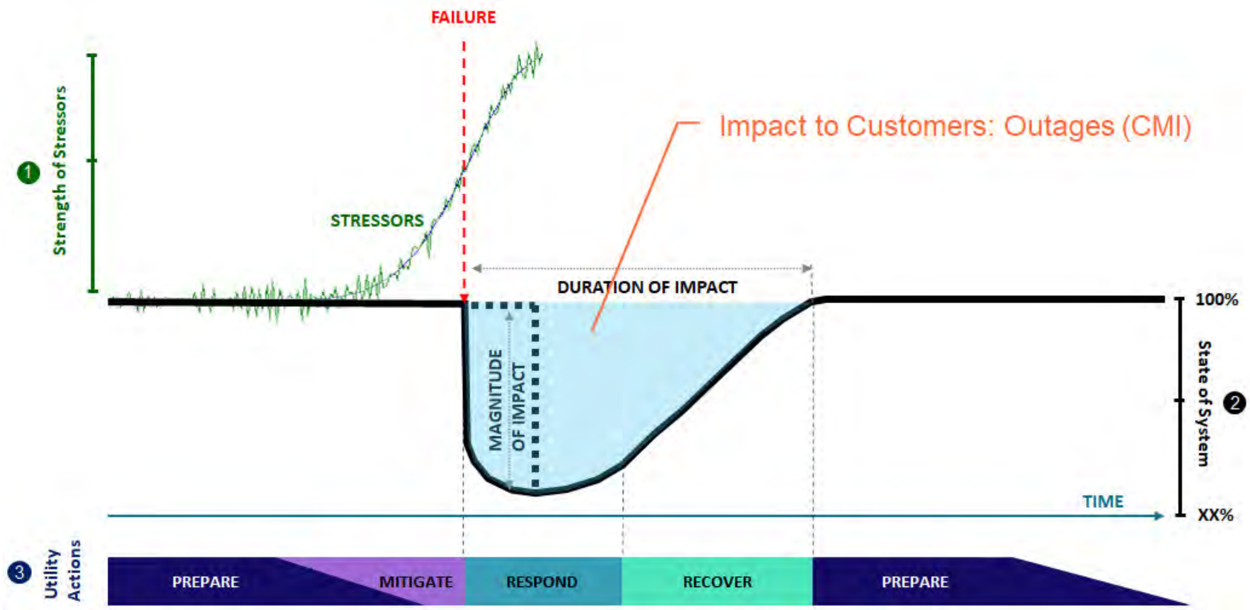
Figure 3-6: Hydro Ottawa Historical CMI



3.2 The Impact of Customer Outages

The core case for resilience starts with the impact to customers and grid stakeholders. Figure 3-7 demonstrates the impact to customers from an outage perspective, within the Resilience Conceptual Framework. The area in blue represents the overall customer outage time. Within the utility industry, this is quantified by CMI. Within the blue-shaded portion of Figure 3-7, CMI is the impact of magnitude in terms of customers without service at each minute of time summed together.

Figure 3-7: Resilience Framework & Customer Outages



The CMI outage metric is not new for utilities. It has been used for several decades to understand utility performance and calculate the impact of grid outages. What has changed over the decades is the impact to customers and society of grid outages. Twenty-five years ago, grid outages used to be seen as an inconvenience or nuisance to life; today grid outages cause serious stress and economic harm for customers depending on the duration and time of the event. Extended outages caused by major events are a real concern for the health and safety of society's most vulnerable.

Several factors have caused the outages of today to be more impactful than the outages of decades past. These changes for customers and society are a key reason for why resilience investment in the electric grid is needed. The following sub-sections outline many of these customer and societal changes.

3.2.1 Critical Customers

Hydro Ottawa serves many different customer types, including some customers that are highly dependent on an uninterrupted, infrequent, and resilient power supply as possible. This includes customers with life sustaining medical devices, critical function customers (such as nursing homes, hospitals, and police stations), and warming centers.

Critical customers who serve the community in a service or healthcare role, among other necessary functions. There is a total of 1,061 critical customer facilities served by Hydro Ottawa, including but not limited to the following customer types:

- Ambulance Depot
- Ambulance Facility
- Child-care Center
- Community Police Center
- Fire Station
- Hospital
- Long Term Care Facility
- Police Station
- Public Works Garage/Community Police Station
- Recreational Facility
- School
- Veterinary Facility

Investing in grid resilience has a crucial impact on customers whose health is tied to power dependent medical devices, and critical customers whose purpose is to provide public, or healthcare services rely on resilient power to serve the community effectively and efficiently. Disrupted power interferes with their ability to provide care and assistance, especially during critical times.

3.2.2 Work from Home

Today, the largest number of the workforce is working from home than in history. Ottawa has the nation's highest percentage of the workforce who work from home (40% in December 2022) [16]. The catalyst for increased work from home was spurred by the COVID-19 pandemic. This compares to a Canadian national average of approximately 4% in 2016[17].

For this population, insulating against outages and fluctuations in power supply directly impacts a customer's bottom line. When power is interrupted from the home

[16] https://www.thestar.com/business/opinion/2023/05/10/working-from-home-10-surprising-facts-that-complicate-everything.html
[17] https://www.statista.com/topics/7816/remote-work-in-canada/#topicOverview

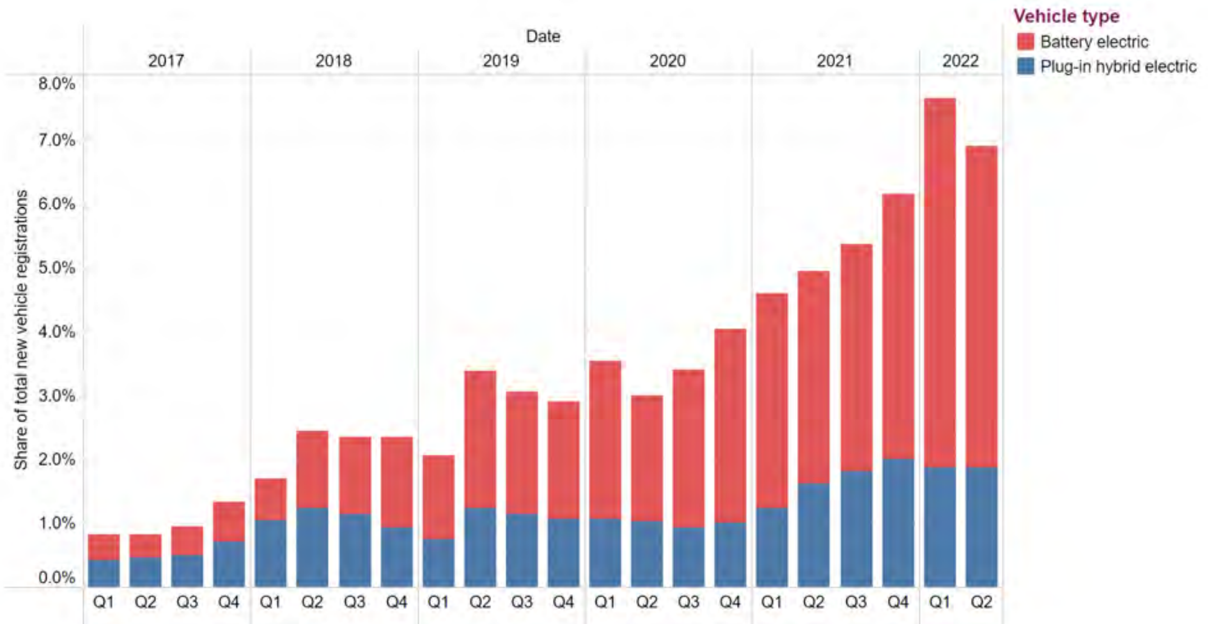
working space, this may cause an employee to use paid or unpaid leave, or incur additional costs to outsourced support in the form of additional childcare, commuting costs, etc. For the modern employee and business, power resilience is critical to maintain operations and lower business risk.

3.2.3 Electrification and Decarbonization

As mentioned in Section 3.0, Canada has very aggressive decarbonization plans which center around electrification of traditionally fossil fuel intensive activities. As the country plans to move the majority of activities that require power to electric power, the reliability and resiliency of the electric grid become critical. While this shift will affect many industries and activities, this section focuses on transportation electrification as an example, but the plan to decarbonize includes electrification of residences, commercial locations, industrial equipment, industrial processes, and agriculture to name a few.

This shift to electrification will cause growth in demand on the distribution system as an increased number of systems and services become electrified. Customers will expect the distribution grid to handle the new technology and subsequent increased load in real time. To illustrate this concept, EV adoption in Canada is a prime example. As customers continue to adopt electric vehicles, demand for decreased grid instability is at the forefront of customer's minds. For the customers that commute or otherwise rely on vehicles to perform daily tasks, it is expected that they are able to drive after a night of charging. Figure 3-8 shows the adoption of EVs within Canada as a percentage of total sales through mid 2022.

Figure 3-8: EV Vehicle Adoption in Canada[18]



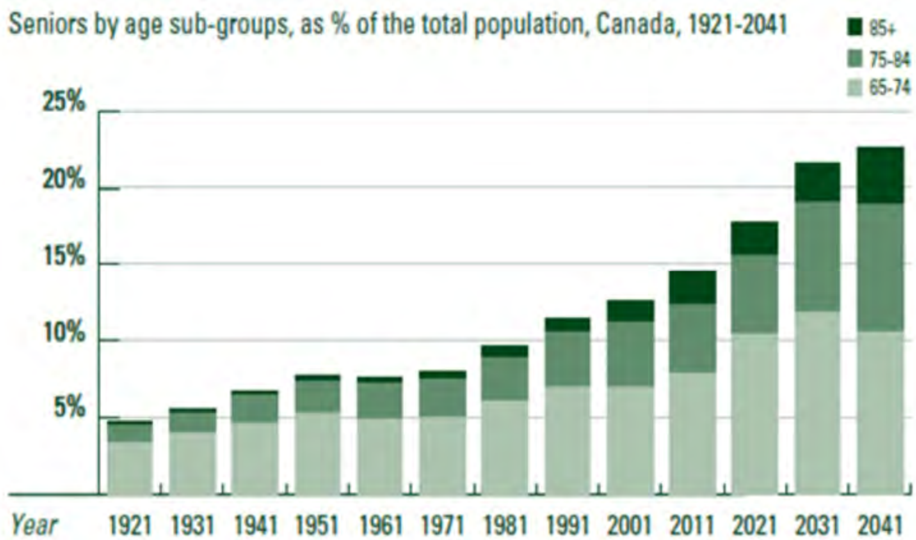
Residential customers are not the only customers affected by this change. Since residential customers work at industrial and commercial customers, these larger customers will see reduced productivity and revenue when their employees can't commute to work (for those that can't work virtually). Additionally, those with commercial vehicles for shipping or local delivery would be heavily impacted by a significant disruption in power.

3.2.4 Aging in Place

Nearly 90 percent of Canadians state their preference is to remain in their current homes as they age.[19] The number of Canadian residents that are over 65 are trending up, as shown in Figure 3-9.

[18] https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2022/market-snapshot-record-high-electric-vehicle-sales-canada.html
[19] https://www.readersdigest.ca/health/healthy-living/aging-in-place/

Figure 3-9: Population of Canadian Over 65 from 1921-2041[20]



For seniors who plan to age in their current homes, the decreasing of long-lasting and widespread power outages, and increased time to power restoration are critical to independence and their overall health and safety. During the Texas blackouts of February 2021, 246 people died when power was lost to large portions of the state in freezing weather. Of those deaths, 67% were due to hypothermia and the rest were due to pre-existing illness, vehicle accidents, carbon monoxide poisoning, fires, and falls[21]. Of these fatalities, approximately 60% were over the age of 60.[22]

3.2.5 Integrated Society

Decade over decade society is evolving and becoming more and more reliant on electrical power. Consider just 25 years ago when the personal computers were starting to emerge as a business necessity, but widespread adoption in homes had not begun yet. The internet was a fascination, but not central to how customers lived life. On-line shopping for essentials was not yet a mainstream concept. Networking was by telephone landlines or in-person, with "virtual" mediums of communication, such as video calling, not yet possible. Modern electrical vehicles with practical

[20] https://www.elections.ca/content.aspx?section=res&dir=rec/part/sen&document=index&lang=e
[21] https://www.texastribune.org/2022/01/02/texas-winter-storm-final-death-toll-246/
[22] https://www.courthousenews.com/wp-content/uploads/2022/02/texas-state-health-services-department-report-on-winter-storm-uri-death-toll.pdf

ranges were not at the prototype stage. Productivity was not as intertwined with electric power availability as it is today, since work and personal functions were still done in person.

Energy resilience is now business-critical and is having a higher impact on people's lives as society continues to become more integrated. Our society today is highly intertwined on both the macro and micro scale. We have grown to understand this integration from the supply-chain disruption following the global pandemic, and personal experience with productivity interruptions in daily life. A real-life example helps prove the point – a utility consulting engineer recently had to take a day off unexpectedly because of a power outage at his child's daycare in Austin, TX. This engineer was part of a larger group, based in Kansas City. The Kansas City team had to re-arrange their day to cover for this engineer's time out, causing decreased productivity and efficiency for the team as a whole. In an efficient society with 'just-in-time everything' and families where all heads of households are employed, minor disruptions in the utility grid can cause economic harm and stress.

Industries, large and small, work cohesively to allow society to function at the level of productivity and financial success currently achieved. If one of these falls due to unavailable power, the ripple effect is not contained to just one employee, business, or industry.

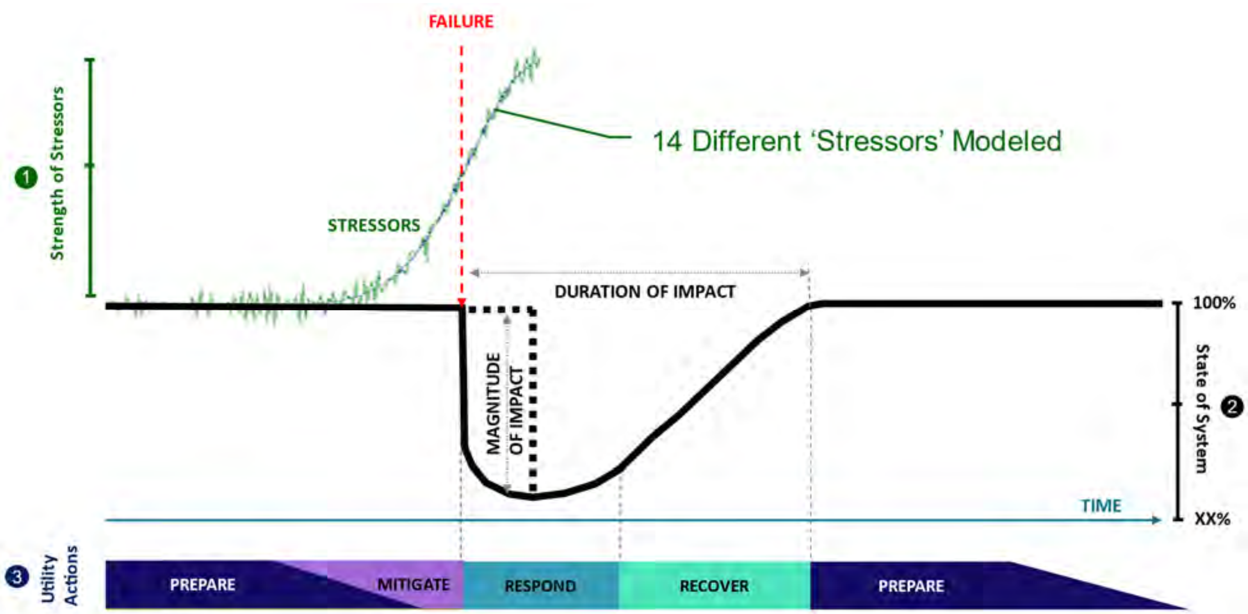
3.3 Major Events 'Stressors'

The case for resilience continues with disruptive events or 'stressors'. The types of events and their frequency is key to understanding the grid's resilience, measuring it, and performing the business case for investments.

Because of this, measuring a grid's current resilience is forward looking. This forward-looking nature causes challenges in measuring resilience since the future needs to be modeled and the future is uncertain. While it may be tempting and much easier to measure resilience from a historical perspective, this leaves grid stakeholders, especially customers, at high risk. For instance, grid stakeholders may have a false sense that their grid is resilient by comparing their customer outages to their peers. However, this may only be because the stakeholder's grid did not experience many events in the last 5 or 10 years as their peers. Section 8.0 shows that Hydro Ottawa's service territory has had periods of very low major events and periods of high major events. A historical focus provides a misleading measure for grid resilience and leaves grid stakeholders exposed to disruptive events.

As discussed above, the level of grid resilience is firstly based on the number and type of events. Within the resilience conceptual framework, Figure 3-10 shows that this evaluation includes 14 different stressors or major events. Section 8.0 outlines each of these 'stressors' in more detail and the approach to estimating their future frequency.

Figure 3-10: Resilience Framework 'Stressors'



Since grid resilience is foundationally based on potential future stressors, it is critical to formulate the 'universe' of events that could impact the grid. Several factors need to be considered. Firstly, the type of events, such as natural disasters (e.g. tornados, ice storms) or human driven disruptions (e.g. cyber/physical infrastructure attacks). This evaluation covers the range of weather-based natural disaster events in the modeling of resilience. Second is the level of impact. This evaluation includes a wide range of events, from the upper bound impact events (strong thunderstorm/derecho) to the lower bound impact events (regional weather events). The type of events included in measuring resilience is based on the goals grid stakeholders have for mitigating disruption. This evaluation mainly leverages historical events as a guide for the future as a conservative assumption.

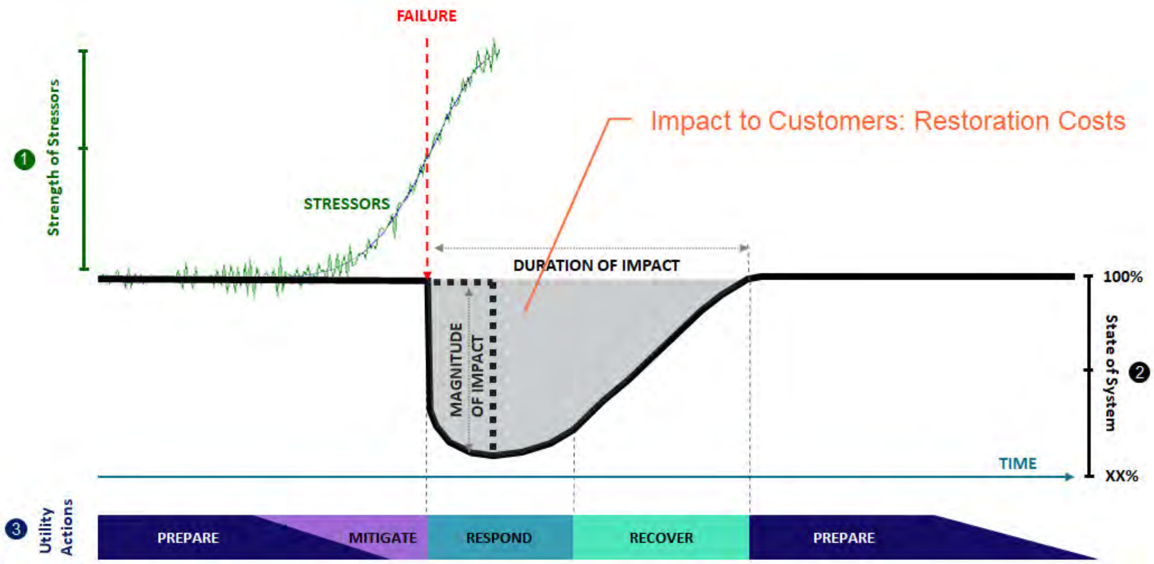
Within this evaluation, system resilience is a sum of all the events weighted by their expected future probability. Specifically, the resilience measurement is done for each of the 14 identified event types multiplied by their expected future probability, then totaled together. The entire system worth of assets do not fail, so the resilience impact is a double failure calculation, 1. Probability of an event 2. Probability an asset fails.

The range and type of 'stressors' outlined in Section 8.0 is the key driver for the case for resilience investment. The historical record shows a wide range of event types to impact the Hydro Ottawa service territory. As the effects of climate change are expected to increase over time, these types of events could increase in relative frequency in the future.

3.4 Restoration Costs

While the foundation of the case for resilience is the overlap of the modern customer and integrated society with the range of major events, restoration costs are a further driver. Figure 3-11 shows this customer impact within the Resilience Conceptual Framework. It should be noted that the cost represented in the 'grey' area includes both the immediate cost to restore the system during the event and the costs to rebuild the grid to standard following the event.

Figure 3-11: Resilience Framework & Restoration Costs



Over time, the cost to replace infrastructure has increased. This is especially the case during major events. Replacing infrastructure during a failure event typically requires overtime and more resources than for a proactive approach. It also includes 'patches' during the respond and recover phases, which are followed on by rebuilds to appropriate standards after the event, sometimes weeks or months later. This causes reactive infrastructure rebuilds for a disruptive event to be 1.5 to 2.0 times higher than for similar planned activities. Depending on the size of the event, utilities may leverage mutual assistance from other outside utilities in the restoration effort. These costs can be 3.0 to 5.0 times higher than using local crews. These higher multipliers are due to the double time, per diems, mobilization and de-mobilization, equipment fees, and general higher inefficiencies in managing a high level of resources all at one time. The urgency to speed up recovery times results in a premium price for services, and these costs eventually get passed on to the customer.

Proactive resilience investment can mitigate some of these costs. If enough resilience investment is completed, a utility will have less infrastructure failures during events, therefore will use less resources and crews in the restoration process.

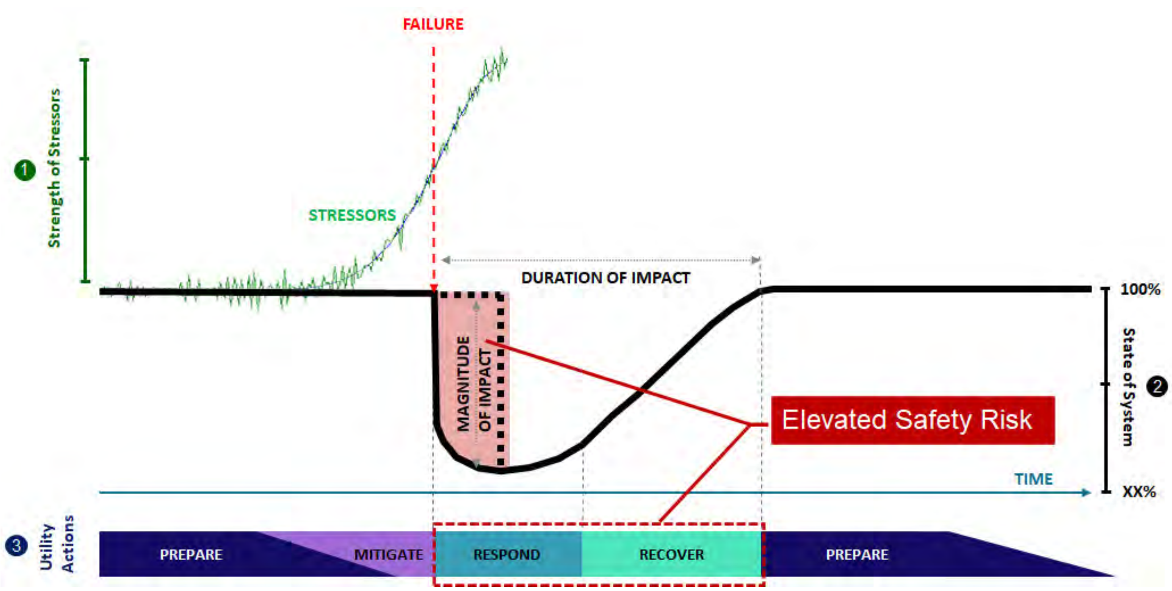
With smart resilience investment, the grid can be rebuilt to not only withstand major events but also enable the customer of the future's demand for electrification and

DER penetration. Given the current expectations for the future customer, a fully reactive approach could cause infrastructure rebuilds to be 2.5 to 4.0 times more than a proactive approach. To date, the level of infrastructure rebuilds at this higher life-cycle cost has been low, but with the increasing age of the system the percentage of the system that would be rebuilt at these levels will be much higher.

3.5 Safety Risks

Similar to restoration costs, mitigating safety risks is another additional driver of resilience. This is done on two fronts. Firstly, during an event, infrastructure failures expose the general public to elevated levels of safety risks. Additionally, utilities crews during the respond and recover phases are rebuilding the grid in a more unpredictable situation. Often times, the rebuilding efforts can be late into the evening, in the dark, and in conditions that are potentially hazardous. The long hours and maneuvering around debris, broken infrastructure, and hard to reach places increases safety risks. These elevated levels of safety risk are shown within the Resilience Conceptual Framework in Figure 3-12.

Figure 3-12: Resilience Framework & Elevated Safety Risk



Rebuilding resilient infrastructure will help to mitigate the safety risks. As discussed in more detail below, this benefit stream is not overtly quantified in this evaluation.

However, this benefit stream should not be ignored within the resilience business case framework.

4.0 RESILIENCE OBJECTIVE

As the utility industry has yet to develop an agreed upon definition for resilience, establishing an ultimate objective for resilience and measuring how to achieve it are further behind. Nevertheless, electric utilities are taking action to harden the grid (see Section 5.0) while the industry evolves on defining resilience, setting an objective for it, and establishing metrics to grade progress and achieving the objective of resilience.

4.1 Measuring Resilience Conceptual Framework

Resilience metrics are in their infancy and relatively immature within the utility industry. Some utilities are exploring resilience metrics through derivations from reliability metrics. In developing metrics for resilience, 1898 & Co. has leveraged the conceptual resilience framework from Section 2.2, to measure resilience for electric utilities. This framework provides the underlying design philosophy and basis for the Resilience Investment Model (see Section 6.0). 1898 & Co.'s guiding principles for measuring resilience are:

- **Customer-Centric –** Since the case for resilience is founded on the impact to customers, metrics need to have direct 'line-of-sight' to customer impacts. Where possible, metrics should take into account differences in customer and community types. 1898 & Co. has included an initial recommendation for the value of customer outages in this report (see Section 6.2).
- **Incorporate the 'universe' of events –** The other foundation for the case for resilience is the range of events. This includes the typical events that occur several times a year through High Impact Low Probability (HILP) events that may have a frequency of '1 in 100' years or even '1 in 500' years. This may mean including events that are not part of the historical record. Similar to the value of various customer types and communities, the process of identifying the 'universe' of events should include various grid stakeholders. Additionally, the unknown unknowns of climate change make it vital to collaborate with a larger stakeholder group. 1898 & Co.'s evaluation for this resilience investment evaluation included both forecast based on historical information as well as a climate change forecast.

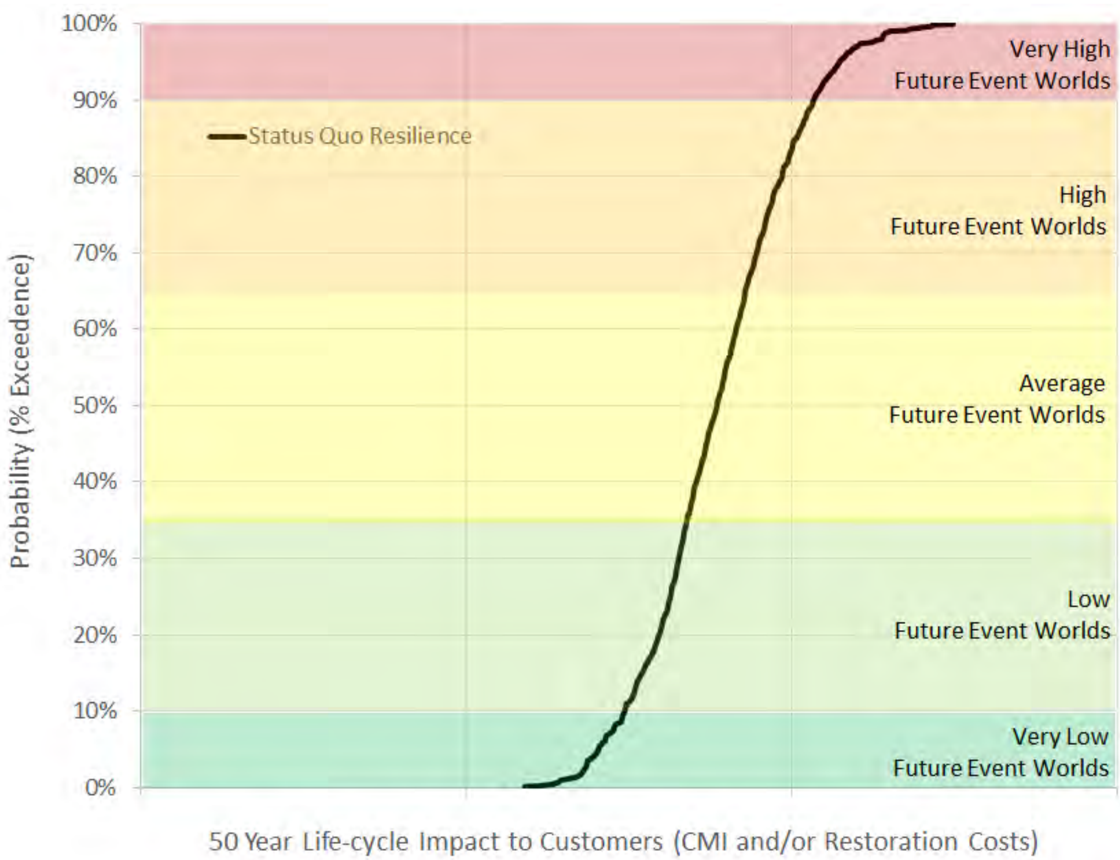
- **Future-focused –** Since resilience is about mitigating future disruptive events, metrics should aim to focus on potential future events. While capturing historical performance is objective and rooted in data, solely focusing on them may provide a false sense of actual resilience depending on the time horizon. Future-focused allows for the inclusion into a resilience metric the HILP events, historical only metrics may exclude HILP events since they have not occurred in the recent past. If only historical metrics are used to evaluate a grids resilience, it may leave stakeholders with a false sense of system resilience. This is often why a major event 'catalyst' occurs before real change happens. For this reason, it is vital that metrics include a future focus to understand the real risks exposed to grid stakeholders.
- **Encompass the arc of time –** Recency bias is a real concern for resilience metrics. The historical records show periods of time with few events and periods of time with higher-than-average number of events. If resilience metrics only include a short time horizon, it may provide a false sense of a system's actual resilience. Metrics should strive to include decades long time horizons if possible.
- **Integrate system characteristics / vulnerabilities –** Disruptive events, especially weather, are unpredictable. For instance, major wind events can have gusts of 50 mph winds in one part of the service territory, and only 15 mph winds 5 miles away. Focusing only on event-based metrics would exclude the fact that all parts of the system are not the same in age, vegetation density, etc. For example, the infrastructure impacted by the 15 mph winds may be much older, with high vegetation density compared to the infrastructure hit with 50 mph winds. For this reason, it is critical that resilience metrics focus on the vulnerable parts of the system agnostics of events.
- **Range of potential outcomes (stochastic modeling) –** While there is uncertainty around future events, this uncertainty is not unbounded. Bounds or confidence bands can be developed through stochastic modeling (generally Monte Carlo techniques). Time horizons of interest can be modeled and better understood by utilizing the historical record to statistically characterize and forecast the range of future system outcomes.

- **Data-Driven with Industry Experience Insights-** Data availability and quality are continually improving. As data availability grows, more effective and insightful indicators can be developed and explored. This will not happen in a vacuum as both the frontier of data science and industry insights are continuing to evolve.
- **Simplicity –** Resilience is a multifaceted and complex topic as outlined above. In measuring resilience, there is balance between metrics that are simple and easy to communicate, and metrics that are complex and include all necessary details.
- **Enables Effective Prudency Evaluation-** The cost of mitigation measures is often considerable. Metrics and investment evaluations need to ensure limited resources are being deployed effectively and providing value to the utility's customers. Metrics that produce financial justification results provide more direct alignment for stakeholders in evaluating investment prudency.

The conceptual framework, discussed above in Section 2.2, is useful as a starting point to develop a framework for measuring resilience. The conceptual framework for resilience is for a specific event and shows the customer impacts in terms of CMI (see Section 3.2) and restoration costs (see Section 3.4). A whole system resilience metric can be estimated by summing the impacts of all events weighted by their expected frequency over the arc of time. In other words, sum the conceptual framework figures for the 'universe' of events multiplying each by their expected future frequency.

The result of this approach produces the life-cycle customer impact for the 'universe' of events as represented in Figure 4-1. The figure shows the range of potential impacts to customers for all events and their range of frequencies over the next 50 years. The figure shows several potential event 'worlds' from very high to very low. It also incorporates the range of events permutations that could occur over the time horizon. The 50-year time horizon is recommended as it is the minimum of a '1 in 100' year type of event and the average expected life of utility infrastructure, 50 years. This conceptual approach to measuring resilience meets many of the guiding principles outlined above with the exception of complexity in understanding and enabling effective prudency evaluation. It is also the foundation for understanding the goal of resilience.

Figure 4-1: Measuring Resilience Framework



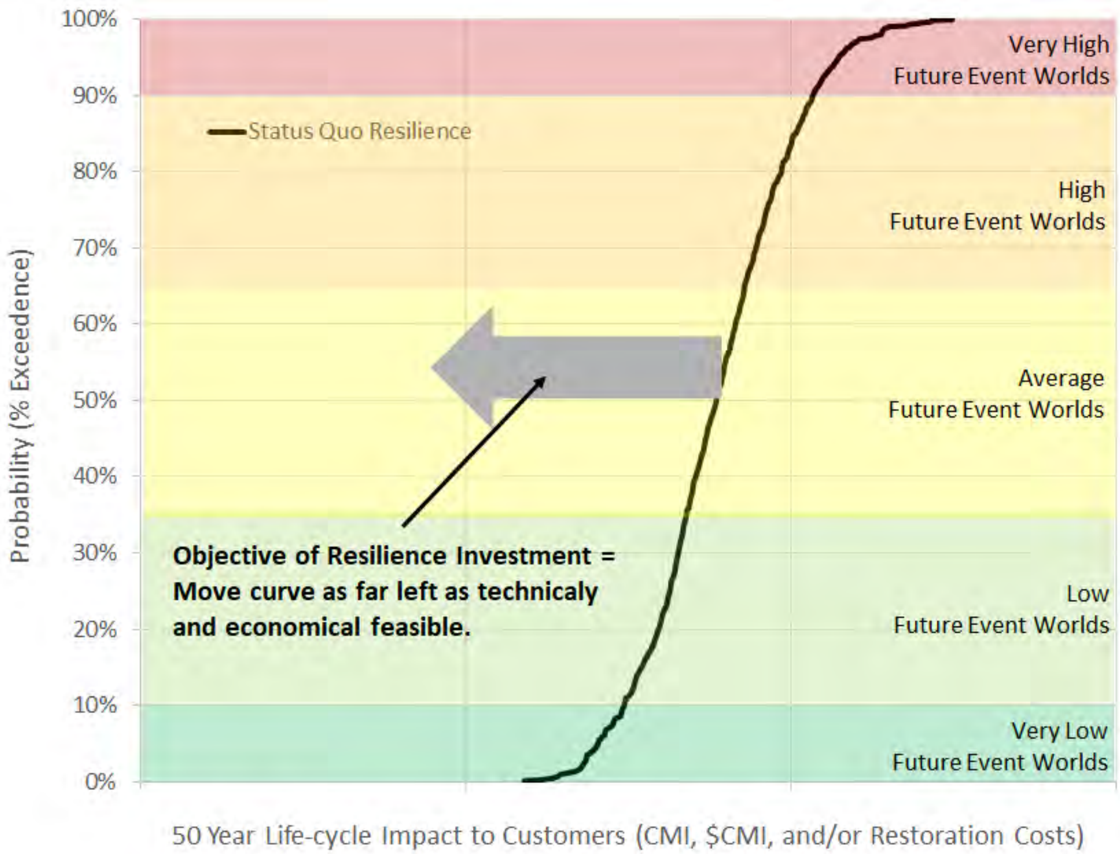
4.2 The Objective for Grid Resilience

The objective for grid resilience investment is two-fold:

1. Minimize to the extent technically feasible the impact of disruptive events to customers over the life-cycle of infrastructure
2. Invest in resilience upgrades with a positive business case, benefit to cost ratio >= 1

This is depicted within the resilience measuring framework in Figure 4-2.

Figure 4-2: Resilience Investment Objective



This two-fold objective for resilience investment seems simplistic enough on the surface but a deeper evaluation is needed to fully understand its implications.

- **Minimize to extent feasible –** Investments over time should be made to a level that they provide meaningful change in event impact. Since events impact all over a utility service territory, resilience investments will need to be substantial over the long term to provide meaningful change. Meaningful change being decreasing all system major event outages and restoration costs by over 30 to 40 percent. This approach allows for all customers to benefit through significantly shorter event's durations and restoration costs. For example, 4 day events before a long-term resilience plan could be a 2.5 day event after a resilience plan is implemented on the system. This also means that the impact of events cannot be fully mitigated. There will always be residual risk.
- **Investments with a positive business case –** The substantial level of investment is balanced or constrained by only including investments with a

positive business case. Over investment is also a risk with achieving a goal of resilience. Because customers ultimately pay for both proactive and reactive system costs, it is important that over investment risk be managed. Limiting investments to those with a positive business case helps utilities to not overinvest in resilience measures.

- Measuring the impact to customer – Customers are impacted in terms of restoration costs which eventually get passed along through rates and outages. Minimizing outages and restoration costs should be included in the objective for resilience. In fact, the Florida legislature outlined this two-fold objective for evaluating investments of decreasing customer outages and restoration costs as the focus for Florida electric utilities in developing their 10-year Storm Protection Plans. It should be noted that a specific metric was not proposed, rather utilities metrics need to be aligned to this two-fold objective. The impact of customer outages is complex in that different customers and communities have significantly different impacts to them based on the type of event and duration of the event. Measuring resilience will require grid stakeholders to place a value on different customer and community types and the duration of events. This is critical to identifying direct investments for customers and building the business case for investments. While restoration savings is part of the business case, the main component is the value of avoided outages. For this reason, 1898 & Co. shows CMI, monetized CMI ($CMI), and restoration cost for measuring resilience investments. The valuing of societal costs for different event durations is currently a gap for electric utilities stakeholders. In other words, what is the societal cost of a 4-day outage for a residential customer versus a 2 day outage. 1898 & Co. has included its baseline approach for the value of outages, sometimes referred to as the value of lost load, in Section 6.2.

Before exploring specific metrics to evaluate resilience and improving it, it is important to understand how it can be improved through infrastructure upgrades. The following section discusses this topic.

4.3 Improving System Resilience

There are several approaches to mitigating the impacts of major disruptive events and improving the overall resilience of the system. From an infrastructure enhancement perspective, there are three main approach types to improving system resilience:

1. **Resistance** – the ability of the system to retain its service, to completely or partially fend off the effects of a major event.
2. **Absorptive Capacity** – the ability of the system to mitigate the effects of a major event by implementing contingency measures that restore all or part of the system.
3. **Recoverability** – the ability of the system to more quickly return to full service.

Each of these three approaches is targeted at the ‘prepare’ phase. The following sub-sections describe each of these approaches in relation to the Resilience Conceptual Framework. The sections use example infrastructure improvements for each of the three approaches. The focus of this evaluation is undergrounding, but other resilience investment alternatives will be discussed for completeness. Undergrounding is expected to be part of a larger Resilience Investment Plan. In developing a resilience investment plan, it is important to use all three of these approaches for a multi-prong approach to improve resilience, prioritizing those investments that provide the most resilience ‘bang-for-buck’. This is discussed in Section 6.0.

4.3.1 Resistance Investments and Resilience Impact

Resistance investments aim to strengthen the system so that major events do not impact the system or have minimal impact on the system. Examples of these types of grid investments include:

- Stronger Structures / Poles
  - Wood to Steel (or other manufactured) Conversions
  - Wood Pole Upgrades (e.g. Class 3 conversion to Class 1 or Class C or B construction to Class B+ or A)
- Rebuild with Tree-wire
- Overhead to Underground Conversions

- Substation Elevation

The focus of this evaluation is undergrounding, but other resilience investment alternatives will be discussed for completeness. The level of improvement in system resilience for each of these investment types is dependent on the level of penetration of the investment across the system and the types of stressors to impact the system. Figure 4-3 shows the impact of resilience improvement assuming weaker stressors with the entire system having been rebuilt with much stronger structures or poles. For the weaker stressors, the figure shows that this type of investment can nearly fully mitigate the impact of events.

Figure 4-3: Resilience Improvement and Hardening All Infrastructure (Weaker Event)

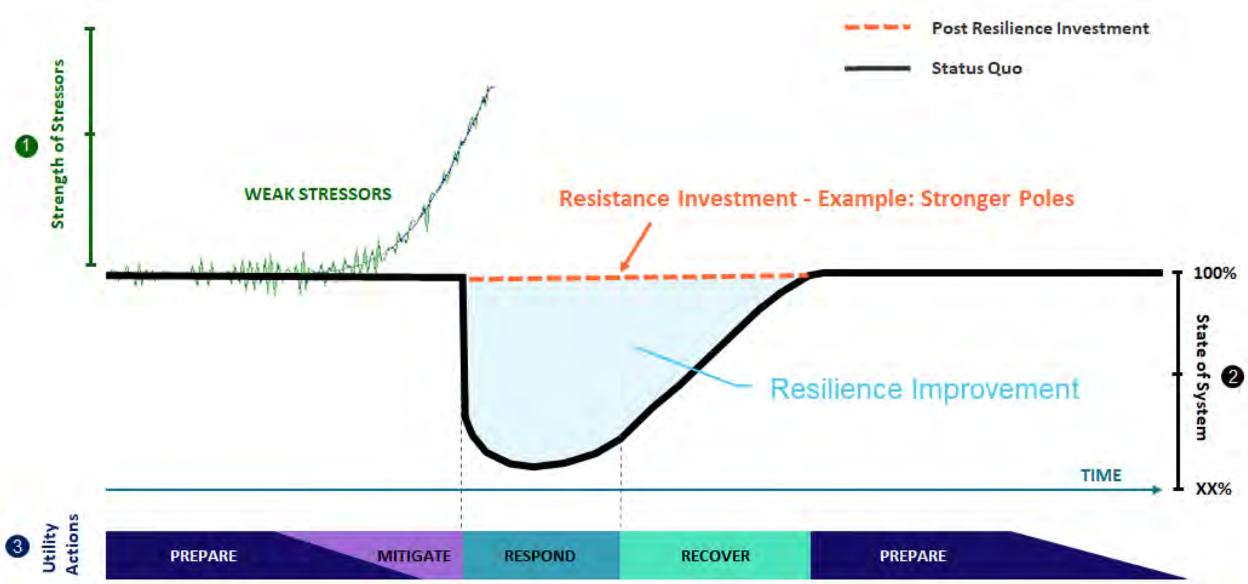


Figure 4-4 shows the resilience improvement for this same investment strategy, stronger poles across the entire system, for the stronger stressors. With the stronger infrastructure, it now takes a stronger or more intense stressor to cause asset failures. This is represented in the figure by failure now occurring at point ‘B’ as opposed to point ‘A’ without the infrastructure upgrade. The hardening did not prevent failures but delayed it and shortened the outage duration. While it might take more work to erect the stronger, and bigger, poles, fewer structures fail in this scenario. Fewer asset failures means that more crews will be able to work on the assets that do fail, which can have a beneficial multiplying effect on outage reduction time. Of course, if only a small fraction of the structures are hardened the overall resilience improvement is small.

Figure 4-4: Resilience Improvement and Hardening All Infrastructure (Stronger Event)

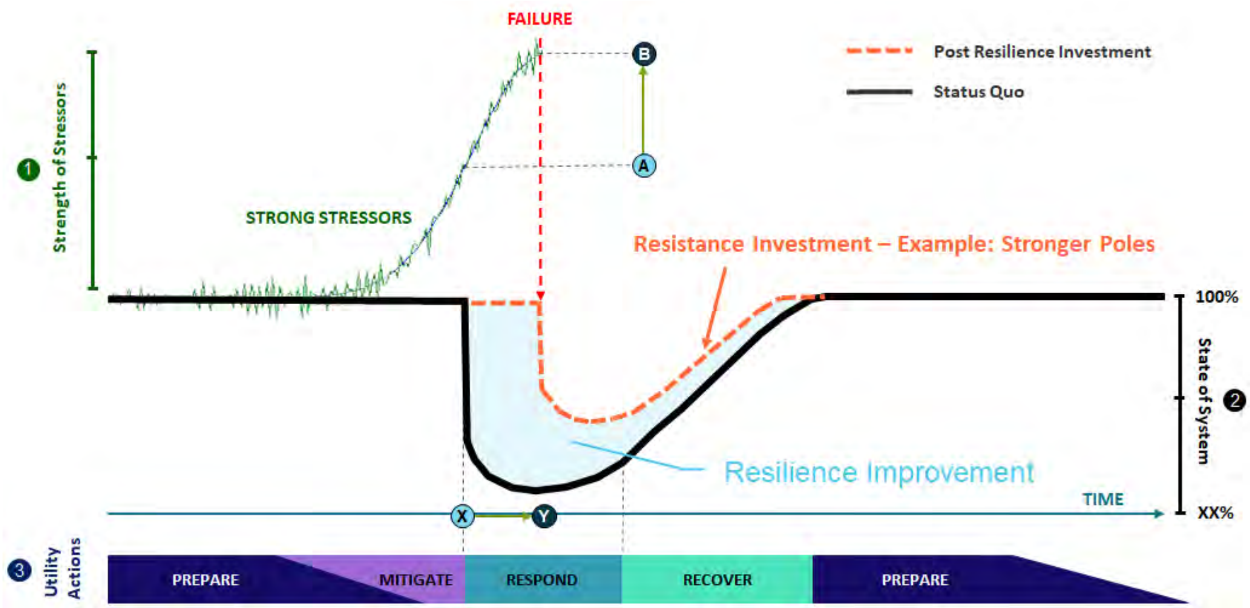


Figure 4-3 and Figure 4-4 show the range of resilience improvement for utilizing stronger structures or poles for the resistance investment approach. The cost effectiveness of this strategy is dependent on the relative mix of weaker and stronger stressors. Undergrounding infrastructure, while expensive, does provide maximum resilience benefit, nearly fully mitigating the impact of the range of stressors. Figure 4-5 visualizes the resilience benefit within the Resilience Conceptual Framework. The figure is based on a fictitious scenario where the entire system is undergrounded. Figure 4-6 provides a more realistic resilience improvement scenario with partial system undergrounding.

Figure 4-5: Resilience Improvement and Undergrounding All Infrastructure

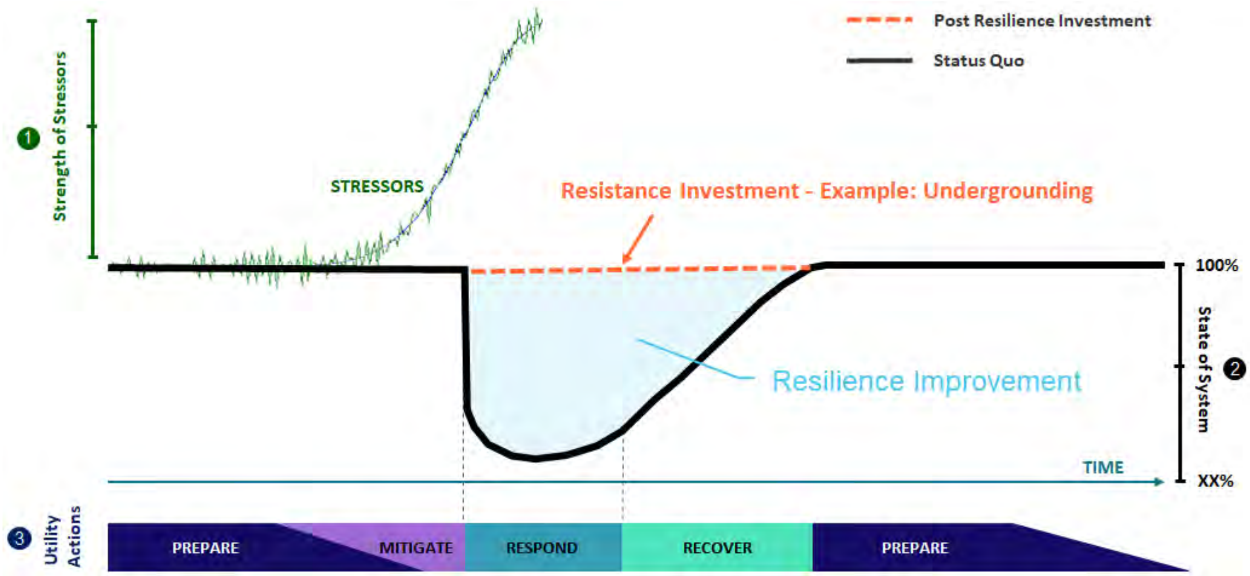
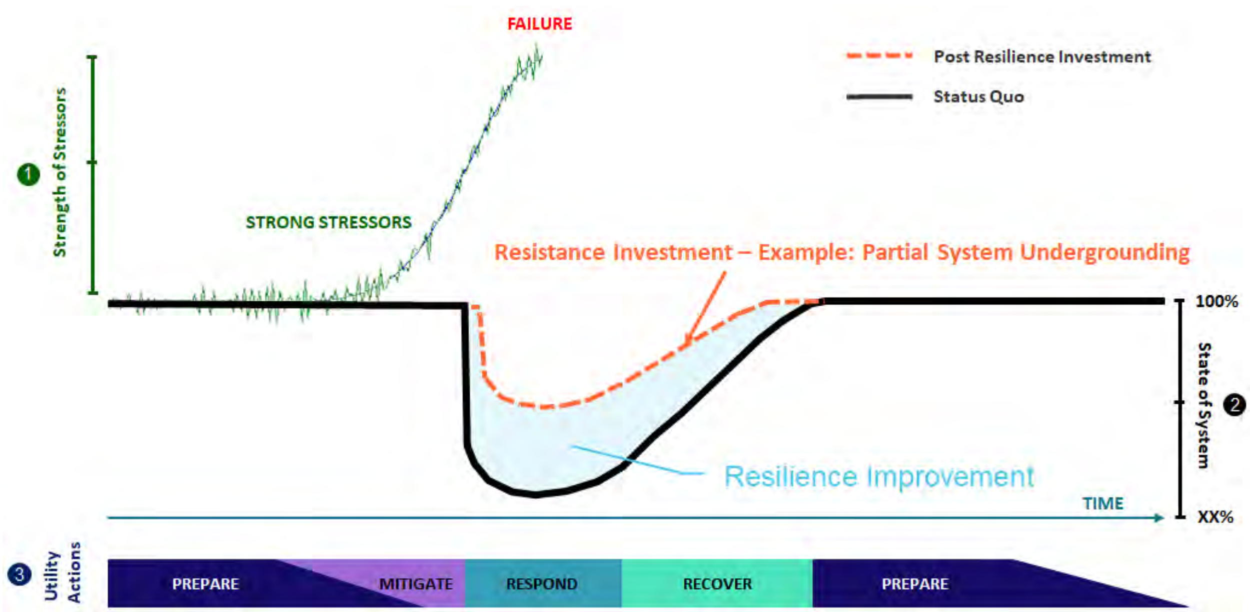


Figure 4-6: Resilience Improvement and Partial System Undergrounding



The resistance investment approach can provide significant benefits for all grid customers. Firstly, directly for the customers whose infrastructure has been hardened or undergrounded. These customers directly benefit from the hardening activities. Secondly, even customers whose upstream infrastructure was not hardened achieve benefits from this strategy. As Figure 4-4 and Figure 4-6 both show, the overall duration of the major disruptive stressors are less than a status quo approach. With less infrastructure to rebuild after a major event, crews can rebuild the failed infrastructure much faster. Additionally, depending on the severity of the storm, there could be additional benefits of needing less costly foreign crews to restore the system.

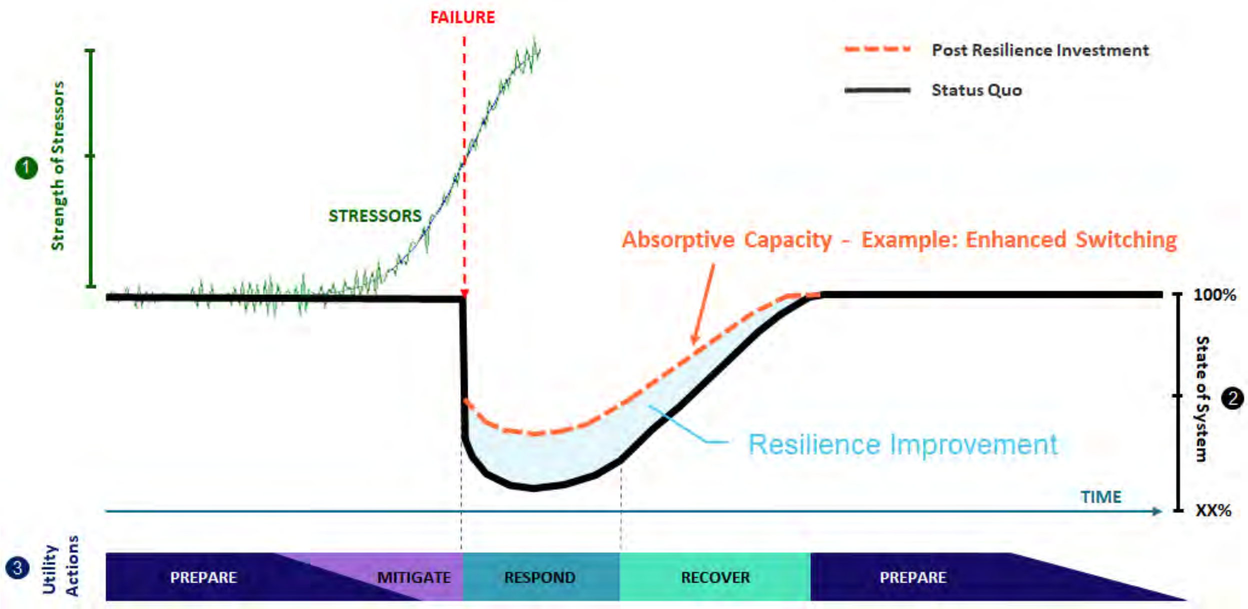
4.3.2 Absorptive Capacity Investment and Resilience Impact

Absorptive capacity investments aim to mitigate the impact of the event by implementing contingency measures that restore part of the system. Examples of these types of grid investments include:

- Enhanced Switching
  - Distribution Automation
  - Adding more circuit ties
- Looping and diverse paths

The focus of this evaluation is undergrounding, but other resilience investment alternatives will be discussed for completeness. Figure 4-7 shows the impact of resilience improvement from absorptive investment strategies, specifically enhanced switching capabilities. While this type of investment does not mitigate asset failures, it does mitigate the impact to customers. In the case of enhanced switching, customers can be swapped over to parts of the system that have not failed, decreasing the number of customers impacted. For enhanced switching, the overall duration of the event is not mitigated making the overall resilience improvement less than a resistance strategy. However, the cost of these approaches relative to resistance investment approaches can be significantly less.

Figure 4-7: Resilience Improvement and Enhanced Switching



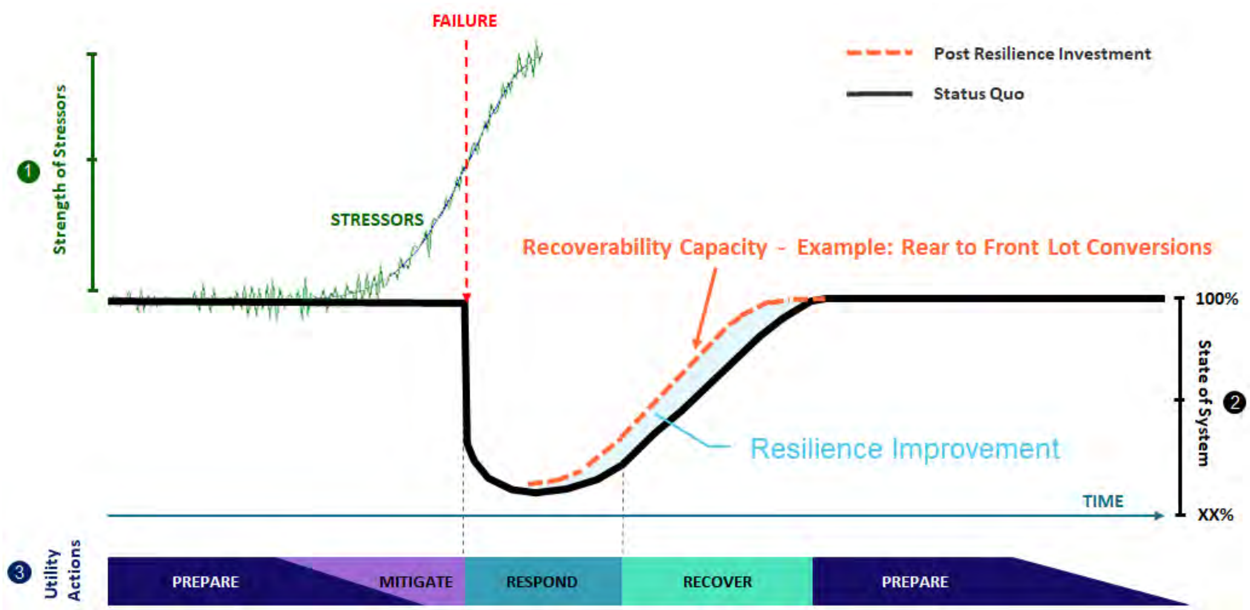
4.3.3 Recoverability Capacity Investment and Resilience Impact

Recoverability is the ability of the system to quickly return to full service. Typically, recoverability for major events is achieved through operational strategies like number of crews, staging of equipment, and optimization of crew development to name a few. From an infrastructure investment perspective, a main approach to improving recoverability is to enhance access to the infrastructure. Assets in deep right-of-way are far more challenging to rebuild as access for crews and trucks is challenging. Examples of these types of grid investments include:

- Improving Access to Right-of-ways
- Bridge and Road Access
- Rear lot to Front Lot Conversions (all else equal)

The focus of this evaluation is undergrounding, but other resilience investment alternatives will be discussed for completeness. Figure 4-8 shows the impact of resilience improvement from recoverability investment strategies, specifically rear lot to front lot conversions. As the figure shows, the absolute impact on the system is not mitigated, rather the overall duration is decreased to improve the overall resilience. In the long-term, this investment strategy does not mitigate asset failures, unless the infrastructure is built to a stronger standard with the conversion, it does allow crews to get access to and fix the infrastructure much faster. Recoverability only based investment strategies are not typically done at scale since the cost can be significant. Rather, this strategy is more on an opportunistic basis or done at the same time with cost efficiencies with a resistance or absorptive investment strategy.

Figure 4-8: Resilience Improvement and Rear to Front Lot Conversions



5.0 RESILIENCE INVESTMENT PLANS WITHIN THE INDUSTRY

Across the United States, Canada, and around the world, utilities are pursuing resilience investment plan filings in response to the greater impact major events have on the electrical system. While some states have strong stances on resilience requirements (Florida, New York), others have chosen to provide recommendations for utilities to consider. As seen with New York's recent move from resilience recommendations to codified filing requirements, resilience investment requirement levels are in a state of flux. Many Public Service Commissions (PSC) are recognizing the importance of resilience but there are still a wide range of regulatory environments out there. The following section is an initial review of resilience investment across the United States and Canada.

5.1 Maryland & Virginia

In 2012, a derecho storm impacted Maryland during a sustained heat wave, and together resulted in the 47 fatalities according to NOAA[23]. In response, Executive Order 01.01.2012.15 directed the State Energy Advisor, in conjunction with other agencies including the Maryland Energy Administration (MEA), to solicit recommendations from industry experts on how to improve the resilience and reliability of the distribution system – resulting in the formation of the Grid Resiliency Task Force. This group included almost 50 experts who evaluated the effectiveness and feasibility of undergrounding power lines, options for improving grid resilience infrastructure investments, and alternative financing and cost recovery for capital investments. The resulting *Weathering the Storm* report included 11 recommendations, including to implement a ratemaking structure that aligns customers and utility incentives by rewarding reliability that exceeds established reliability metric and penalizes failure to meet those metrics.

In 2016, MDPSC initiated a proceeding titled Public Conference 44 (PC44)[24] to review electric distribution systems in Maryland, aiming to explore issues that will

[23] National Oceanic and Atmospheric Administration (NOAA). (2013 January). *The Historic Derecho of June 29, 2012*. U. S. Department of Commerce

[24] https://www.psc.state.md.us/transforming-marylands-electric-grid-pc44/

maximize benefits and choice to Maryland electric customers and assess how the evolving grid impacts low- and moderate-income ratepayers. In the first notice, seven topics were considered for the proceeding, including the following:

- Rate design
- Electric Vehicles
- Competitive Markets and Customer Choice
- Interconnection Process
- Energy Storage
- Distribution Planning

Building on the information from the Task Force on Comprehensive Electricity Planning (compromising of the NARUC and NASEO), MDPSC created the Distribution System Planning Work Group in 2021 with the goal of aligning planning processes with state goals and proliferation of distributed energy resources through comprehensive examination of distribution system planning in Maryland[25].

In 2019, the MEA sponsored an incentive program called Resilient Maryland, aimed at growing the adoption of microgrid and other distributed generation systems. This pilot program provides competitive grants to stakeholders in the development of microgrids, combined cycle heat and power, and resilience hubs in the state. The program disbursed $297,000 in 2019, $1.03 million in 2020, $1.59 million in 2021, and $1.58 million in 2022. Applications for 2023 are currently open[26].

The MDPSC approved a request from Potomac Electric Power Company (Pepco) to include a “Grid Resilience Charge” on customer’s monthly bills in Montgomery and Prince George countries. This charge allowed Pepco to secure $24 million from ratepayers in Case No. 9311, in order to replace priority distribution feeders in 2014. In 2016, Pepco requested approval under Case No. 9418 for an additional $31.6 million under the same program.

[25] https://news.maryland.gov/mea/2021/02/11/maryland-announces-plan-for-electric-grid-of-the-future/
[26] https://energy.maryland.gov/business/Pages/ResilientMaryland.aspx

Pepco and Dominion Energy (Dominion) are utilities with similarities to Hydro Ottawa. A summary of efforts by these utilities is summarized Table 5-1 below:

Table 5-1: Pepco and Dominion Resilience Efforts to Date

Utility	Resilience Program	Area	Projects	Time Horizon	Budget
Pepco	DC Plug Projects	District of Columbia (DC)	Undergrounding distribution feeders – Wards 3, 4, 5, 7, and 8.	2012-Present	$500M*
	Capital Grid Projects	DC & Maryland	Substation upgrades, new substations, 10 miles of undergrounding transmission lines	2020-2028	$1.1B
Dominion	Strategic Underground Program	Virginia & North Carolina	Undergrounding tap lines most prone to outages over the last 10-years	2019-2026	$179M per year
	Grid Improvement Programs	Virginia	Hardening main feeders, vegetation management for ash tree mortality due to invasive insects.	2018-2030	$3B

*This program is funded by Pepco, and the District of Columbia.

Additionally, MEA (along with 12 other states), declared commitment to a more efficient and resilient energy future in February of 2011, following the conclusion of the two-year initiative hosted by the NARUC and the National Association of State Energy Officials (NASEO).

5.2 Florida

In 2006, the Florida Public Service Commission (FPSC) passed a requirement for electric utilities to develop storm protection plans. In 2019, this became codified by the Florida legislature, also allowing utilities to recover the costs of approved plans through a charge separate and apart from base rates. Each utility must file a petition with the Commission for approval of a T&D Storm Protection Plan (SPP) that covers the utility's immediate 3-year planning period and their longer 10-year planning horizon. Per the legislation and SPP rule, each utility is required to provide an updated SPP at least every 3 years. The SPP rule following the legislation lays out requirements for plans. From a benefits perspectives, the plans are required to show benefits in terms of avoided customer outages and avoided storm restoration costs.

In November 2022, FPSC approved 4 plans submitted by power company utilities for efforts to harden the state's power grid over the next 3 years. The FPSC approved nearly all of the investments over the next 3 years for each of the four electric utilities; Florida Power and Light (FPL), Duke, Florida Public Utilities and Tampa Electric Company (TECO).

5.2.1 Florida Power & Light

FPL requested approval for plan totaling $13.77B. The commission approved nearly all of the requested funding for programs for the first 3 years of the 10-year plans. Table 5-2 provides an overview of their SPP filing.

Table 5-2: FPL Storm Hardening Estimated Categories and Spends

Program	Annual Cost	Timeframe (Years)
Distribution Inspection	$66.9M	10
Transmission Inspection	$67.2M	10
Distribution Feeder Hardening	$270.8M	9
Distribution Lateral Hardening	$939M	10
Transmission Hardening	$50.4M	10
Distribution Vegetation Management	$76.6M	10
Transmission Vegetation Management	$14.4M	10
Substation Storm Surge/Flood Mitigation	$16M	2
Distribution Winterization (withdrawn)	$22.3M	2
Transmission Winterization (withdrawn)	$22.3M	2
Transmission Access Enhancement	$11.70	10
Total	**$1.54B**	

5.2.2 Duke Florida

Duke Florida requested approval for plan totaling $7.17B. Table 5-3 provides an overview of their SPP filing. Duke Florida's Plan programs include the following:

Table 5-3: Duke Storm Hardening Estimated Categories and Spends

Program	Annual Cost	O&M Cost	Timeframe (Years)
Feeder Hardening	$2.0B	$49M	10
Lateral Hardening	$2.9B	$74M	10
Underground Flood Mitigation	$15M		10
Distribution Vegetation Management	$23M	$517M	10
Transmission Structure Hardening	$1.6B	$34M	10
Substation Flood Mitigation	$38M		10
Loop Radially-Fed Substation	$82M		10
Substation Hardening	$133M		10
Transmission Vegetation Management	$126M	$127M	10
Self-Optimizing Grid (3yrs)	$340M	$11M	10
Total	**$7.257B**	**$812M**	

5.2.3 Florida Public Utilities

Florida Public Utilities requested approval for plan totaling $243.1M. The plan includes Distribution Overhead Feeder Hardening, Distribution Overhead Lateral hardening, Distribution Overhead Lateral Undergrounding, T&D Vegetation Management, Future T&D Enhancements, Transmission/Substation Resiliency, Transmission Inspection and Hardening, and SPP Program Management. Table 5-4 provides an overview of their SPP filing. Florida Public Utilities Plan programs include the following:

Table 5-4: Florida Public Utilities Storm Hardening Estimated Categories and Spends

Program	2022 Cost	2023 Cost	2024 Cost
Overhead Feeder Hardening	$300,000	$3.01M	$3.07M
Lateral Feeder Hardening	$60,000	$580,000	$1.01M
Lateral Undergrounding	$110,000	$1.12M	$1.67M
Distribution Inspection and Replacement	$1.2M	$1.52M	$1.62M

Transmission System Inspection and Hardening	$620,000	$620,000	$620,000
Transmission & Substation Resiliency	-	-	$9.35M
Transmission & Distribution Vegetation Management	$9.5M	$11.5M	$14M
Future Transmission & Distribution Enhancements	-	-	-
Total	**$11.81**	**$18.35M**	**$31.34M**

5.2.4 TECO

TECO requested approval for a plan totaling $1.45B for Distribution lateral Undergrounding, Substation Extreme Weather (Distribution & Transmission), Distribution Overhead Feeder Hardening, Transmission Access Enhancement, along with things like environmental management and future maintenance. Table 5-5 provides an overview of their SPP Filing.

Table 5-5: TECO Storm Hardening Estimated Categories and Spends

Program	Annual Cost	Timeframe (Years)
Distribution Lateral Undergrounding	$105M	3
Supplemental Distribution Circuit Vegetation Management	$60,200	10
Mid-Cycle Distribution Vegetation Management	$58,100	10
69kV Vegetation Management Reclamation	$2,185	1
Transmission Asset Upgrades	$53.1M	3
Substation Extreme Weather Hardening	$5M	3
Distribution Overhead Feeder Hardening	$94.8M	3
Transmission Access Enhancements	$3M	3
Wood Pole Inspections	$1.1M	10
Transmission Inspections	$430,000	10
Groundline Inspections, ground Patrol, Aerial Infrared Patrol, Above Ground Inspections, Substation Inspections	$150,000	10
Disaster Preparedness & Recovery Plan	$300,000	Annually
Distribution Pole Replacements	$82.9M	10
Total	**$345.9M**	

5.3 Louisiana

The state of Louisiana saw two storm resilience plans filed in 2022, both from Entergy. The filings were the results of two major category 4 hurricanes impacting the Entergy service territory in 2020 and 2021 (Laura and Ida, respectively). First, Entergy New Orleans enacted a grid hardening and resilience filing with the New Orleans City Council (their applicable regulator). The plan detailed nearly $1.3 billion in spending over 10 years and asserted 890 grid resilience projects were identified in the plan. These projects include distribution and transmission projects involving over 33,000 structures and 650 line-miles. The annual plan costs are shown in Table 5-6.

Table 5-6: Entergy New Orleans Resiliency Estimated Spends by Year

Year	Approx. Investment
2023	$0
2024	$20M
2025	$36M
2026	$47M
2027	$197M
2028	$200M
2029	$205M
2030	$188M
2031	$230M
2032	$154M
Total	**$1.276B**

The second filing in Louisiana was done by Entergy Louisiana, with a proposed plan capital investment for approval by the commission of approximately $5 billion for the first five years of the 10-year plan. The total 10-year plan investment level is nearly $9 billion. This plan proposes the following resilience programs, as shown in Table 5-7.

Table 5-7: Entergy Louisiana Resiliency Estimated Spends by Year and Category[27]

Year	Distribution Feeder Hardening (Rebuild)	Distribution Feeder OH to UG Conversion	Lateral Hardening (Rebuild)	Lateral OH to UG Conversion	Transmission Rebuild	Substation Control House Remediation	Substation Storm Surge Mitigation	Total
2023	$0	$0	$54,700	$0	$0	$700	$3,800	**$59,200**
2024	$48,000	$0	$252,700	$26,648	$11,800	$3,100	$16,900	**$359,148**
2025	$382,100	$0	$281,900	$68,260	$80,500	$5,000	$40,900	**$858,660**
2026	$556,200	$25,800	$257,600	$61,062	$258,400	$3,400	$51,200	**$1,213,662**
2027	$364,000	$5,800	$241,300	$29,273	$271,300	$0	$27,800	**$939,473**
2028	$532,200	$0	$269,100	$49,533	$326,900	$0	$5,000	**$1,182,733**
2029	$555,300	$0	$319,900	$42,690	$217,500	$0	$5,600	**$1,140,990**
2030	$513,300	$0	$250,000	$58,223	$226,200	$0	$5,300	**$1,053,023**
2031	$419,700	$0	$166,000	$50,045	$133,100	$0	$3,600	**$772,445**
2032	$222,100	$0	$261,900	$25,311	$12,200	$0	$0	**$521,511**
2033	$441,100	$0	$74,800	$20,403	$0	$0	$0	**$536,303**
2034	$183,900	$7,800	$15,900	$1,210	$0	$0	$0	**$208,810**
Total	**$4,217,900**	**$39,400**	**$2,445,800**	**$432,659**	**$1,537,900**	**$12,200**	**$160,100**	**$8,845,959**

Both Entergy filings proposed to recover costs through a resiliency and storm hardening cost recovery rider, to permit timely recovery of the Resilience Plan's revenue requirements due to the level and pace of spending through the plan.

5.4 New York

The state of New York has seen multiple named events in recent years, most notably Hurricane Sandy. In response, the Columbia Center for Climate Change Law filed a formal petition with the New York PSC requesting all utilities under its jurisdiction be required to develop climate change adaptation plans, which in turn led Consolidated Edison (Con Ed) to file a plan of the same name in 2014. The initial plan

[27] **Source:** Application of Entergy Louisiana, LLC For Approval of the Entergy Future Ready Resilience Plan (Phase 1), Table 8-1

investment level was $1 billion and was recoverable through its own recovery rider. This same year, a group of NGOs and academic centers were ordered by the PSC to continue the Storm Hardening and Resiliency Collaborative in the form of four working groups with the scope of addressing storm hardening design standards, alternative resiliency strategies, natural gas system resiliency and risk assessment/cost benefit analysis. Additionally, the PSC required Con Ed's commitment to conduct a Climate Change Vulnerability Study, which was performed in 2013, and again in 2019.

The New York State Senate passed Bill S4824A in 2021, which requires electrical corporations to submit a storm hardening system resiliency plan to the PSC, authorizes utility companies to petition the PSC for a waiver of reimbursement requirements, requires utility companies to reimburse customers for certain widespread prolonged outages, and prohibits utility companies from recovering costs incurred due to power outages from customers. The bill, named the Soil Health and Climate Resilience Act, went into effect in 2022 and requires utilities to perform climate change vulnerability studies by 2023. An updated plan must be filed five years after the approval of an original plan, and utilities can make an annual filing to recover costs associated with the preparation of the plan. Additionally, each utility must establish a climate resilience working group no later than 2023, and include in the group representatives from the PSC, municipalities, customer advocacy groups, and energy and environmental advocacy groups.

5.5 New Jersey

Public Service Electric and Gas (PSEG) was granted approval of the $550 million "Energy Strong" infrastructure hardening and resiliency plan in 2014 and $207 million in 2019. The cost recovery for this plan was a new recovery rider, for both gas and electric investments. The program spends by phase are detailed in Table 5-8.

Table 5-8: PSEG Energy Strong Program Investment Levels by Phase

Program	Approx. Investment
Phase 1	
Substation Flood Hardening	$400M
Grid Modernization	$150M
Phase 2	
Distribution Circuit Hardening	$100M
Communication and ADMS Upgrades	$107M
Total	**$757M**

5.6 California

California is currently executing plans to mitigate the impact of wildfires in the state. California's investor-owned utilities plan to spend over $10 billion to mitigate the risk. The investments are aimed at reducing the risk of wildfires in their service territories. These programs employ several strategies, including inspecting and repairing equipment, trimming back trees and other vegetation that could fall into power lines, and investing in grid technologies and system hardening.

5.7 Texas

In response to very disruptive natural disaster events that cause disruption throughout the midwestern portion of the United States, Texas has passed House bill 2555 that creates a new cost recovery mechanism to allow transmission and distribution investments to harden those systems. Specific rules to implement House Bill 2555 are expected from the Texas Public Utility Commission by the end of 2023.

5.8 IEEE Resilience Working Group

The Institute of Electrical and Electronic Engineers (IEEE) created a working group in 2019 dedicated to the discussion, defining, and quantification of resiliency in the electric distribution system. The group's scope includes capturing common methods and applications utilities may use prior to and following extreme natural events and/or environmental conditions to improve distribution system resiliency. The topics covered by the group include but are not limited to the following:

- System design and implementation
- Hardening Efforts
- Inspections and maintenance activities
- Response consideration
- Quantitative measurements

This group does not consider events surrounding cybersecurity or deliberate physical security attacks. The work group is comprised of 27 industry professionals, contributing to seven different chapters, with each chapter's scope as follows:

- Chapter 1: Literature Review
- Chapter 2: Resilience Goal/Objectives
- Chapter 3: High Impact Weather/Storm Event Risk Identification
- Chapter 4: Quantification of Resiliency
- Chapter 5: System Modeling and Storm Simulation
- Chapter 6: Guide for Infrastructure and Operational Improvements
- Chapter 7: Use Cases and Resiliency Study

Currently, the work group's goals through 2023 include building a consensus on resilience metrics between the following factors: common tools among utilities, common tools among research, and bringing a consensus among available data to utilities, data infrastructure, and research methods. Through 2024, the group aims to create a common framework for quantitative metrics of resilience with a focus on available data by starting a risk-benefit analysis of investments on both new infrastructure and grid hardening.

5.9 Ontario Energy Board Resilience Policy Analysis[28]

[28] https://engagewithus.oeb.ca/sectorresilience

In 2023, the Ontario Energy Board engaged London Economics International LLC to analyze and define resilience and explore related policy questions as they apply to electric distributors in Ontario. The result was a comprehensive report "Resilience in the electricity distribution sector and related policy questions" that outlined an initial road map that could be used to guide strategy and tactics related to resilience initiatives aimed at mitigating threats to the electrical distribution system. While the report concludes that resilience investment are warranted to best serve the needs of electrical customers and financial justification should be required before specific investments are funded, it leaves some key elements unresolved around the areas of the appropriate evaluation framework, the funding mechanism to support resilience investment, and how to measure the effectiveness of the investments after implemented.

6.0 RESILIENCE INVESTMENT MODEL

Hydro Ottawa and 1898 & Co. utilized a resilience-based planning approach to identify, prioritize, and perform a business case for resilience investment in the distribution system. The resilience-based planning approach utilizes 1898 & Co.'s Resilience Investment Model. The Resilience Investment Model leverages the Conceptual Resilience Framework outlined in Section 2.0 and was designed based on the guiding principles outlined in Section 4.1. The model takes the "theory" of the frameworks and develops an actional investment plan that prioritizes resilience investments based on available data, analytics models, and a business case methodology. The approach calculates the resilience improvement at the asset, project, and program level. For the purposes of this evaluation, resilience benefits for projects are estimated from a customer centric perspective. The customer benefits are shown in terms of the:

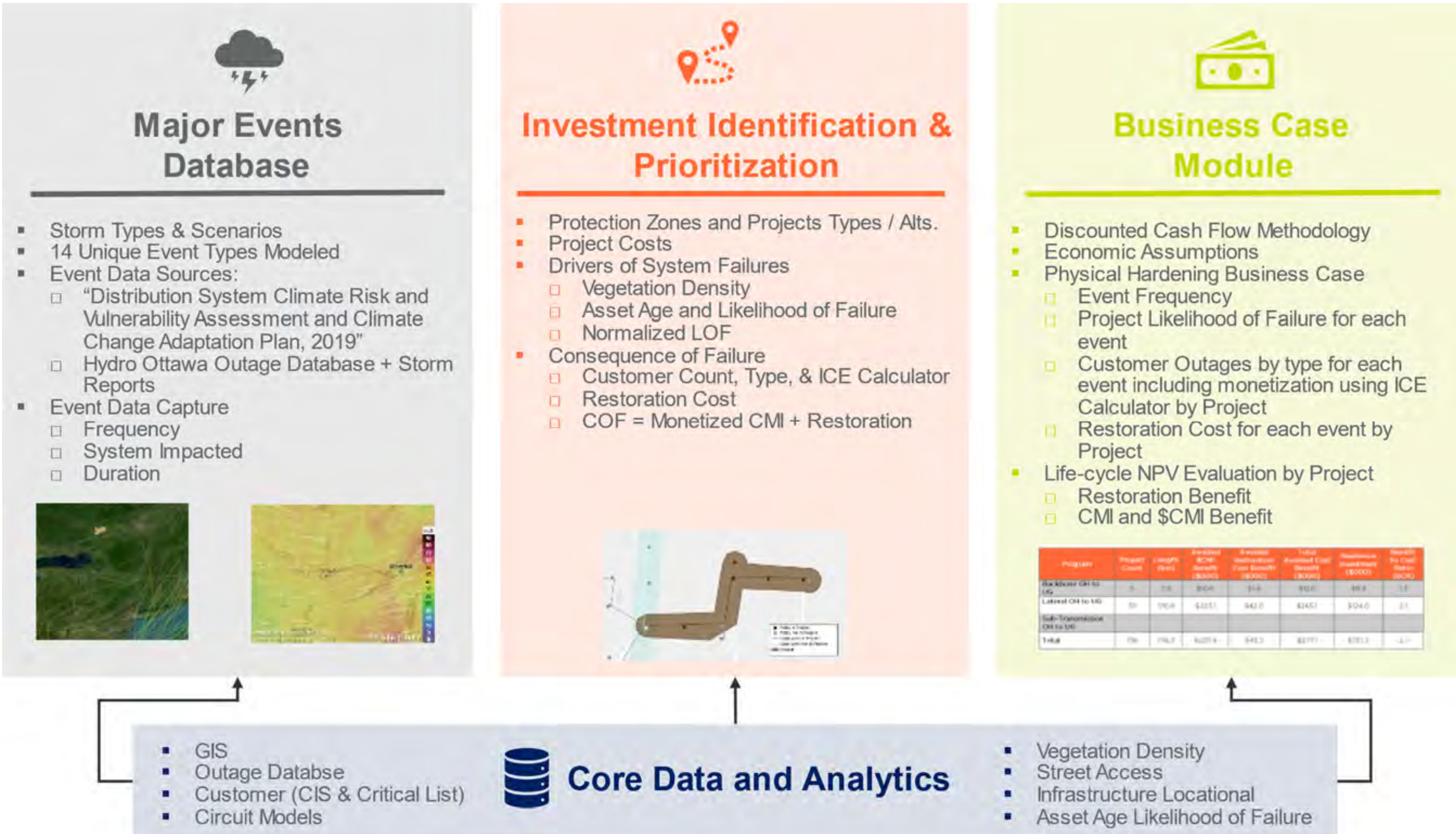
1. Decrease in the Event Restoration Costs
2. Decrease in the customers impacted and the duration of the overall outage, calculated as CMI and monetizing the CMI (discussed in Section 6.2)

The Resilience Investment Model employs a data-driven, decision-making methodology using robust and sophisticated algorithms to calculate the resilience benefits. The following sections provide an overview of the model, the approach to monetizing customer outages, and why modeling using this approach is important and necessary.

6.1 Resilience Investment Model Overview

Figure 6-1 provides an overview of the Resilience Investment Model to identify and prioritize hardening investments and calculate their customer centric business case.

Figure 6-1: Resilience Investment Model Overview



6.1.1 Core Data and Analytics

The Resilience Investment Model is foundationally data centric. It utilizes Hydro Ottawa enterprise data sources as well as external sources. From an internal enterprise perspective, the model utilizes Hydro Ottawa's Geospatial Information System (GIS) for the collection of assets and their attributes (age, type, etc.). This allows the resilience-based planning approach to be asset-centric. The model also utilizes Hydro Ottawa's Outage Database to understand the relationships between protection devices and the types of outage events, particularly larger events. The third core enterprise data set includes information from the Customer Information System (CIS). The fourth core dataset includes Hydro Ottawa distribution circuit models. 1898 & Co. linked these datasets to create the relationship between assets and customers and customer types. This allows the resilience-based planning approach to be customer-centric.

1898 & Co. also leveraged external data sources for the evaluation linking them to the internal data sources. The external data sources included satellite tree canopy for vegetation density analysis, and age deterioration analytics from 1898 & Co. own proprietary modeling. These external sources provided valuable information in identifying infrastructure that would more likely fail during events.

6.1.2 Major Event Database

Since the magnitude of the restoration cost decrease and CMI decrease is dependent on the frequency and magnitude of future major events that may impact the Hydro Ottawa service area, the Resilience Investment Model starts with the 'universe' of major weather events that could impact Hydro Ottawa's service area. The Major Event Database provides the high-level impact to the system of the storm stressor. The major events database includes the following:

- Event Type
- Frequency of an event occurring
- Percentage of the system impacted
    - Sub-Transmission Protection Devices
    - Backbone Protection Devices
    - Lateral Protection Devices

- Duration of the event
- Restoration Cost

6.1.3 Investment Identification

The Investment Identification develops the list of potential underground hardening projects and their costs. The evaluation is comprehensive in evaluating nearly the entire system. Underground hardening investments are defined based on a customer-centric perspective at the protection zone level for distribution circuits. The module also estimates the costs for each of the projects.

6.1.4 Resilience Business Case Module

The Resilience Business Case Module calculates the business case for each project with total benefit per dollar invested from the Investment Identification Module. The business case is based on a discounted cash flow methodology over a 50-year time horizon. The business case for each project is a sum of the avoided reactive costs and avoided monetized customer outages for each of the events within the Major Events Database.

The output of the Resilience Business Case Module is:

- Resilience Business Case for highest resilience improvement projects
  - Project Cost and High Level Scope
  - Life-Cycle Net Present Value (NPV) Benefits
  - Benefit to Cost Ratio (BCR)

6.2 Societal Impacts & Monetizing Outages

Society's reliance on electricity continues to expand from one decade to the next. This includes the increasing number of connected devices, aging in place, working from home, and electrification to highlight some of the more obvious drivers of an increased reliance on the grid. Section 3.2 provides further discussion of the many societal impacts tied to the loss of electrical power. From a customer's perspective, there is a real impact to their lives, and these impacts should be considered and factored into the development of a business case for each proposed resiliency project. .

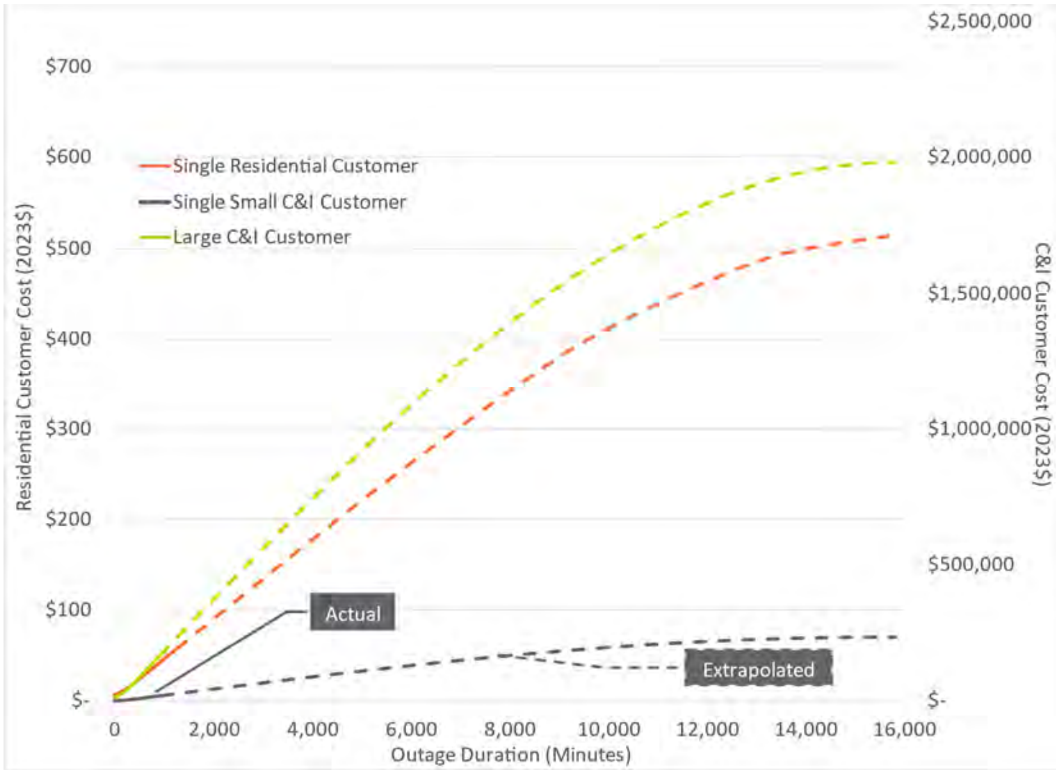
The DOE ICE calculator provides a third-party independent estimate of the value of eliminating or partially mitigating an outage. While there are some known deficiencies that generally result in underestimating the monetized customer impact, it is still the most recognized and utilized approach for the monetization of customer outages.

The ICE Calculator is an electric reliability planning tool developed by Freeman, Sullivan & Co. and Lawrence Berkeley National Laboratory. This tool is designed for electric reliability planners at utilities, government organizations, or other entities interested in interruption costs and/or the benefits associated with reliability improvements in the United States. The ICE Calculator was funded by the Office of Electricity Delivery and Energy Reliability at the DOE.

The value of interruption costs within the calculator are based on customer surveys from 15 research efforts conducted by 10 utility companies resulting in 34 different data sets totaling over 105,000 observations from 1989 to 2012. Greater than 44 thousand Medium to Large C&I customers, greater than 27 thousand small C&I customers, and over 34 thousand residential customers. The developers of the ICE calculator have also noted significant advancements in societal use of devices and other technologies including a higher number of people working from home. With most of the surveys being done before these advancements in the last 10 to 15 years, the developers of the ICE Calculator consider the current cost of interruptions to be conservative. The developers of the calculator have received additional funding to update the surveys which would reflect these key changes, especially the value of interruptions in a post-pandemic society. As this update will not be reflected until 2024, this business case evaluation does not attempt to normalize the ICE Calculator for these factors, rather the evaluation utilizes the result directly from the current calculator to be conservative.

The calculator includes the estimated interruption costs for residential, small commercial and industrial (C&I), and large C&I customers for a range of durations. The calculator was extrapolated for the longer outage durations for storm-based outages. Figure 6-2 shows the cost of interruptions for New York (closest US state to Ottawa) customers for each customer class in Canadian dollars. The figure also shows the extrapolation for longer outages. Hence a customer interruption monetized value can be derived for an outage of any duration for each of the listed customer classes.

Figure 6-2: ICE Calculator Monetized Cost of Outage Summary



6.3 Resilience Investment Model – 'The Why'

The Resilience Investment Model was designed and developed for the purpose of identifying and ranking T&D resilience investments to provide the most benefit for customers. For Hydro Ottawa, it was utilized only for the distribution system. The resilience-based planning approach described within this report are appropriate to model resilience investment for the following reasons:

- **Event-Based -** The benefits of resilience projects are wholly dependent on the number, type, and overall impact of future events to impact the region served by Hydro Ottawa. Different events have dramatically different impacts to Hydro Ottawa's distribution system. For this reason, the resilience-based planning approach includes 14 different potential major events that could impact Hydro Ottawa over the next 50 years capturing event forecasts provided within the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan" produced by Stantec Consulting Ltd. (additional details in Section 8.0) and Hydro Ottawa's outage records. The evaluation is not limited to only recent events to minimize recency bias, but rather includes data going back 170 years.

- Asset and Root-Caused Focused - Major events cause assets to fail, and assets collectively serve customers. Moreover, it only takes one asset failure to cause customer outages. The cost to restore the failed assets is dependent on the extent of the damage and resources used to fix the system. The duration to restore affected customers is dependent on the extent of the asset damage and the extent of the damage on the rest of the system. It may only take 4 hours to fix the failed equipment, but customers could be without service for 4 days if crews are busy fixing other parts of the system for 3 days and 20 hours. All of this is dependent on the type of storm to impact the system. Modeling this series of events for the entire system at the asset and project level for both a "Status Quo" and "Hardened" scenarios is needed to accurately model resilience project benefits. Therefore, the resilience-based planning approach calculates the phases of asset and project resilience for each of the 14 storm events for both scenarios.
- Data-Centric - By breaking down the entire distribution system by protection zone, the resilience-based planning approach is foundationally data centric and links the appropriate assets to each possible resiliency project. The model utilizes Hydro Ottawa's GIS, outage database, CIS, distribution circuit models, and critical customer information. It also utilizes satellite tree canopy data and road layers.
- Customer-Centric - By breaking down the entire distribution system by protection zone, the resilience-based planning approach is foundationally customer centric. Each protection zone has a known number of customers and type of customers such as residential, small or large commercial and industrial, and critical customers. The objective is to harden each asset that has a higher risk of failing, which would result in a customer outage. Since only one asset needs to fail downstream of a protection device to cause a customer outage in that zone, failure to harden all the necessary assets still leaves vulnerable

components that could potentially fail in an event. Rolling assets into projects at the protection device level allows for hardening of all vulnerable components in the project zone and for capturing the full benefit for customers.

- Granular - The granularity at the asset and project levels allows Hydro Ottawa to invest in portions of the system that provide the most value to customers from both a restoration cost reduction and avoided CMI perspective. For example, a circuit may have 10 laterals that come off a feeder, and the resiliency investment model may determine that only 3 out of the 10 should be hardened. Without this granularity, a suboptimal or inefficient level of investment could occur. The adopted approach provides confidence that the final overall plan is investing in parts of the system that provide the most value for customers.
- Comprehensive - The approach is comprehensive and evaluates nearly all of the assets on Hydro Ottawa's distribution systems. By considering and evaluating those systems on a consistent basis, the results of the final underground hardening plan provide confidence that portions of Hydro Ottawa's distribution assets are not overlooked for potential resilience benefit.
- Business Case Foundations - The output of the model is the resilience benefit of each project for each of the 14 storm types. The life-cycle resilience benefit for each resilience project is dependent on the probability of each storm and the mix of storm events to occur over the life of the resilience projects. A project's resilience value comes from mitigating outages and associated restoration costs not just for one storm event, but from several over the life-cycle of the assets. For this evaluation, the future of major storm events is assumed to be equal to the historical frequency based on 170 years of weather data. The number of storm scenarios is significant given there are 14 unique types of storm events that could impact grid infrastructure.
- Consistency: The model calculates benefits consistently for all projects. The model carefully normalizes for more accurate benefits comparison between asset types. For example, the model can compare an overhead rebuild resilience project to a lateral undergrounding project to a distribution

automation project. This is a significant achievement allowing the assessment to accurately compare a wide range of investment types.

- Drives Prudency: The assessment and modeling approach drives prudency for the final comprehensive hardening plan on two main levels. First, the granularity of potential resilience projects allows Hydro Ottawa to invest in the portions of the system that provide the most value to customers. Without granularity, there is risk that parts of the system "ride the coat-tails" of needed investment causing inefficient allocation of limited capital resources. Secondly, the customer-centric financial justification of project investments allows Hydro Ottawa to prioritize investments that provide significant customer 'bang for buck'.

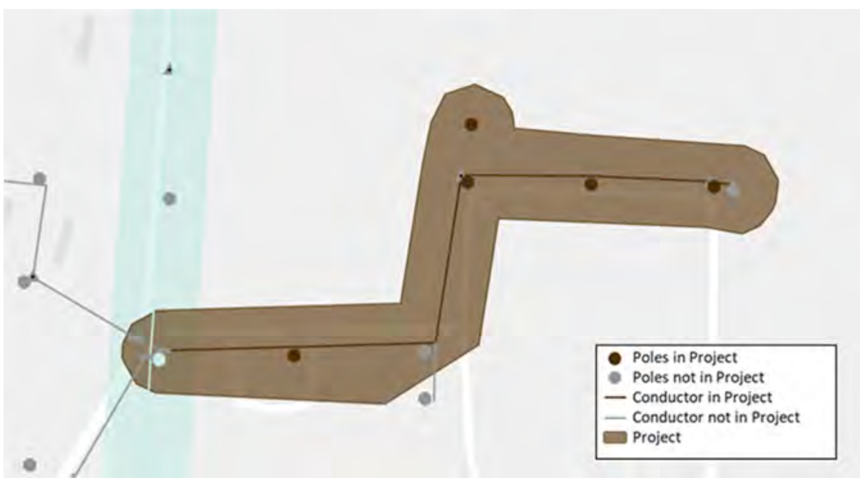
7.0 CORE DATA AND ANALYTICS

The resilience-based approach and methodology is data driven. This section outlines the core data sets and base algorithms employed within the Resilience Investment Model. This section includes both data from Hydro Ottawa's systems and external data sources.

7.1 Geographical Information System

The GIS provides the list of assets in Hydro Ottawa's system and how they are connected to each other. Since the resilience-based approach is fundamentally an asset management bottom-up based methodology, it starts with the asset data, then rolls all the assets up to projects, and all projects up to programs, and finally the programs up to the Resilience Investment Plan. The relationship between assets and projects is illustrated in the geospatial figure below.

Figure 7-1: Asset to Project Relationship



The Resilience Investment Plan created by 1898 & Co. only modeled overhead to underground projects, therefore all underground assets were removed from the evaluation. The existing underground system makes up 56% (3,463 km) of the total length of primary conductor. In addition to removing underground assets 22% (600 km) of overhead conductor was excluded from review for being 4 kV conductor which was outside the scope of this project.

In alignment with this methodology, 1898 & Co. utilized the connectivity within Hydro Ottawa's GIS to link each distribution voltage asset up to a lateral (fuse protection device) or feeder (breaker or recloser protection device). This linkage of assets to protection zones provides a granular evaluation of the distribution system that allows projects to be created to target only portions of a circuit for resilience investment. Through this approach, 1898 & Co. was able to use the asset level information from Table 7-1 and convert it to the project level summaries in Table 7-2. It is important to note that each asset in Table 7-1 is tied to one of the projects listed in Table 7-2, which provides a bottom-up analysis.

Table 7-1: Hydro Ottawa Asset Base

Asset Type	Units	Value
Sub-Transmission Circuits	[count]	72
Poles / Structures	[count]	3,387
Conductor Length	[kilometers]	312.5
Distribution Circuits (OH)	[count]	203
Feeder Poles	[count]	20,916
Lateral Poles	[count]	14,577
Feeder OH Primary	[kilometers]	1,178
Lateral OH Primary	[kilometers]	644

Table 7-2: Projects Created from Hydro Ottawa Data Systems

Count	Program	Project Count
1	Backbone OH to UG	324
2	Lateral OH to UG	1,338
3	Sub-Transmission OH to UG	81
	Total	1,743

7.2 Outage Database

The outage database includes detailed outage information by cause code for each circuit and protection device over the last 11 years. The Storm Resilience Model utilized this information to understand the historical storm related outages for the various distribution laterals and feeders on the system.

7.3 Customer Type Data

Hydro Ottawa provided customer count and type information with database relationships to the GIS and OMS. Using connectivity from the distribution circuit to the breaker, the customer relationship to the substation was also established. This data allowed the Resilience Investment Model to directly link the number and type of customers impacted to each protection device. Types of customers include residential, small C&I, and large commercial and industrial. This customer information is used in concert with the estimated event duration to estimate the CMI for each project which is monetized using the DOE ICE Calculator. This is foundational for the customer-centric business case approach. Figure 7-2, Figure 7-3, and Figure 7-3 show the customer counts for trunk backbone, lateral and subtransmission protection zones.

Figure 7-2: Customers by Backbone Protection Device

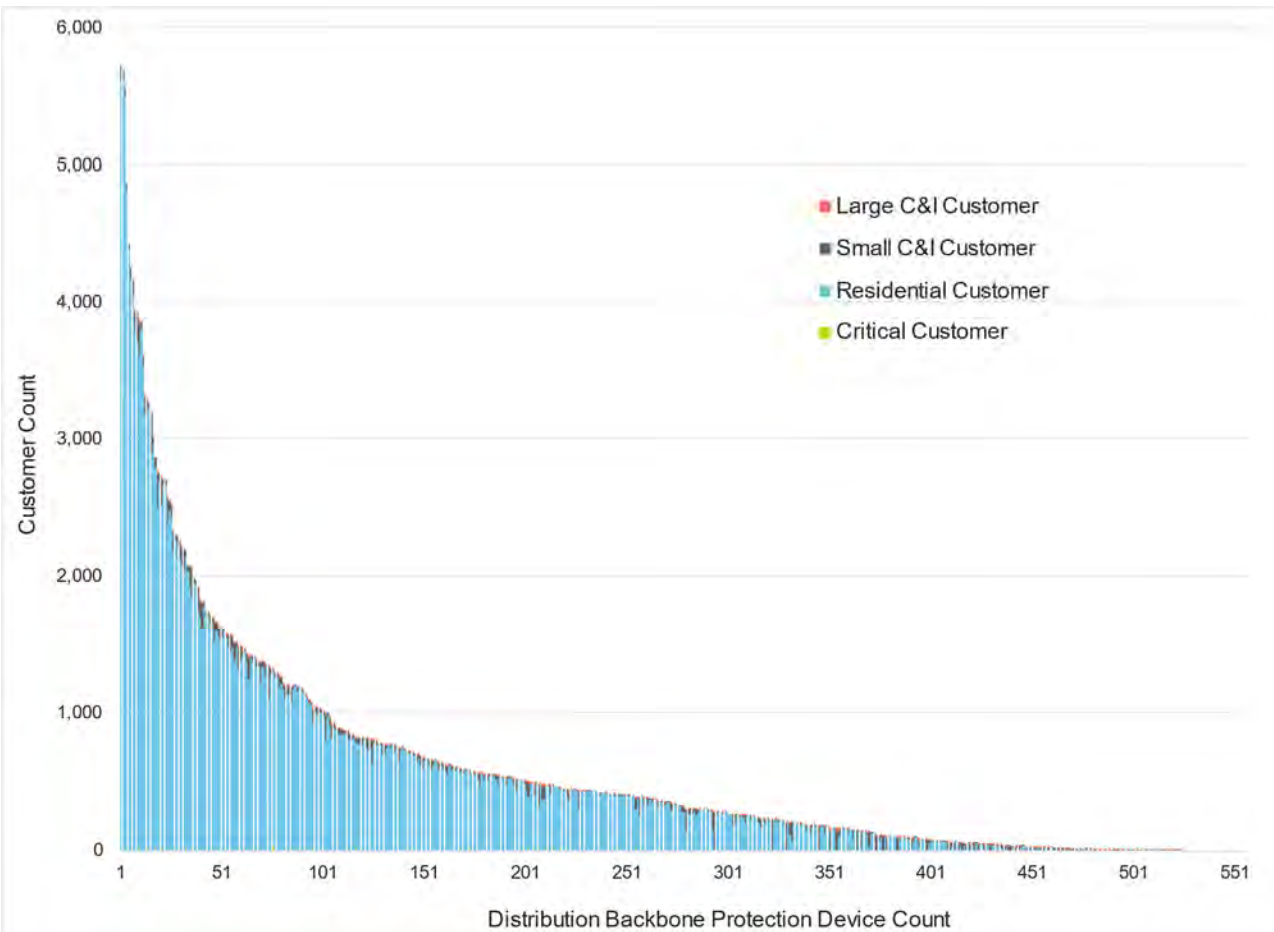


Figure 7-3: Customers by Lateral Protection Device

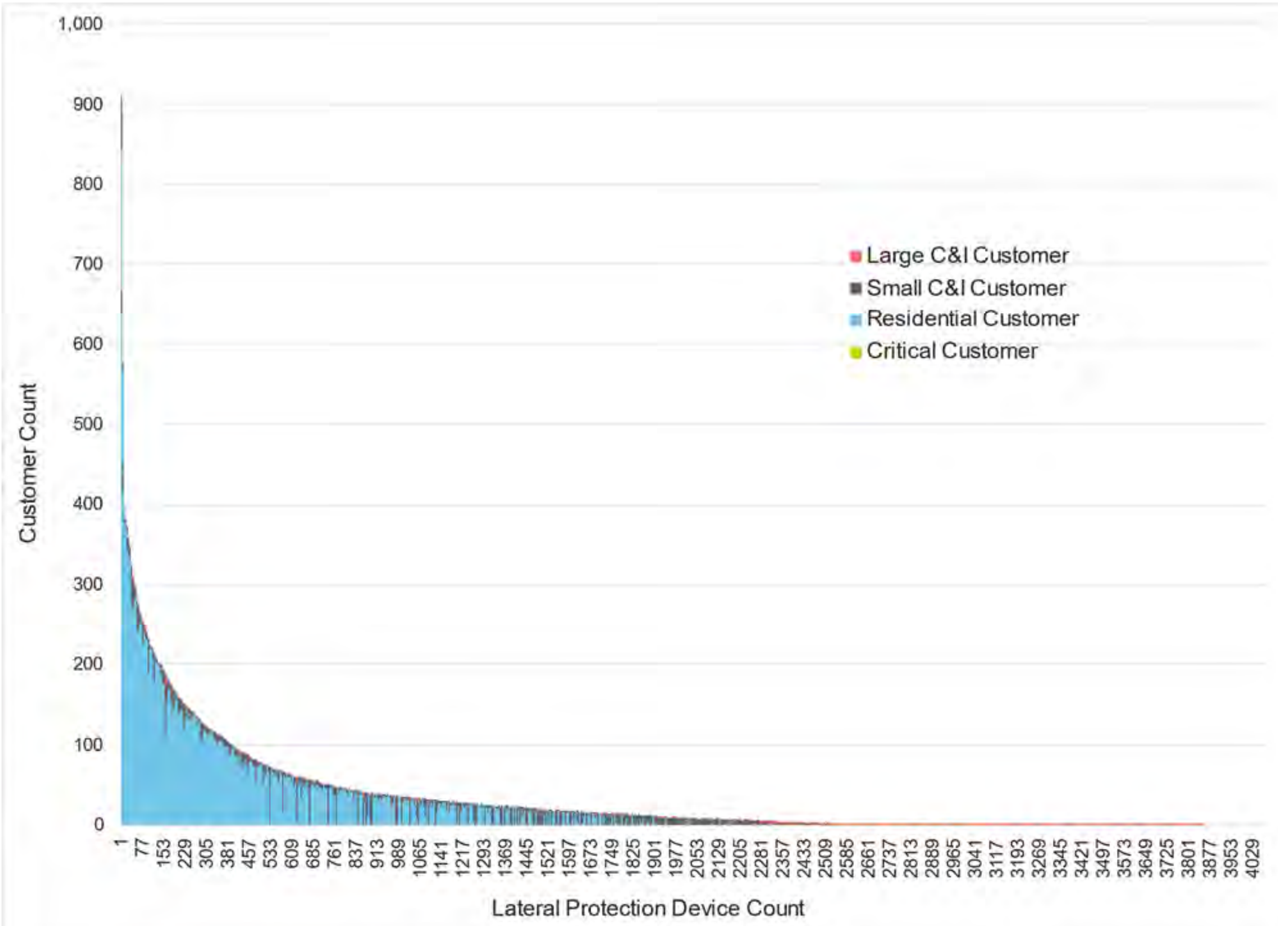
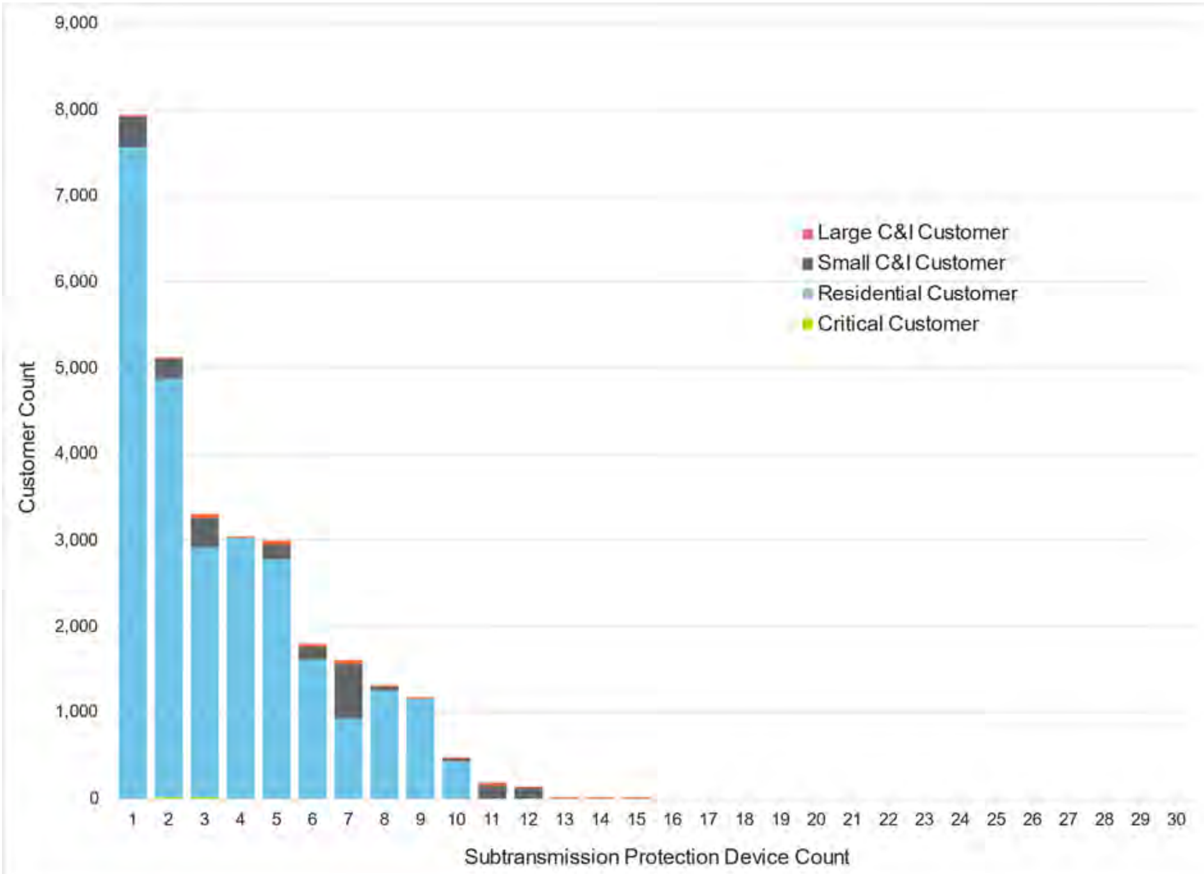


Figure 7-4: Customers by Subtransmission Protection Device



7.4 Vegetation Density Algorithm

The vegetation density for each overhead conductor is a core data set for identifying and prioritizing resilience investment for the circuit assets because vegetation, both inside and outside of the trim zone, blowing into conductor is a significant cause of outages during major storm events. The Resilience Investment Model calculates the vegetation density around each distribution overhead conductor. The model utilizes satellite tree canopy data to calculate the percentage of vegetation within the entire Hydro Ottawa system. The ± 6 meters on either side of the conductor is indicative of the vegetation density on the system from a major storm perspective. For each span of conductor (approximately 54,466) a vegetation density is assigned based on the vegetation density surrounding the conductor. This information is used to identify the portions of the system most likely to have an outage for each type of storm.

Figure 7-5 shows the range of vegetation density for OH Primary. The figure ranks the conductors from highest to lowest level of vegetation density. As shown in the figure, approximately 20 percent of the conductor spans (not weighted by length) for OH Primary have near zero tree canopy coverage, while approximately 60 to 70 percent have some level of coverage all the way up to 90 percent coverage.

Figure 7-5: Vegetation Density on Hydro Ottawa Primary Conductor

7.5 Age

As poles age, they lose some of their original design strength. Therefore, aged poles (all else equal) will fail at lower dynamic load levels than poles with their original design strength. The Resilience Investment Model utilizes 1898 & Co.'s asset management solution, AssetLens Solutions, to estimate the age based LOF for each wood pole and structure. 1898 & Co.'s AssetLens Solutions utilizes industry standard survivor curves with an asset class expected average service life and the asset's age to estimate the age based LOF over the next 10 years.

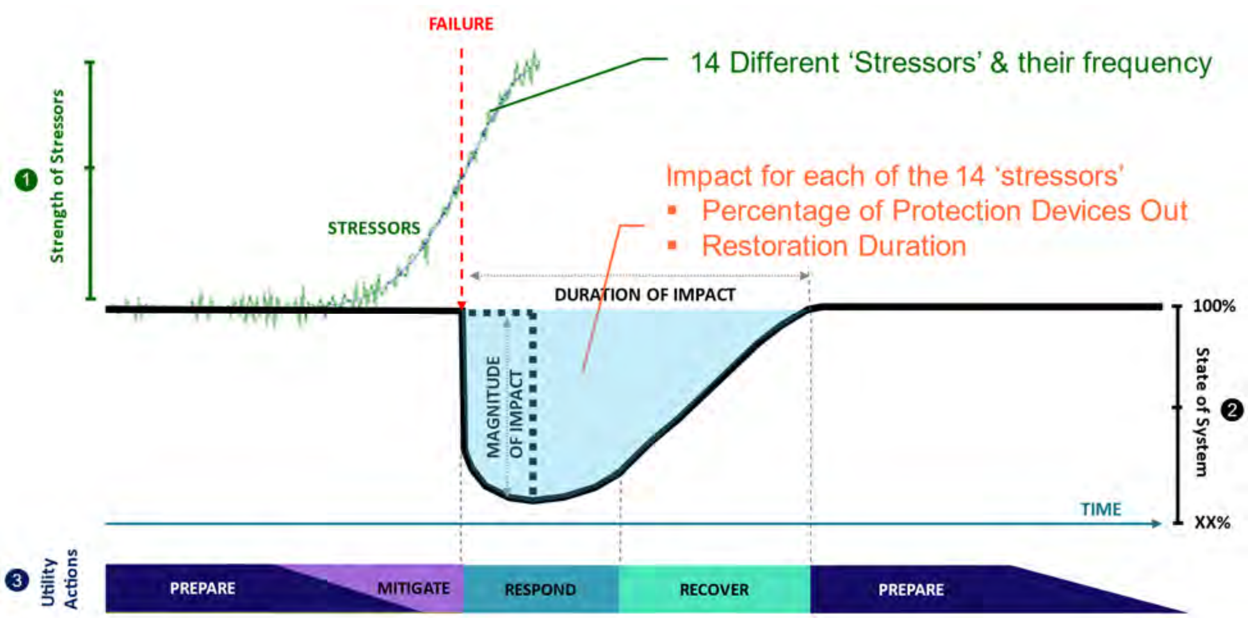
7.6 Accessibility

The accessibility of an asset has an impact on the duration of the outage and the cost to restore that part of the system. Rear lot structures take much longer to restore and cost more to restore than front lot structures. To take differences in accessibility into account, the Resilience Investment Model performs a geospatial analysis of each structure against a data set of roads. Structures within a certain distance of the road were designated as having roadside access; others were designated as in the deep right-of-way (ROW). This designation was used when calculating restoration and resilience project costs in the Resilience Investment Model. Approximately 73 percent of the Hydro Ottawa structures have road access while 27 percent are in the deep right-of-way.

8.0 MAJOR EVENT ('STRESSORS') DATABASE

The first component of the Resilience Investment Model is the Major Storms Event Database. The database includes the probabilities for each of the events as well as range of impacts to the distribution system while also outlining the duration and customers impacted. Figure 8-1 shows the Major Event Database within the Resilience Framework. The database outlines from a top-down perspective the type of events that impact the grid, their frequency, and high-level impact.

Figure 8-1: Resilience Framework & Major Events Database



This section describes the data sources and approach used to develop the database. Since the benefits of resilience projects are directly related to the frequency and impact of major storm events, the resilience-based planning approach starts with developing the range and frequency of storm types that could impact Hydro Ottawa's service area.

8.1 Event Database Evaluation

1898 & Co. reviewed several event data sources to determine the range of major events and the future frequency of events to impact the Hydro Ottawa service territory.

8.1.1 Event Database Review

The National Oceanic and Atmospheric Administration (NOAA) includes a database of major named-storm events over the past 170 years, beginning in 1852. The database includes Category 1 through 5 hurricanes, Tropical Storms, and Tropical Depressions. This database was mined to evaluate the different types and frequency of major storms to impact the Hydro Ottawa service area.

NOAA also includes a database of non-named major storm events over the past 26 years, beginning in 1996. The database includes the rain, wind and winter types of storm types organized by high-level and low-level types. Unlike the hurricane data that reports storm paths, these events are recorded at the county or sub-county level. 1898 & Co. mined this data for Saint Lawrence County in New York which was very close to the Hydro Ottawa service territory.

Additional relevant information is an update to the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019". Hydro Ottawa retained Stantec Consulting Ltd. (Stantec) to provide an independent third party assessment to better understand system risk posed by weather events. Within the report forecasts were developed based on both historical frequencies and also proposed climate change forecasts. This provides a basis for helping to develop a resilience strategy for two different risk tolerance levels. One with a 50 year forecast based on historical frequencies and one based on an independent climate change forecast. This can be helpful information to discern the appropriate level of investment as part of a resilience plan to appropriately mitigate resilience risks associated with weather events. 1898 & Co. utilized the study forecasts to understand storm types and frequencies that have the largest impact on the Hydro Ottawa service territory.

Hydro Ottawa's Outage database characterizes some outages as a Major Event Day (MED). The database also includes the duration, cause, date, and customer impact for each outage listed. 1898 & Co. mined this data for frequency and impact of major event days that impacted the Hydro Ottawa service territory.

8.1.2 Event Database Considerations and Selection

1898 & Co reviewed multiple weather event data sources as part of the evaluation. Each data set contained unique information pertaining to the frequency and strength of various weather events. However, after reviewing NOAA major named storms, non-named events, and the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan", 1898 & Co. determined the weather forecasts contained in the study provided the best basis for evaluating the business case for converting overhead sub-transmission and distribution lines to underground. While NOAA provided some regional insights, the data was not specific for Ottawa as the focus is generally contained to the United States. In contrast the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan" was commissioned by Hydro Ottawa and specific to Hydro Ottawa' service territory. Therefore, the alignment to the Hydro Ottawa outage data was better than other event data sources.

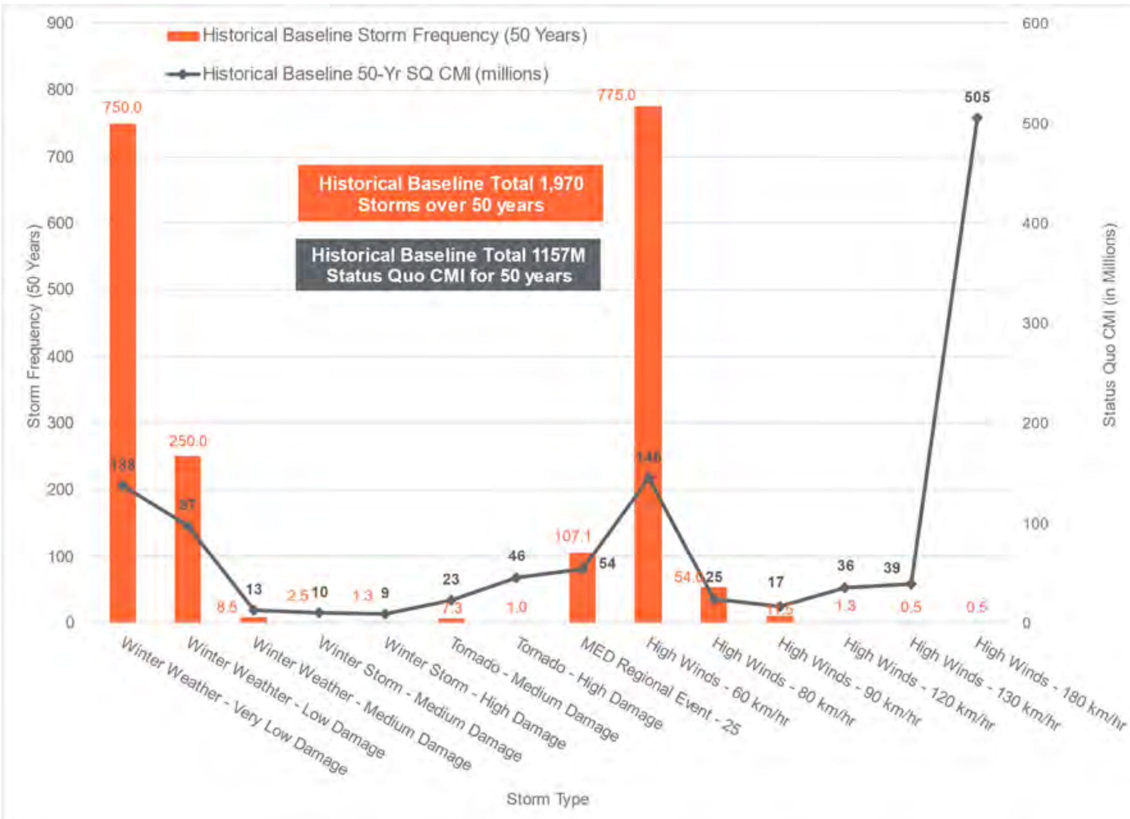
8.2 Major Event Forecast

One of the critical elements of the Major Event Database is the frequency and severity of the storms' impact on the system. As outlined in Section 8.1 the basis for frequency and severity comes from the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019". 1898 & Co. then did analysis for both the baseline historical and climate change forecasted frequencies in the evaluation.

8.2.1 Baseline Historical

Historical frequencies were put together by Stantec using external data sources as outlined in the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019". Figure 8-2 shows the frequency forecasted for each storm type over the next 50 years in orange and the status quo (SQ) CMI value for each storm type over the next 50 years in grey that was used in the Resilience Investment Model. The figure shows the storm with the highest CMI impact, High Winds – 180 km/hr, has some of the lowest frequencies in the next 50 years with a 50% chance of that size storm hitting in the next 50 years. While this is a high impact low probability event, 2022 demonstrated that the threat is credible and real.

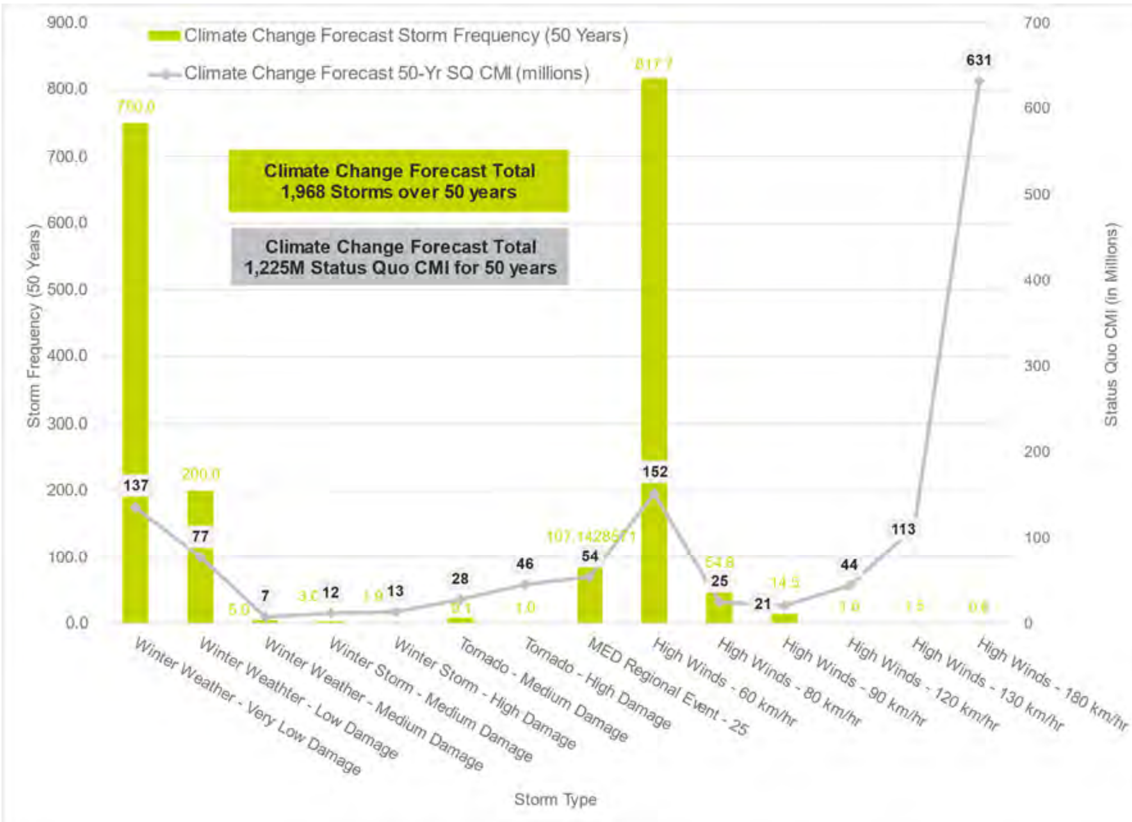
Figure 8-2: Baseline Historical 50 Year Storm Frequency and SQ CMI



8.2.2 Climate Change Forecast

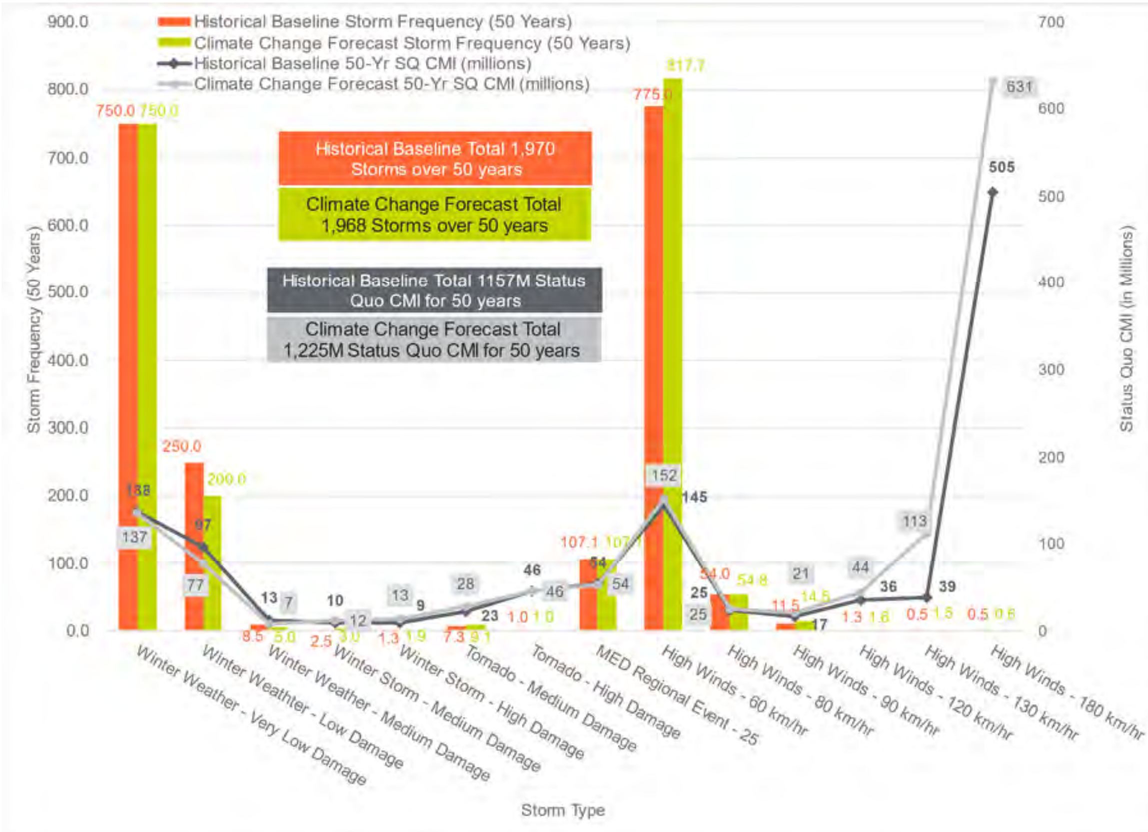
Climate change forecasted frequencies were put together by Stantec using external data sources as outlined in the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019". Figure 8-3, similar to Figure 8-2 for the baseline historical frequencies, shows the frequency of each storm type over the next 50 years in green and the status quo CMI value for each storm type over the next 50 years in light grey that was used in the Resilience Investment Model.

Figure 8-3: Climate Forecast 50 Year Storm Frequency and SQ CMI



The figure shows a very similar trend and outcome as seen in Figure 8-2 with the historical data. A comparison of the two forecasts is shown in Figure 8-4. In Figure 8-4 the estimated storms to hit in the next 50 years according to historical baseline is 1,970. According to the climate change forecast storm frequency, it is estimated to be less with 1,968 as the winter weather storms are on a slight downward trend. However, there is an estimated 68M CMI increase in the climate change forecast as higher impact storms are forecasted to be more frequent.

Figure 8-4: Baseline Historical 50 Year Storm Frequency and SQ CMI



8.3 Hardening Investment Types

In developing the types of hardening and resilience investments to include in the evaluation, 1898 & Co. leveraged the following:

- Current state of the Hydro Ottawa system and types of impact to customers based on operational experience.
- Balance of investment strategies to improve system resilience: resistance, absorptive capacity, and recoverability (see Section 4.3). Additionally, how various investment types would provide benefits on 'blue-sky' days.
- Types of events to impact the Hydro Ottawa service territory (see Section 8.0).
- Types of resilience investments other utilities within North America are making (see Section 5.0).
- Feedback from utilities on recent evaluation of recent major events.

Based on these items, Hydro Ottawa and 1898 & Co. identified the following investment types to include in the evaluation:

- Trunk / Backbone Hardening - converting overhead to underground. OH undergrounding for each protection zone is based on the level of vegetation density around the infrastructure.
- Lateral or Tap – converting overhead to underground. OH rebuilding or undergrounding for each protection zone is based on the level of vegetation density around the infrastructure and if the infrastructure has street access.
- Sub-Transmission Hardening - converting overhead to underground.

8.4 Major Events Database Overview

Table 8-1 shows the Major Events Database included within the Resilience Investment Model. The database includes 14 event types, the expected future annual frequency, and the impact of the event. The impact of the event is characterized by the percent of the sub-transmission, backbone, and lateral protection devices out and the duration to restore those devices. The database is sorted by the highest percentage of laterals protection devices out. It is based on the data sources and assessment described above.

Table 8-1: Major Events Database

Event No.	Major Event Type (Impact Level & Distance)	Annual Future Frequency (Historical Baseline)	Annual Future Frequency (Climate Forecast)	Percent of Protection Devices Out		Outage Duration (Minutes)	
				Backbone / Sub-T	Lateral	Backbone / Sub-T	Lateral
1	High Winds - 180 km/hr	0.01	0.01	28.39%	49.69%	13,500	17,190
2	High Winds - 130 km/hr	0.01	0.03	4.87%	9.30%	1,600	3,300
3	Tornado - High Damage	0.02	0.02	3.04%	5.17%	1,350	2,750
4	High Winds - 120 km/hr	0.03	0.03	1.81%	3.88%	1,350	2,750
5	Winter Storm - High Damage	0.03	0.04	0.23%	1.94%	1,350	2,750
6	Winter Storm - Medium Damage	0.05	0.06	0.13%	1.29%	1,400	3,000
7	High Winds - 90 km/hr	0.23	0.29	0.13%	1.29%	750	1,200
8	Winter Weather - Medium Damage	0.17	0.10	0.13%	1.29%	830	1,190
9	Tornado - Medium Damage	0.15	0.18	0.13%	1.29%	1,200	1,700
10	MED Regional Event - 25	2.00	2.00	0.06%	0.32%	830	1,190
11	High Winds - 80 km/hr	1.08	1.10	0.06%	0.26%	830	1,190
12	Winter Weather - Low Damage	5.00	4.00	0.06%	0.19%	500	1,400
13	High Winds - 60 km/hr	15.50	16.35	0.03%	0.13%	207	1,350
14	Winter Weather - Very Low Damage	15.00	15.00	0.03%	0.13%	165	1,315

9.0 INVESTMENT IDENTIFICATION & PRIORITIZATION MODULE

The Investment Identification and Prioritization Module develops the list of potential resilience projects, their costs, then prioritizes them based on the benefit cost ratio. The evaluation is comprehensive in evaluating nearly the entire system. Hardening investments are defined based on a customer-centric perspective at the protection zone level. The module also estimates the costs for each of the projects. The prioritization of each project is based on their benefit cost ratio. The results of the module are:

- Project scope and cost
  - Original pole count
  - Length of under grounding (km)
  - Estimated overhead to underground project cost (Can 2023$)
- Project Benefits
  - 50 year CMI reduction
  - Monetized CMI (50 year PV)
  - Restoration savings (50 year PV)

9.1 Evaluated System for Resilience Investment

The Resilience Investment Model is comprehensive in that it evaluates nearly all of Hydro Ottawa's overhead distribution system. Table 9-1 shows the asset types and counts included in the Resilience Investment Model.

Table 9-1: Hydro Ottawa Asset Base Modeled

Asset Type	Units	Value
Sub-Transmission Circuits	[count]	72
Poles / Structures	[count]	3,387
Conductor Length	[kilometers]	312.5
Distribution Circuits (OH)	[count]	203
Feeder Poles	[count]	20,916
Lateral Poles	[count]	14,577
Feeder OH Primary	[kilometers]	1,178
Lateral OH Primary	[kilometers]	644

9.1.1 Distribution Projects Identification

For distribution projects, assets were grouped by their most upstream protection device, which was either a breaker, recloser, or a fuse. This approach focuses on reducing customer outages. The objective is to harden each asset that could fail and cause a customer outage. Since only one asset needs to fail downstream of a protection device to cause a customer outage, failure to harden all the necessary assets still leaves vulnerable components that could potentially fail in an event and result in an outage. Rolling assets into projects at the protection device level allows for hardening of all vulnerable components in the circuit and for capturing the full benefit for customers including avoidance or mitigation of an outage.

For distribution circuit projects (laterals and feeders), undergrounding was the hardening option considered. Overhead hardening rebuilds are generally lower cost than undergrounding projects, but they generally provide fewer resilience benefits than undergrounding since the hardened overhead infrastructure is still exposed to wind and debris from vegetation and other materials.

9.1.2 Sub-Transmission Project Identification

The 44 kV and 13 kV sub-transmission circuits primarily supply distribution substations and large customers. Sub-Transmission circuits behave more like transmission than distribution since they are often looped and built with redundancy. However, very damaging events like very high damage thunderstorms and named storms cause enough damage to several circuits leaving 10,000+ customers without power. Due to the looped nature of the sub-transmission system, rebuilding smaller protection zones is not an option, and the entire sub-transmission circuit must be considered for resilience hardening.

9.1.3 Potential Resilience Projects Evaluated

Table 9-2 contains a list of potential resilience projects based on the methodology outlined above. Section 9.3 outlines the approach to selecting the resilience projects that provide the most value to customers from a perspective of reducing both restoration cost and CMI.

Table 9-2: Potential Resilience Projects Included in Evaluation

Count	Program	Project Count
1	Backbone OH to UG	324
2	Lateral OH to UG	1,338
3	Sub-Transmission OH to UG	81
	Total	1,743

For the resilience evaluation, 1898 & Co. evaluated each protection zone as independent from others. In other words, 1898 & Co. assumed each electrically connected protection zone was not physically connected to another protection zone on shared structures. Given the complexities of shared infrastructure within the GIS models, this simplifying assumption was made.

9.2 Project Cost

Project costs were estimated for the projects in the Resilience Investment Model. Project costs were estimated using the asset level data within the Resilience Investment Model to estimate scope (length and project type: lateral, backbone, sub-transmission) and then multiplying by unit cost estimates to calculate the project costs. See Table 9-3 for the estimates used per kilometer for lateral, backbone, and sub-transmission.

For each project, Hydro Ottawa's GIS data was used to determine the length of overhead conductor to be converted to underground, and additional GIS analysis determined adjustments that were made for downtown circuits and protection zones that were in the deep right of way.

Table 9-3: Hydro Ottawa Unit Costs

Project Type	Voltage	Cost per Kilometer
Lateral	All voltages	$718,000
Backbone	8kV, 12kV, and 28kV	$1,259,000
Backbone	13kV	$935,000
Backbone	13kv - Downtown	$1,485,000
Sub-Transmission	44kV	$1,459,000

9.3 Project Prioritization

For each of the projects outlined in Table 9-2, 1898 & Co. estimated a 50 year present value benefit. The benefits are based on a 50 year forecast of both likelihood of failure (LOF) and consequence of failure (COF) for each of the storm types. The calculation is done at the potential resilience project level, estimating the likelihood and consequence of failure of the existing infrastructure in the project during an event.

9.3.1 Likelihood of Failure (LOF)

Based on the event types and resilience upgrades 1898 & Co. developed a framework to estimate each asset's likelihood of failing during the events. The LOF values are based on the drivers of failure. Often the wind speeds can cause vegetation outside the typical trim zone to come into contact with the overhead lines. For more minor events, the consequence is simply vegetation coming into contact with electrical lines causing the protection device to lock out. Very little infrastructure may need to be replaced. For more major events, the dynamic loading of the vegetation in the lines and wind against the wires and structure can cause the structure top or structure to fail. These failures can be costly to fix. Compromised structure or older assets are more likely to fail given their internal strength is weakened.

Since vegetation and structure age / condition are the main drivers of what would cause infrastructure to fail given an event, the overhead infrastructure LOF is based on the vegetation density around the infrastructure and the age based remaining life of the asset. As described in Section 7.4, 1898 & Co estimated the vegetation density for each span of conductor in Hydro Ottawa's system. Additionally, as described in Section 7.5, 1898 & Co. estimated the age based LOF for each structure based on end-of-life curve and expected remaining life. The combination of these factors is the LOF for each overhead asset.

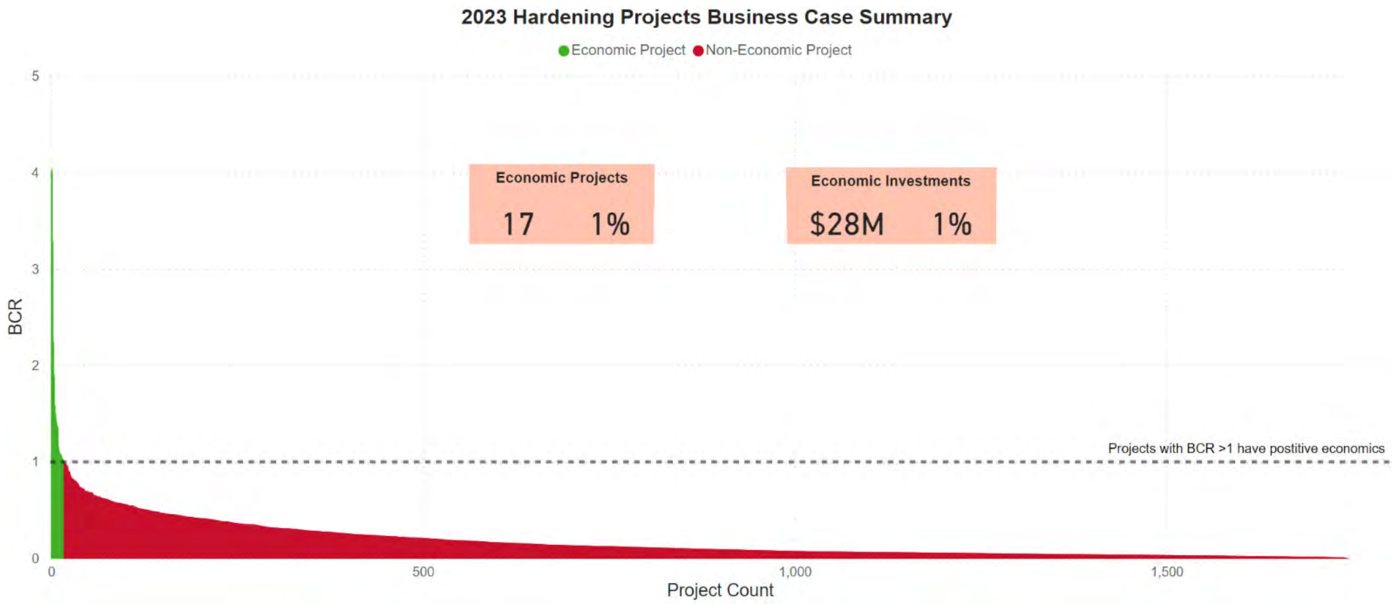
9.3.2 Consequence of Failure (COF)

The consequence of failure for each overhead asset is based on their downstream customers. As described in Section 7.3, 1898 & Co. linked each asset to their downstream customer count and type. The consequence of each asset is based on the monetization of the outage duration based on the customer outage from the DOE ICE Calculator (see Section 6.2) for the customers impacted should that asset fail.

9.3.3 Resilience Prioritization

The resilience projects are prioritized based on the benefit cost ratio of each potential project. Figure 9-1 shows the resulting project resilience ranking, BCR per project cost, for all potential projects included in the evaluation with a historical baseline storm forecast.

Figure 9-1: **Project Resilience Ranking by BCR for Historical Baseline Storm Forecast**



As the figure shows approximately 1 percent of the projects evaluated show a resilience benefit cost ratio value of more than one. This metric is used to identify the most vulnerable parts of the system that yield the greatest return per dollar spent.

Figure 9-2 shows the resulting project resilience ranking, BCR per project cost, for all potential projects included in the evaluation with climate change storm forecast.

Figure 9-2: **Project Resilience Ranking by BCR for Climate Change Forecast**

As the figure shows approximately 1 percent of the projects evaluated show a resilience benefit cost ratio value of more than one. This metric is used to identify the most vulnerable parts of the system that yield the greatest return per dollar spent.

These results are based on a 60 year time horizon with 2.0% escalation and a discount rate of 6.0%. The business case for each project is a sum of the avoided reactive costs and avoided monetized customer outages for each of the events within the Major Events Database. The output of the Resilience Business Case Module is:

- Resilience Business Case for highest resilience improvement projects
  - Project Cost and High Level Scope
  - Life-Cycle Net Present Value (NPV) Benefits
  - Benefit to Cost Ratio (BCR)

10.0 RESULTS & CONCLUSIONS

Hydro Ottawa and 1898 & Co. utilized a resilience-based planning approach to identify, prioritize, and justify resilience investments in Hydro Ottawa's distribution system. Project benefits are shown in terms of the:

1. Decrease in the Storm Restoration Costs
2. Decrease in the customers impacted and the duration of the overall outage, calculated as CMI.

Additionally, the results are presented assuming monetization of the CMI using the DOE ICE Calculator, modified for resilience. The ICE Calculator is discussed in Section 6.2. The monetization of the CMI in conjunction with the storm restoration costs allows for the calculation of a benefit cost ratio for each potential overhead to underground project.

10.1 Resilience Business Case Results for Beneficial Projects

The Resilience Investment Model calculates the Resilience Benefit Cost Ratio for each potential overhead to underground project. The Resilience BCR is the sum of the present value of avoided restoration costs and the present value of the monetized avoided customer outages divided by the project cost. Table 10-1 shows the summary business case results for resilience investments within Hydro Ottawa's system with a resilience benefit to cost ratio greater than or equal to 1. The table shows:

- There is significant opportunity to improve the resilience of Hydro Ottawa's grid for the benefit of customers with strategic projects that have quantified benefits that outweigh the costs.
  - Approximately $27.5 million in total investment when using historical baseline forecasts and approximately $57.3 million in total investment when using climate change forecasts
  - A range between 12.6 – 28.4 kilometers of resilience overhead to underground investment, depending on the scenario being evaluated.

  - For both the historical forecast scenario and climate change forecast, over 15 potential projects were identified where benefits outweigh their costs, note 1898 & Co. organized Hydro Ottawa system into over a thousand projects that were evaluated within the Resilience Investment Model.
- Each of the programs have robust business cases results with benefit to cost ratios in the range of 1.0 to 4.03 with an average of 1.60 based on the historical forecast scenario. Similarly, for the climate change forecast scenario, the benefit to cost ratios range is 1.0 to 4.78 with an average of 1.66.
- Most of the benefits come from the monetized avoided customer outages benefit. This is an alignment for the main case for resilience investment, the integration of the modern customer and integrated society and major events.
- Avoided restoration costs cover approximately 6 percent of the resilience investment level, the remaining benefit stream to cover the resilience investment is the monetization of customer outages.

It is expected that any initial resilience plan budget would be based on a subset of the provided list. Each project was evaluated based on appropriate planning assumptions, however, upon detailed review and walkdowns, Hydro Ottawa may discover technical challenges that dramatically impact the business case of a project. For instance, Hydro Ottawa may discover that underground rock conditions are much worse than anticipated or easement costs or other costs will be much higher than planned. These discovered challenges would cause the project cost to increase significantly. In this situation, Hydro Ottawa would swap out the project for another from the provided Excel project list. It should be noted that the projects in the table can be filtered such that the quantified benefits are equal to or greater than the costs (BCR ≥ 1).

Table 10-1: Historical Baseline Resilience Business Case Summary Results

Program	Project Count	Length (km)	Avoided $CMI Benefit ($000)	Avoided Restoration Cost Benefit ($000)	Total Avoided Cost Benefit ($000)	Resilience Investment ($000)	Benefit to Cost Ratio (BCR)
Backbone OH to UG	3	3.34	$7.6	$0.27	$7.6	$6.6	1.15
Lateral OH to UG	13	6.82	$26.7	$1.9	$28.6	$16.4	1.75
Sub-Transmission OH to UG	1	2.47	$4.7	$0.3	$5.0	$4.6	1.10
Total	**17**	**12.64**	**$38.7**	**$2.5**	**$41.2**	**$27.5**	**1.50**

Table 10-2: Climate Change Forecast Resilience Business Case Summary Results

Program	Project Count	Length (km)	Avoided $CMI Benefit ($000)	Avoided Restoration Cost Benefit ($000)	Total Avoided Cost Benefit ($000)	Resilience Investment ($000)	Benefit to Cost Ratio (BCR)
Backbone OH to UG	3	3.34	$9.2	$0.27	$9.5	$6.6	1.43
Lateral OH to UG	18	8.93	$37.9	$2.3	$40.2	$22.0	1.83
Sub-Transmission OH to UG	5	16.11	$31.8	$3.1	$34.9	$28.7	1.22
Total	**26**	**28.38**	**$78.9**	**$5.7**	**$84.6**	**$57.3**	**1.48**

10.2 Conclusions

The following include the conclusions of this resilience evaluation for Hydro Ottawa:

- The resilience of the grid is becoming increasingly important. The case for selective overhead to underground resilience investment is sound for Hydro Ottawa; resilience is at the cross section of major events, the modern customer and integrated society. The impact of major events to today's customer and society are much greater than in the past. Much of this is due to:
  - Number of critical customers
  - Number of people working from home
  - Aging in place
  - Electrification and Decarbonization
  - Integrated society

  Major grid disruptions due to major events now cause real economic harm to customers, increases customer stress levels, and puts societies' most vulnerable at risk to life. This is evident from recent events in 2022. Proactive investment today and over the next decade is needed to mitigate the impact of these events. With the expectation of an even more integrated and connected society with electrification and decarbonization causing greater reliance on electricity in the Ottawa area, the resilience of the grid becomes increasingly important. Additionally, the case for resilience effectively mitigates reactive costs and safety risks.
- There is opportunity to improve the resilience of Hydro Ottawa's grid for the benefit of customers over the long-term with strategic overhead to underground projects that have quantified benefits that outweigh the costs.
  - Approximately fifty million in total investment that will benefit customers.
  - Over Twelve km of resilience circuit investment.
  - 17-26 of potential beneficial overhead to underground projects.
- The development of a Resilience Investment Strategy using the Resilience Investment Model results provides confidence to Hydro Ottawa grid stakeholders. The model provides confidence for the following reasons:

- **Event-Based –** each project is evaluated against its event performance for 14 different weather events types that are based in the historical record and also climate forecasts with similar conclusions.
- **Asset and Root-Caused Focused –** each project includes the relationship to their underlying assets. Asset likelihood of failures are based on the assets age and surrounding vegetation.
- **Data-Centric** – the model utilizes Hydro Ottawa's GIS, OMS, CIS, distribution circuit models, and critical customer information.
- **Customer-Centric** – the model links each asset to the impacted customer count and type.
- **Granular -** the granularity at the asset and project levels allows Hydro Ottawa to invest in portions of the system that provide the most value to customers from both a restoration cost reduction and avoided CMI perspective.
- **Comprehensive -** The approach is comprehensive and evaluates nearly all of the assets on Hydro Ottawa's overhead distribution systems.
- **Business Case Foundations** - The output of the model is the life-cycle resilience benefit and benefit cost ratio in financial terms.
- **Consistency**: The model calculates benefits consistently for all potential projects.
- **Drives Prudency**: The assessment and modeling approach drives prudency for the comprehensive overhead to underground hardening evaluation on two main levels. First, the granularity of potential resilience projects allows Hydro Ottawa to target investment in the portions of the system that provide the most value to customers. Secondly, the customer-centric financial justification of project investments allows Hydro Ottawa to prioritize investments that provide significant customer 'bang for buck'.

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FINAL REPORT

HYDRO OTTAWA DECARBONIZATION STUDY

Prepared by Black & Veatch

PREPARED FOR

Hydro Ottawa

15 OCTOBER 2024

BLACK & VEATCH

Disclaimer

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1.0 Executive Summary

1.1 REPORT BACKGROUND AND OBJECTIVES

In June 2021, the Canadian Net-Zero Emissions Accountability Act became law and codified the country's commitment to Net Zero Emissions by 2050 in alignment with the Paris Agreement. The City of Ottawa has made a similar commitment with interim emissions reductions targets in the near-, mid-, and long-term. These goals will have far-reaching implications for the energy sector, particularly for the infrastructure, assets, and systems of utilities.

Hydro Ottawa Limited (HOL), the primary electric distribution utility for the City of Ottawa, has prioritized and is embarking on an important initiative to evaluate the complex impacts of these decarbonization policies on their distribution system. HOL engaged with Black & Veatch to explore the implications of decarbonization initiatives and the relative impact of decarbonization-driven electrification on future load and the HOL distribution system. The results of this study are provided in this comprehensive narrative final report. While broader decarbonization-driven impacts are expected, this study specifically and intentionally does not explore changes in the electricity generation mix or downstream customer impacts.

More specifically, this study examines the changes in load curves resulting from decarbonization-driven electrification of buildings and transportation between 2024 and 2050. Decarbonization load projections, rough-order-of magnitude (ROM) capital costs, and insights from this study are provided to inform how Hydro Ottawa's distribution assets could change to serve these increasing and evolving load requirements.

This report provides a directional overview of when and where new infrastructure investment will be required, the forecasted impact of electrification on the resiliency of the HOL grid, and the role of non-wires solutions (NWS) to maintain reliability and resiliency of HOL-owned assets. This report summarizes the methodology and results of this study, including key policy drivers and uncertainties that should be considered in future-looking assessments. This study and results summarized herein were guided by the following objectives:

1. Evaluation and understanding of the main variables impacting electrification in the HOL service territory.
2. Evaluation of the impact of the future decarbonized load projections on the HOL distribution system.
3. Consideration of the NWS that may be leveraged in the short-, mid-, and long-term to defer traditional wires upgrades.
4. Development of directional ROM investments for the necessary NWS and traditional wires upgrades forecasted to maintain reliability on the HOL grid.

Decarbonization In Ottawa: Policy Context and Trends

Electrification is expected to dramatically increase across the globe as end-users, utilities, and corporations transition from carbon-intensive fuels such as oil, diesel, and natural gas to low carbon solutions. As interim decarbonization targets quickly approach, distribution utilities like HOL need to be prepared to fully plan for the dramatic increases of electricity needs on their system.

It is well documented that global temperatures are increasing, and Canada is no exception to this global increase. According to Canada's Changing Climate Report, Canada is warming at double the rate of the rest of the world.[1] The Canadian government has taken serious strides to ensure that their global emissions impact actively declines. As an example, the Canadian Net-Zero Emissions Accountability Act sets a legally binding target for Canada to achieve net-zero greenhouse gas emissions by 2050, which means that any remaining emissions would need to be balanced by removing an equivalent amount of emissions from the atmosphere. The Act also requires the Canadian government to set interim emissions reduction targets for 2030, 2035, and 2040, and to report on progress towards these targets every five years.[2]

Similarly, the Greenhouse Gas Pollution Pricing Act imposes a federal price on carbon pollution, incentivizing the adoption of low carbon energy sources and electrification.[3] The 2030 Emission Reduction Plan complements these efforts by promoting electric vehicle adoption and setting targets for zero-emission vehicle sales. Ottawa's Climate Change Master Plan further outlines strategies for emission reduction and resilience building. Together, these policies strive to expedite the transition to a low carbon economy, foster renewable energy uptake, and address the impacts of climate change in Ottawa and throughout Canada.

An increase in electricity demand across Canada and in Ottawa can further be expected in part due to the incentives outlined in the 2030 Emission Reduction Plan. This plan aims to facilitate the transition to electric vehicles by allocating $900 million CAD towards the installation of an additional 50,000 Zero-Emission Vehicle chargers nationwide.[2] Moreover, the Canadian government is providing $1.7 billion CAD to extend incentives for the Zero-Emission Vehicles (iZEV) Program, making it more affordable and convenient for Canadians to purchase and operate new electric light-duty vehicles.[2]

The goal of the iZEV funding is to ensure that, by 2026, at least 20% of new light-duty vehicle sales will be zero-emission vehicles, with at least 60% by 2030, and 100% by 2035. It is important to note that the medium- and heavy-duty vehicle (MHDV) market will also be affected, as the Government intends to develop an MHDV ZEV regulation requiring 100% of MHDV sales to be ZEVs by 2040 for a subset of vehicle types. [2]

The City of Ottawa, in addition to aligning with the required Canadian Net-Zero Emissions Accountability Act, has also aligned with the Intergovernmental Panel on Climate Change (IPCC). Through new short-, mid-, and long-term targets, the Canadian capital intends to reduce both community and corporate

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[1] Canada Changing Climate Report, 2019.
[2] Canada's 2030 Emissions Reduction Plan targets reducing emissions by 40-45% from 2005 levels. The 2030 plan was public in March of 2022, building on the existing 2020 climate plan, and the Pan-Canadian Framework from 2016.
[3] Greenhouse Gas Pollution Pricing Act, 2019.

emissions by 100% by 2050 and 2040, respectively.[4] This decarbonization of buildings and vehicles will undoubtedly impact the demand on HOL's distribution grid, potentially necessitating upgrades or even new wire networks to supply power to locations across the city.

In continuation of the plans and investment areas stated in the larger 2021 Canadian Net-Zero Emissions Accountability Act and the 2030 Emission Reduction Plan, the City of Ottawa's Climate Change Master Plan lays out the city's objectives for both its corporate and residential residents. The City of Ottawa's Climate Change Master Plan includes eight priority action areas to achieve its ambitious net-zero emissions target. These areas will impact the energy market, reliability, resiliency, and electrification within Ottawa. The plan includes initiatives such as implementing a Community Energy Transition Strategy, applying a climate lens to asset management and capital projects, exploring carbon sequestration methods, and developing a governance framework for tackling climate change.

These strategies and initiatives have already resulted in significant energy savings, with conservation initiatives creating an estimated cumulative annual utility savings of approximately 5.9 million kWh of electricity, 297,909 m^3 of natural gas, and 48,662 m^3 of water.[4] As the city continues to implement these strategies and invest in energy-saving projects, it will help reduce the total load of carbon emissions generated by current development, leading to a more sustainable and electrified future.

Canada's policies and regulations demonstrate a proactive approach to combating climate change and promoting sustainability. The Canadian Net-Zero Emissions Accountability Act, Greenhouse Gas Pollution Pricing Act, and 2030 Emission Reduction Plan in particular incentivize decarbonization and renewable energy sources. These legislative frameworks, coupled with Ottawa's Climate Change Master Plan, outline a comprehensive approach to address climate challenges, promote electrification, and enhance resilience.

By embracing these measures, critical stakeholders like HOL can adapt to evolving regulatory landscapes through forward-looking decarbonization studies like this one to ensure their organizations are prepared for the expected shifts in demand from decarbonization-driven electrification.

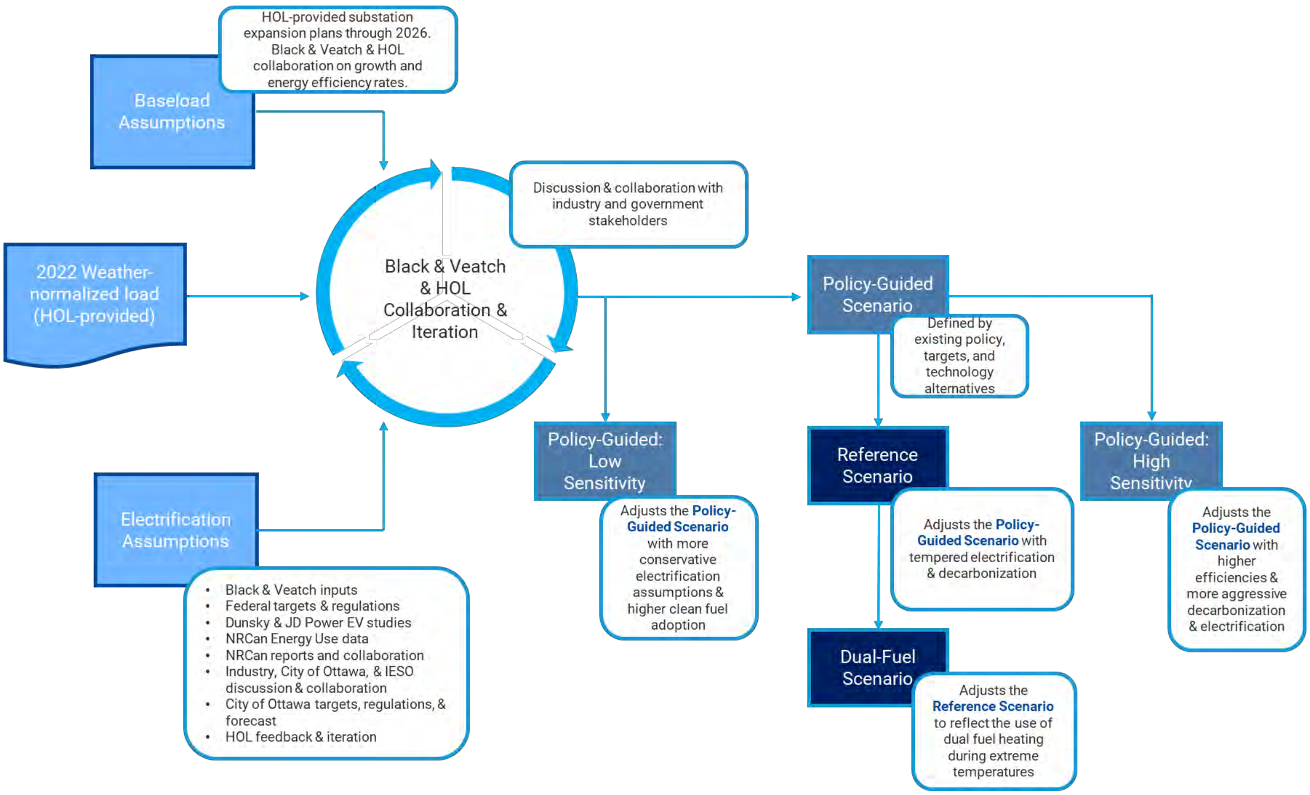
1.2 SUMMARY METHODOLOGY & APPROACH

To accomplish these objectives, HOL and Black & Veatch leveraged a scenario-based approach to model a future decarbonized system load. The team considered known policy drivers and trends, reviewed and examined existing decarbonization and emissions reduction studies, and leveraged subject matter expertise to forecast and evaluate the impact of decarbonization initiatives on the HOL service territory and distribution system.[5] Black & Veatch and HOL reviewed these assumptions on an ongoing basis with external stakeholders to ensure transparency in the assumptions development process and also to ensure

[4] Ottawa Climate Change Master Plan, 2020.
[5] Section 5: References provides an extensive list of public studies and resources reviewed in this assessment. The Electrification and Energy Transition Panel report titled "Ontario's Clean Energy Opportunities" was published after study assumptions were finalized. However, it is not expected that findings from that report would significantly alter assumptions used in this study.

input in a robust and thoughtful assumptions set. An overview of the study methodology approach is provided in Figure 1.

Figure 1. Study Summary Methodology and Approach



Once a primary base decarbonization load projection (referenced throughout this report as the Policy-Guided Scenario) had been completed, observed trends in load growth and electrification were paired with short-term planning projections to create a “most-likely” Reference Scenario. Two alternative decarbonization scenario load projections were modeled in addition to two sensitivities to capture a full range of plausible outcomes. Each load projection was evaluated through the lens of a possible decarbonized future in Ottawa and what that means for the HOL service territory. Further detail on the development of load projection scenarios can be found in Section 2.2.

This study explores the impact of decarbonization-driven load increases on HOL assets. Focusing on the Reference Scenario, it evaluates the opportunity of NWS as a mitigation strategy when compared to traditional infrastructure upgrades. Once the decarbonization load was projected, a mitigation strategy to manage increases in load was developed in two steps:

(1) an overload analysis to determine which substations are overloaded on an hourly basis; and

(2) review of strategies to manage the overload conditions at specific substations. Overload strategies consistent of either wires only upgrades at each substation or NWS at each substation.

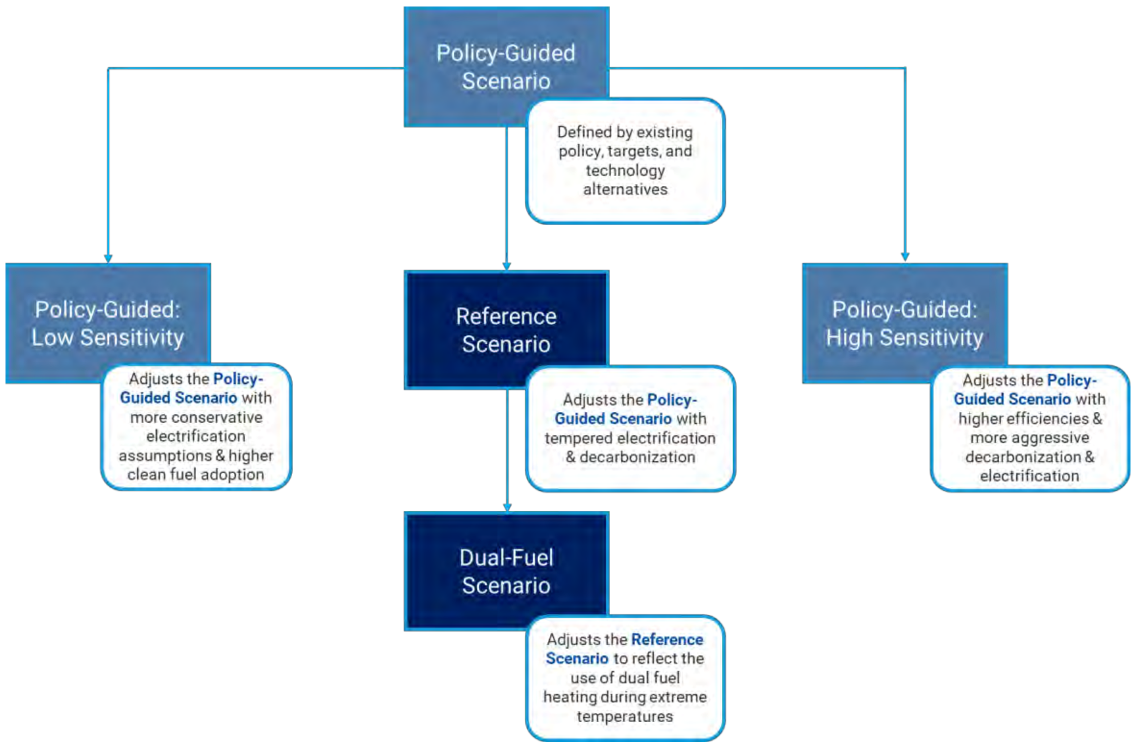
Once the potential for NWS was evaluated, an analysis was conducted to determine the optimal system upgrade solutions based on cost, safety, reliability, resiliency, and environmental factors. The overload analysis was done for the years 2035 and 2050. These two years were selected as 2035 would indicate a lower, but more certain load case in the short term, where the 2050 load case would indicate a higher, but more uncertain load case in the long run. These two cases are used to set lower and upper bounds for needed investments to address the new load profiles on the distribution system. Further detail on this analysis can be found in Section 3.2 in the main narrative of this report.

1.3 KEY FINDINGS

Decarbonization Load Projections

As with any projections, uncertainties around the rate of decarbonization-driven electrification, new technology adoption, technology cost variables, supply chain considerations, and changing political dynamics impact how electrification will change between now and 2050. Given these variations, this study leveraged a scenario-based approach in which one primary Reference Scenario was modeled and evaluated, with two alternative decarbonization scenarios complemented by two sensitivities. The primary and alternative scenarios, as well as the sensitivities, are characterized below.[6,7] The relationship between each projected scenario and sensitivity is shown in Figure 2.

Figure 2. Load Projection Scenario & Sensitivity High-Level Relationship & Descriptions



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6 A deep dive into each scenario is provide in Sections 2.2 and 2.3.

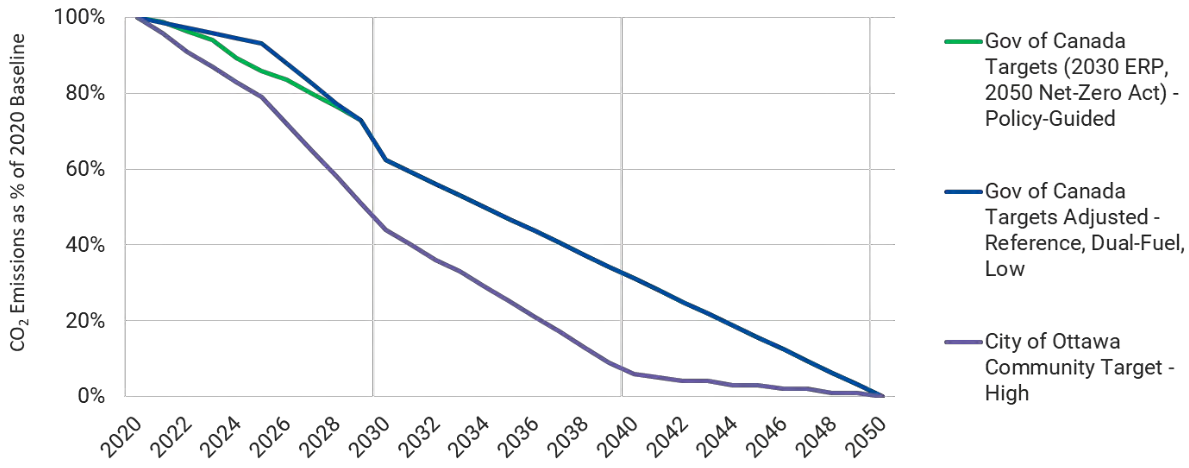
7 Detailed findings in this report focus primarily on the three scenarios rather than the sensitivities, consistent with project scope and alignment with internal HOL forecasts.

Leveraging inputs from ongoing decarbonization trends, existing policy, other published reports and subject matter expertise, the final scenarios and sensitivities evaluated are described in greater detail below.

- The **Policy-Guided Scenario**: characterized by strict adherence to Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. This scenario is defined by existing policy, targets, and technology alternatives. All future scenarios and sensitivities were adjusted off this baseline scenario.
- The **Reference Scenario**: encapsulates the most likely scenario based on observed HOL load projection trends, electrification adoption trends, and subject matter expertise. These inputs position this scenario with tempered electrification in the short-term, as optimal to inform short- to mid-term investments required to maintain reliability on the HOL distribution power grid. For example, peak load on HOL's system has remained mostly flat for the past 15 years with a maximum of 1,518 MW in 2010, a minimum of 1,308 MW in 2014, and a most recent peak of 1,348 MW in 2022. In the mid- to long- term, this scenario assumes increasing policy-driven electrification.
- The **Dual-Fuel Scenario**: applies a space heating and water heating sensitivity during extreme temperatures to the Reference Scenario.
- The **High Case Sensitivity**: provides a sensitivity on more aggressive decarbonization and electrification than the Policy-Guided Scenario.
- The **Low Case Sensitivity**: provides a sensitivity on less aggressive decarbonization and electrification than the Policy-Guided Scenario.

The scenarios evaluated in this study explore different rates of decarbonization in the HOL service territory informed from three primary sources. The Policy-Guided Scenario in this assessment leveraged the Government of Canada's stated goals in the 2030 Emissions Reduction Plan and 2050 Net-Zero Act, which target a 40% reduction in emissions by 2030 and net-zero emissions by 2050. The Reference and Dual-Fuel Scenarios, reflect a decarbonization curve adjusted from federal targets to capture short-term trends observed in HOL service territory. This adjusted curve still meets federal targets albeit at a slower pace in the next 3-5 years before ramping up ahead of the 2030 target date. These targets were used to inform the emissions targets and rates of electrification among each scenario. A comparison of these decarbonization targets is provided in Figure 3.

Figure 3. Scenario Decarbonization Targets



Decarbonization levers were adjusted within each scenario and sensitivity to further inform scenario decarbonization load projections. Decarbonization levers are defined in this study as the primary key inputs and assumptions that inform efficiency and volume of load impact. Though not every single driver of load change is included in the high-level summary below, this study identified these levers as having the highest impact on decarbonization load projections for HOL.[8] Section 2.1 Methodology & Assumptions outlines the following levers in much greater detail:[9]

- HOL service territory population growth
- Energy efficiency assumptions
- Electric vehicles adoption, efficiency, and charging assumptions
- Residential, commercial, and federal building heating and cooling assumptions; technologies and efficiencies
- The future role of low carbon fuels and natural gas
- Adoption and generation from distributed photovoltaics (PV)

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[8] Black & Veatch understands that there are numerous other assumptions that could be considered for the purposes of this analysis. The assumption categories provided above were identified as the most impactful and necessary to complete this scope of work.

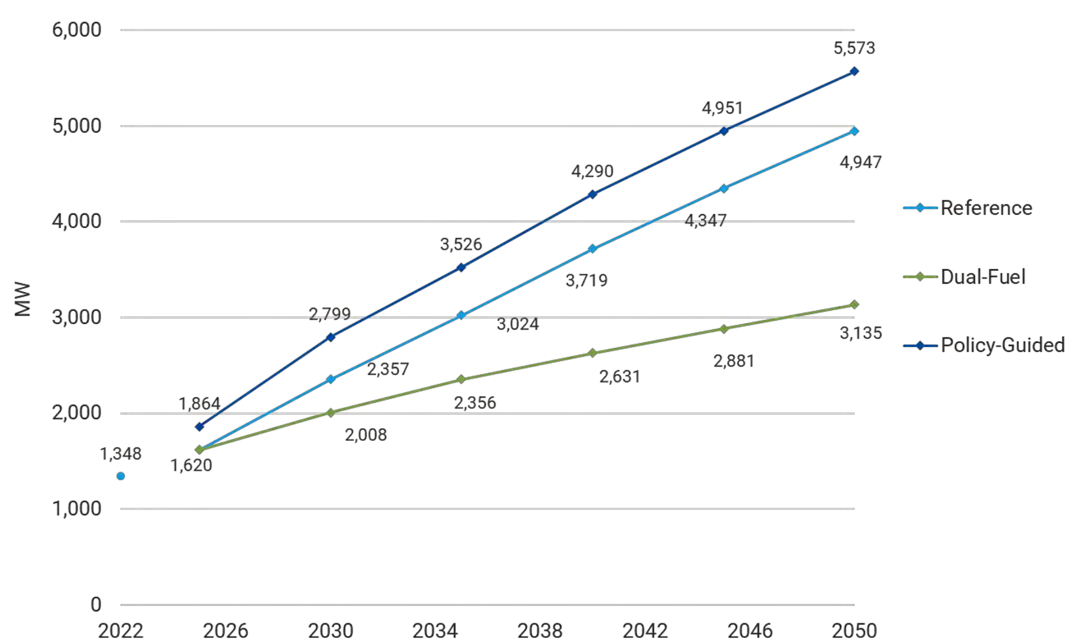
[9] Of important note, this study does not explore or evaluate changes in electric generation portfolios in Canada or Ottawa, or the impacts of decarbonization from the perspective of electric generation. Further this study did not explore the future of natural gas in Canada nor the Hydro Ottawa service territory. Both are outside of the scope of this study.

Figure 4 provides a peak demand comparison of the decarbonization scenarios modeled. In 2022, HOL's weather-normalized peak reached 1,348 MW.[10]

- The Reference Scenario projected a 2050 peak of 4,947 MW, 267% higher than the 2022 HOL weather normalized peak. Decarbonization-driven electrification, particularly associated with heating electrification assumptions drove this load increase.
- The Policy-Guided Scenario was developed to capture the impact of full electrification in meeting decarbonization goals without any load mitigation measures, resulting in a projected peak of 5,573 MW in 2050, or a 313% increase from 2022.
- The Dual-Fuel Scenario represents a future where gas (assumed to be low carbon) continues to provide a portion of space heating needs, especially in extreme cold temperatures. Even with this prevalence of dual-fuel heating systems, peak demand grows by 133% to 3,135 MW in 2050.

In each of these three scenarios, HOL would expect significant impacts to their distribution system and parallel investment needed to maintain reliability and resiliency.

Figure 4. Decarbonization Scenario Peak Demand Comparison of Primary Scenarios



Distribution System Impact Assessment

As part of this study, Black & Veatch evaluated different wires and NWS to ensure that substations facing future overload conditions could meet the required demand. The purpose of this assessment was twofold:

[10] At the time of this study, 2022 load data was the most current available.

(1) to evaluate the directional costs of a wires only solutions scenario to meet project load growth in the Reference Scenario, and

(2) to identify the system-wide combination of wires and NWS that could provide a lower system-wide cost.

Two primary overload solutions scenarios were developed to compare the system-wide cost over both study horizons described above: a wires only solution scenario and a cost optimized solutions scenario. These two primary solution scenarios were developed to inform future detailed feasibility studies in which HOL can use to determine the highest priority substations to upgrade and solutions in which should be considered. The primary solution scenarios are defined as follows:

- The Wires Only Solution Scenario – This scenario assumes that only traditional wires solutions are considered to addressed substation overload conditions. Wires only solutions include upgrades to existing substations and/or the addition of new substations.
- The Cost Optimized Solutions Scenario – This final scenario considered the lowest cost option to each qualified overloaded substation to determine the lowest system-wide rough order of magnitude (ROM) cost assumptions over the horizon. This scenario leverages a mix of wires, Battery Energy Storage Systems (BESS) (if feasible), and reciprocating engines (RECIPs) to address substation overloads.

To account for uncertainty of the decarbonization load projection and limitations of the system model used to determine station overload conditions, each scenario was evaluated at two different years and two different load transfer conditions for a total of four investment model sensitivities. First, each scenario was evaluated using the decarbonization load projection of 2035 and the decarbonization load projection of 2050; 2035 provides a lower but more certain load projection, and 2050 provides a higher but less certain load projection. Then, within each year, the potential to transfer the load to another substation is evaluated. The combined result is four different investment profiles for each scenario. The year 2035 with all potential load transfers assumed to be possible provides the lowest bound of investment required, and the year 2050 load projection with none of the potential load transfers assumed to be possible provided the upper bound of investment required.

In order to develop the cost optimized solutions scenario, two NWS technology assessments were completed: a wires and BESS solution assessment and a RECIP solution assessment. The outcomes of these two assessments, combined with the wires only solutions scenario, directly informed the development of the cost-optimized scenario. The two NWS technology assessments are described below.

- Wires + BESS Solution Technology Assessment – This assessment evaluated the role of BESS as an NWS to address substation overloads over the study horizon. If the substation had enough capacity during non-overload hours to sufficiently charge a BESS to discharge during an overload condition, the substation was determined to be eligible for a BESS. If there was not sufficient power available to charge a BESS prior to the overload, a BESS was not used and the wires only solution was applied.

- RECIP Solution Technology Assessment– This assessment evaluates the role of RECIPs as an NWS to address substation overloads. Each overloaded substation was evaluated to determine the required size and directional cost of the RECIP required.

While the outcome of these technology assessments was necessary in developing the cost optimized solutions scenario, this study dives into the results of these assessments from the perspective of the cost optimized solutions scenario only. Importantly, the two assessments (wires and BESS and RECIPs) are intended as a screening assessment only, meaning that they do not consider BESS and RECIP size limitations, land availability and other important considerations that should be evaluated in future phases of work. Thus, the results provided should be viewed through such lens.

To evaluate the two primary solution scenarios, as well as the NWS, five key measures were identified and evaluated. Each measure was scored on a scale of one to ten, with one being the least desirable and ten being the most desirable. The total score represents the sum of each measure's independent score. The intent of this scoring matrix is to review and evaluate each of the solution scenarios against one another. The measures are defined as follows:

- Solutions Scenario Cost: Represented as the total net present value (NPV) of system-wide capital expenses (CAPEX) and operating expenses (OPEX). Rough order of magnitude (ROM) directional pricing estimates were developed for each solution scenario. The two solutions scenario NPVs were compared against one another, and the lowest cost solution was evaluated as the most desirable.
- Safety: Evaluated as how safe the proposed solutions is and potential risk it could pose to the surrounding area.
- Reliability: Evaluated as to how much power and for how-long an overload could be served by the evaluated solutions. Scenario solutions leveraging dispatch limited solutions were measured as less favorable.
- Resiliency: Evaluated as the total capacity of the wires or NWS assets as well as vulnerabilities to external pressures such as grid outages or fuel limitations.
- Environmental: Evaluated considering greenhouse gas (GHG) considerations, noise, and land use considerations.

The two solution scenarios were evaluated through both the mid-term and long-term lens. The solutions scenario matrix assessment was applied to the 2035 findings to inform shorter-term investment strategies. Figure 5 shows the summary findings of the solutions scenarios in the matrix assessment. Black & Veatch applied quantitative cost metrics from its directional investment modeling results and a mix of qualitative and quantitative expertise to inform a high-level assessment of safety, reliability, resiliency, and environmental considerations. A deep dive into these findings and methodology can be found in Section 3.1 Methodology & Assumptions and 3.2 Substation Overload Results & Solution Scenarios.

Figure 5. Solutions Scenario Comparison Matrix (2035 Horizon Considerations)[11]

	WIRES ONLY	COST OPTIMIZED
Measures		
Cost	5	9
Safety	10	7
Reliability	10	9
Resiliency	5	8
Environmental	5	5
Total Score (Sum)		
Overall Score	35	38

Measures Scoring

1	2	3	4	5	6	7	8	9	10

Least Desirable → Most Desirable

Conclusion & Summary Recommendations

This study evaluated the potential for increases in system load in the HOL distribution system based on various decarbonization and end use electrification scenarios. Additionally, impacts to the system were assessed and potential methods to mitigate those impacts were developed. The model analysis reveals that the electrification of energy end use cases such as transportation and heating will result in a significant increase in system load and is projected to require significant expenditures to address.

The main body of this narrative final report provides a deep-dive into the methodology and assumptions of each decarbonization load scenario, as well as scenario-based comparison of each scenario decarbonization load projection. The impact on peak, load profiles, and total demanded are summarized in great detail in an effort to provide a comprehensive comparison of the impact of different decarbonization levers. Further, a detailed overview of the methodology and approach and resulting findings of the system substation overload analysis, as well as recommended next steps for considerations are provided in Section 3.0 Decarbonization Load Impacts to HOL's Distribution System.

[11] Individual measures were scored on a scale of one to ten. The overall score is the sum of all scores. Discussion regarding each measure score is provided in Section 3.2.

This study provides a robust analysis and thorough examination of potential adjustments needed between now and 2050 for HOL to effectively address future decarbonization-driven load impacts. Though this study provides robust and comprehensive analysis into the possibility of the impact of decarbonization initiatives in the HOL service territory, additional considerations, studies, and analyses should be considered. The analysis performed in this study should be leveraged and built upon to further assess and finalize mitigation strategies to optimize capital investment. In addition to the results provided within this narrative final report, an additional appendix is included titled “Appendix A: HOL Provided Substation Data.” The appendix includes a table which outlines all of the substation assumptions included in the overload analysis provided by HOL. These inputs were used in the assessment of substation overloads from the Reference Scenario load profiles over the study horizon.[12] All public sources used to inform assumptions in this analysis are also provided in Section 5: References.

[12] In additional to the two appendices summarized, Black & Veatch completed and provided extensive data analysis and financial modeling not included herein but used to determine the outcome of this analysis.

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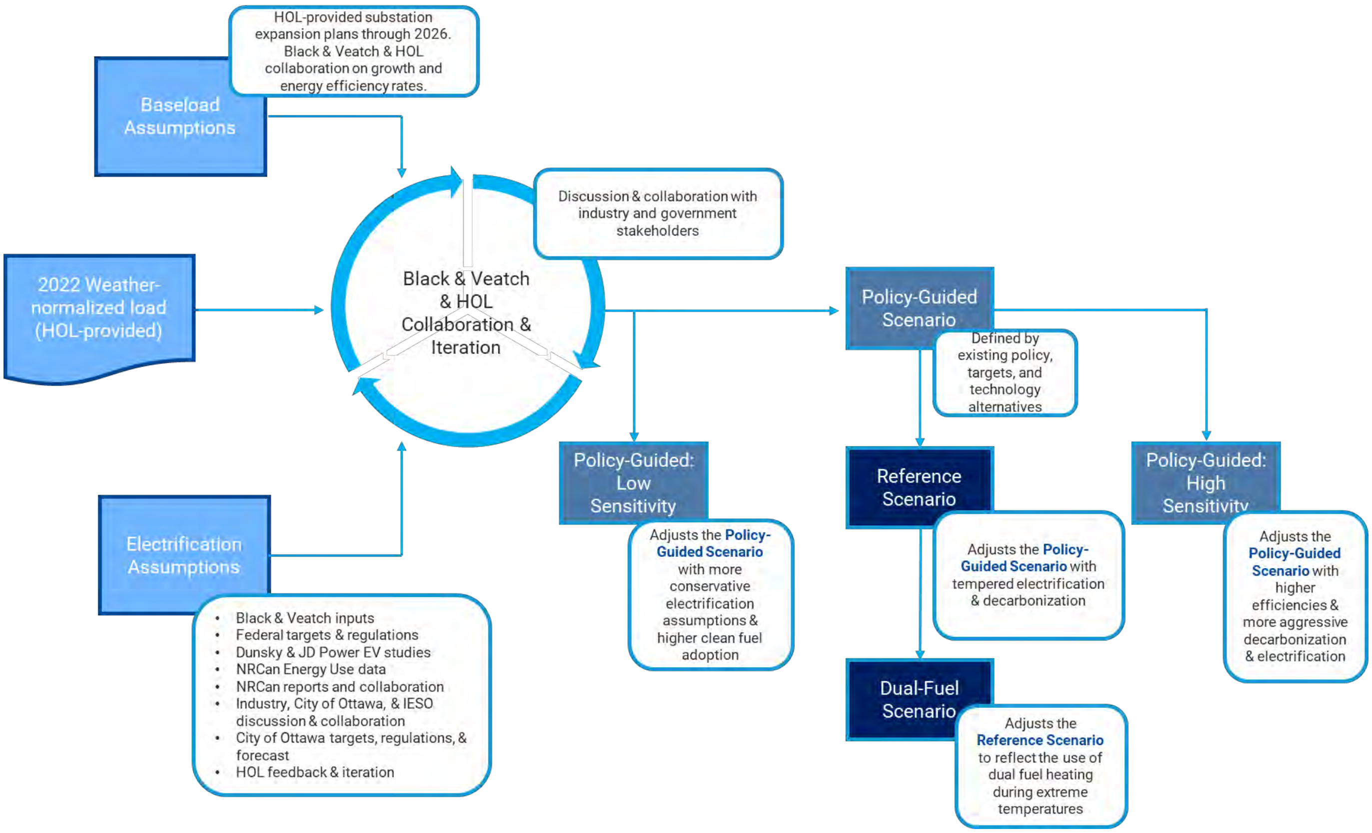
2.0 Decarbonized Load Projections

2.1 METHODOLOGY AND ASSUMPTIONS

In developing the decarbonization load scenarios used in this analysis, Black & Veatch leveraged a combination of public and proprietary HOL data to inform decarbonization assumptions and load trends. This data included historical load profiles at the substation level, weather normalization techniques, short-term system upgrade plans, growth forecasts, distributed energy resources (DER) information, and publicly available decarbonization plans and goals. Black & Veatch and HOL collaborated to define decarbonization load scenarios to inform decarbonization load projections. An overview of the study methodology and approach is provided in Figure 6.

Figure 6. Study Summary Methodology and Approach



As part of the methodology, load modeling was broken into two load categories (baseload and new electrification load). This methodology allows for greater visibility into the drivers of the decarbonization-driven new electrification load, specifically. All decarbonization load projections were completed in 5-year increments for each scenario for the following six years: 2025, 2030, 2035, 2040, 2045, and 2050. The baseload and new electrification load categories are defined as follows:

- **Baseload:** Considers the existing hourly electric consumption at the system level for all end use customer types. It does not include flow transfers between substations and derives from the actual 2022 weather-normalized electric load at the system level. The baseload is projected through 2050 considering growth rates and energy efficiency measures defined for each customer segment, such as residential, commercial, large customers, and federal. The short-term growth rate between 2023 and 2026 was informed by HOL planned capacity expansion at the substation level; and post-2026, the growth rate at the substation level varies by customer segment. The baseload projection is the same across all scenarios and sensitivities modeled.

- **New Electrification:** Includes six segments: Transportation Electrification, Residential Electrification, Commercial Electrification, Federal Building Electrification, Large Customer Electrification, and Distributed PV Generation. Each category was projected using a decarbonization curve and additional assumptions specific to each category, such as space heating, water heating, and technology adoption. Of note, in several scenarios some buildings continue using gaseous fuels through 2050.[13] For the purposes of ensuring that Canada's climate targets are met, this gas was assumed to have net-zero emissions intensity.

Load Category 1: Baseload Methodology

The baseload projection was developed by estimating growth of existing load on HOL's distribution system. Beginning with 2022 weather-normalized hourly electric load, organic load growth was estimated for 2023-2026 based on known capacity expansion plans at the substation level. New substation plans and enhancement projects for existing substations were used to create growth rates that were then applied to specific substation loads.

Beyond 2026, projections were estimated for each of the following customer segments using segment-specific growth and energy efficiency rates: residential, commercial, federal, street lighting, and large customers.

The **Residential** customer segment was created from the Residential HOL rate category, and load growth was projected based on population growth[14]. Energy efficiency gains were estimated at 0.5% per year based on the Independent Electricity System Operator's (IESO's) Gatineau Corridor End-of-Life Study.[15]

The **Commercial** customer segment was created from the following HOL rate categories: Commercial, 50-1,000 kW, 1,000-1,500 kW, and 1,500-5,000 kW. Load growth was projected based on population growth, and energy efficiency gains were estimated at 1% per year based on the IESO's Gatineau Corridor End-of-Life Study.[15]

The **Federal** customer segment was created by mapping 130 federal facilities in the Ottawa region to Canada's 2021 Greenhouse Gas Emissions Inventory to measure annual energy consumption. For federal customers who were also large customers, metered electricity was used instead. Load growth was projected based on historic growth, and energy efficiency gains were estimated at 1% per year based on

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[13] A detailed assessment of the role of the data centers was not included as part of this decarbonization study scope but should be considered in future load projection assessments.
[14] City of Ottawa Growth Projections for the New Official Plan – Medium Projection, 2019. Extrapolated from 2047 to 2050.
[15] IESO Gatineau Corridor End-of-Life Study, 2022.

the IESO's Gatineau Corridor End-of-Life Study.[15] It was assumed that federal buildings with plans to transition to commercial or residential use would maintain similar consumption profiles and growth rates.

The **Large Customer** segment was created from the metered data of 28 of HOL's largest customers. This segment was broken down into subsegments with specific assumptions for each.

- Office Building large customers: growth and energy efficiency were the same as the Commercial customer segment.
- Hospital large customers: growth and energy efficiency were informed by the Commercial customer segment.
- University large customers: growth estimates informed from other university decarbonization and sustainability plans, energy efficiency assumed equal to commercial segment.
- Water Treatment Plant large customers: growth based on population growth and energy efficiency estimated at 0.5% for the industrial segment from IESO's Gatineau Corridor End-of-Life Study.[15]

The **Street Lighting** customer segment was created from the Street Lighting HOL rate category, and load growth was projected based on population growth. No energy efficiency gains were estimated due to the high existing penetration of LED street lighting in Ottawa.

Load Category 2: New Electrification Methodology

Transportation Electrification

Transportation Electrification includes the load from charging electric light-duty, medium-duty, and heavy-duty vehicles (LDV, MDV, HDV). LDVs are projected to comprise the vast majority of EV charging load in the HOL service territory and the following parameters were developed and defined to estimate annual electricity consumption of electric vehicles.[16]

- Number of electric vehicles: informed from existing regulations and public forecast adoptions
- Electric vehicle electric consumption per distance (efficiency rating): utilized the IESO Annual Planning Outlook (APO)[17] estimate of 0.2 kWh/km
- Distance traveled per EV per year: 16,196 km[18]
- Charger efficiency: estimated at 0.85[17]

Annual consumption from EVs was allocated to hourly load profiles at the substation level via:

- Hourly charging profiles developed for different types of residential (L1, L2) and public chargers (L3)
- Residential charging allocated based on population/number of residential customers at the substation

[16] Unless otherwise noted LDV assumptions leveraged proprietary Black & Veatch analysis and research. A detailed study of LDV efficiencies, miles traveled and charging efficiency were outside the scope of this assessment.
[17] IESO Annual Planning Outlook, 2022.
[18] IESO Annual Planning Outlook, 2022, modified slightly by Black & Veatch subject matter experts.

- Public charging allocated based on historical locations (indicative of demand at the location)
- Seasonality of consumption accounted for by using EV consumption data from climates similar to Ottawa

The significant impact of new LDV load is expected to be tempered by rate structures designed to incentivize customers to charge when electricity demand is low, lessening the impact on system-level peaks. From 2023 to 2030, some adoption of the Ontario Government's ultra-low overnight (ULO) rate was assumed.[19] After 2030, new rate structures optimized to flatten future system-level load curves were assumed to be implemented as HOL adapts to the changing load profile of its system. Adoption rates for these rate incentives differ by scenario.

For City of Ottawa's buses, a separate load projection was created using the following assumptions:

- Full electrification of fleet by 2040
- Observed data from the existing OC Transpo Zero Emission Bus Program, including:
    - Distance traveled per bus
    - Electric efficiency of buses
    - Charging load profiles

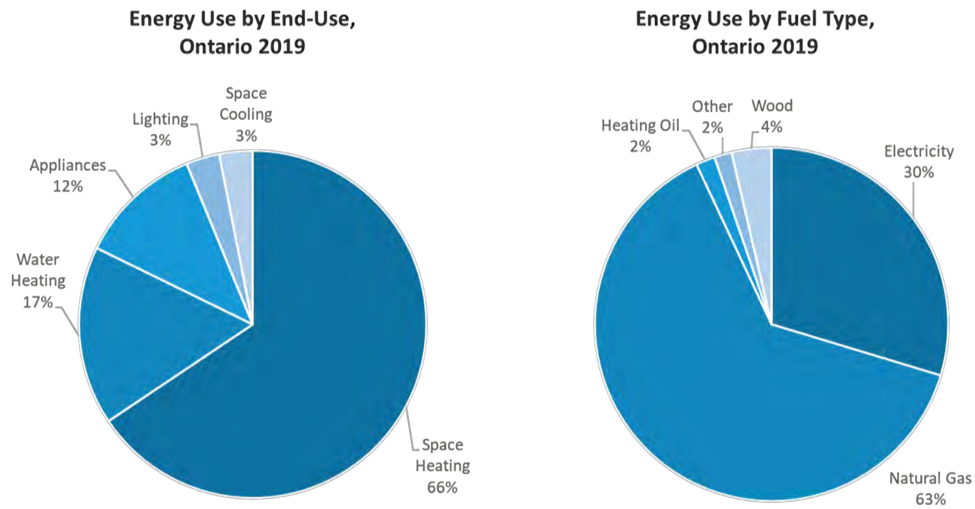
Outside of LDVs and city buses, MDV and HDV load was estimated as a proportion of LDV load using a combination of public and proprietary Black & Veatch sources. Projected MDV and HDV load was then added to the total LDV load.

Residential Electrification

Residential Electrification includes potential electrification load from space heating, water heating, and appliances in the residential sector. According to Natural Resources Canada (NRCan) data, space cooling and lighting in the residential sector are already 100% electric.[20] NRCan data was used to quantify energy consumption by end use (space heating, water heating, appliances) and energy end use fuel type, as shown in Figure 7. Black & Veatch applied a decarbonization curve based on Federal or local climate targets to the entire residential sector. For each energy end use, specific electrification assumptions were developed.

[19] Ontario Ultra-Low Overnight Rate
[20] NRCan Residential Sector Energy Use, Ontario.

Figure 7. Residential Energy Use in Ontario, *Natural Resources Canada*



Space heating and water heating were electrified based on expected technology share (heat pumps, electric resistance, gas) at the end of the study's horizon. These target technology shares leveraged existing publicly available forecasts such as Canada Energy Regulator's (CER) Canada's Energy Future, Enbridge's Pathways to Net Zero Emissions in Ontario, and the City of Ottawa's Energy Evolution GHG Modeling to inform forecasts for this study. For example, the Reference Scenario utilized the forecast in Canada's Energy Future report to arrive at 50% heat pumps, 26% electric resistance heating, and the remainder served by low carbon gas by 2050.

From these technology adoption assumptions, Black & Veatch applied a blended coefficient of performance (COP) to convert the amount of energy used by natural gas to electricity or low carbon fuels such as hydrogen or RNG. Black & Veatch utilized historical weather data in Ottawa to project electrified space heating load curves over the course of a year. For water heating, efficiency metrics (COP) were applied to known energy demand from natural gas-fired residential water heating (NRCan) and known load profiles from similar climates to create annual hourly load projections.[20]

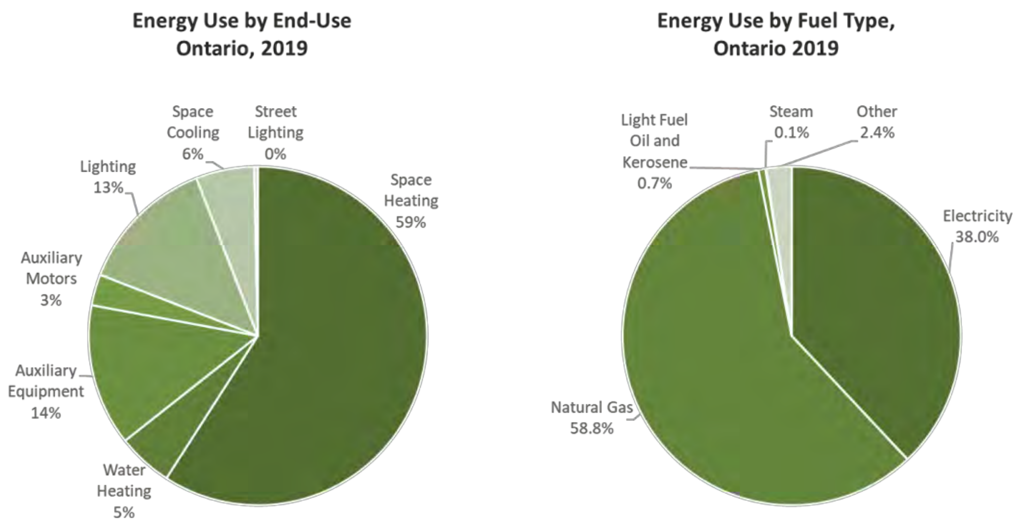
Roughly 63% of energy used in household appliances is provided by natural gas, consistent with NRCan data.[20] In this assessment, the natural gas portion was assumed to be electrified based on scenario-specific decarbonization curves.

Importantly, blended efficiency metrics for both space heating and water heating were reduced in all scenarios for hours at or below -10°C based on historical weather data. This was to account for the assumed diminished efficiency of air-source heat pump technology in extreme temperatures sometimes experienced in Ottawa's climate.

Commercial Electrification

Commercial Electrification includes potential electrification load from space heating, water heating, space cooling, and auxiliary equipment in the commercial sector. Like the residential sector, NRCan data was used to quantify energy consumption by end use (space heating, water heating, etc.) and energy end use fuel type as shown in Figure 8.[21] Black & Veatch applied a decarbonization curve based on federal or local climate targets to the entire commercial sector. For each energy end use, specific electrification assumptions were developed.

Figure 8. Commercial Energy Use in Ontario, *Natural Resources Canada*



Space heating, space cooling, and water heating were electrified based on fuel share (electric vs. low carbon gas) at the end of the study horizon. These target fuel shares leveraged publicly available forecasts such as Canada Energy Regulator's (CER) Canada's Energy Future, Enbridge's Pathways to Net Zero Emissions in Ontario, and the City of Ottawa's Energy Evolution GHG Modeling to inform projections for this study.[22,23,24] Based on the electrification options available for commercial buildings and the minimum performance of alternatives from the National Energy Code of Canada for Buildings, Black & Veatch applied a blended coefficient of performance (COP) to convert the amount of energy used by natural gas to electricity.[25] Black & Veatch utilized historical weather data in Ottawa to project electrified space heating load curves over the course of a year. For water heating, efficiency metrics (COP) were applied to known energy demand from natural gas-fired commercial water heating (NRCan) and load profiles from similar climates to create annual hourly load projections.[21]

Roughly 17% of energy used in auxiliary commercial equipment (e.g., clothes dryers, cooking appliances) is provided by natural gas.[21] Similar to the residential sector, the natural gas portion was assumed to be electrified based on scenario-specific decarbonization curves.

Like the residential sector, blended efficiency metrics for both space heating and water heating were reduced in all scenarios for hours at or below -10°C based on historical weather data. This was to account

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[21] NRCan Commercial Sector Energy Use, Ontario.
[22] Ottawa Energy Evolution Modelling Ottawa's Greenhouse Gas Emissions to 2050.
[23] CER Canada's Energy Future, 2023.
[24] Enbridge Pathways to Net-Zero Emissions in Ontario, 2022.
[25] National Energy Code of Canada for Buildings, 2020.

for the assumed diminished efficiency of existing air-sourced heat pump technology in extreme temperatures sometimes experienced in Ottawa's climate.

Federal Building Electrification

The government of Canada publishes annual Greenhouse Gas Emissions (GHG) Inventories which include all federal facilities in the country. One hundred thirty (130) federal facilities were identified from this inventory in the Ottawa region; each facility was mapped to a substation on HOL's distribution system based on the facility address. From the GHG Inventory, Black & Veatch determined the annual energy consumption at the substation level. For large federal users, metered electricity was used instead (see next section on Large Customer Electrification). Due to similar consumption profiles, commercial electrification assumptions around space heating & cooling, water heating, and auxiliary equipment were applied to federal buildings. These assumptions were applied to scenario-specific decarbonization curves. Black & Veatch assumed these facilities would either remain operational as federal buildings or transition to commercial use cases with similar consumption profiles and growth rates.

Large Customer Electrification

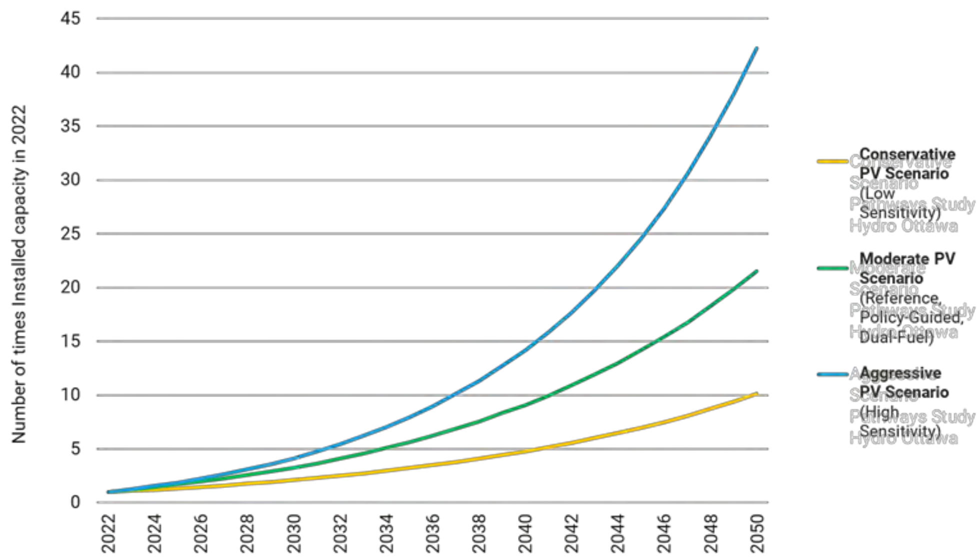
As in the baseload projection, Black & Veatch created a specific set of electrification assumptions for 28 large customers broken into 6 subsegments. Large Customer Electrification did not vary by scenario. Of important note is that the intent of this study was not to develop and project large customer specific or custom decarbonization trends and trajectories, but to understand the directional impact of decarbonization on the HOL distribution system. Thus Black & Veatch leveraged publicly available information to inform assumptions of these large customer groups.

Distributed PV Generation

Black & Veatch completed a load projection of distributed photovoltaic (PV) solar generation growth given its ability to significantly influence system-level peaks, especially during summer months. HOL provided current installed capacity estimates of roughly 42 MW as well as generation profile data observed at selected substations. Substation-level generation profiles and capacity factors were applied to growing capacity load projections. Black & Veatch leveraged forecasts from the City of Ottawa's Pathway Study on Solar Power to apply growth patterns by scenario.[26] Each solar scenario from this study assumes different levels of local effort to encourage rooftop PV and global inputs such as improved economics and technology performance. Figure 9 shows the different distributed PV projections leveraged for this analysis.

[26] City of Ottawa's Pathway Study on Solar Power in Ottawa, 2017.

Figure 9. Distributed PV Projection Assumptions



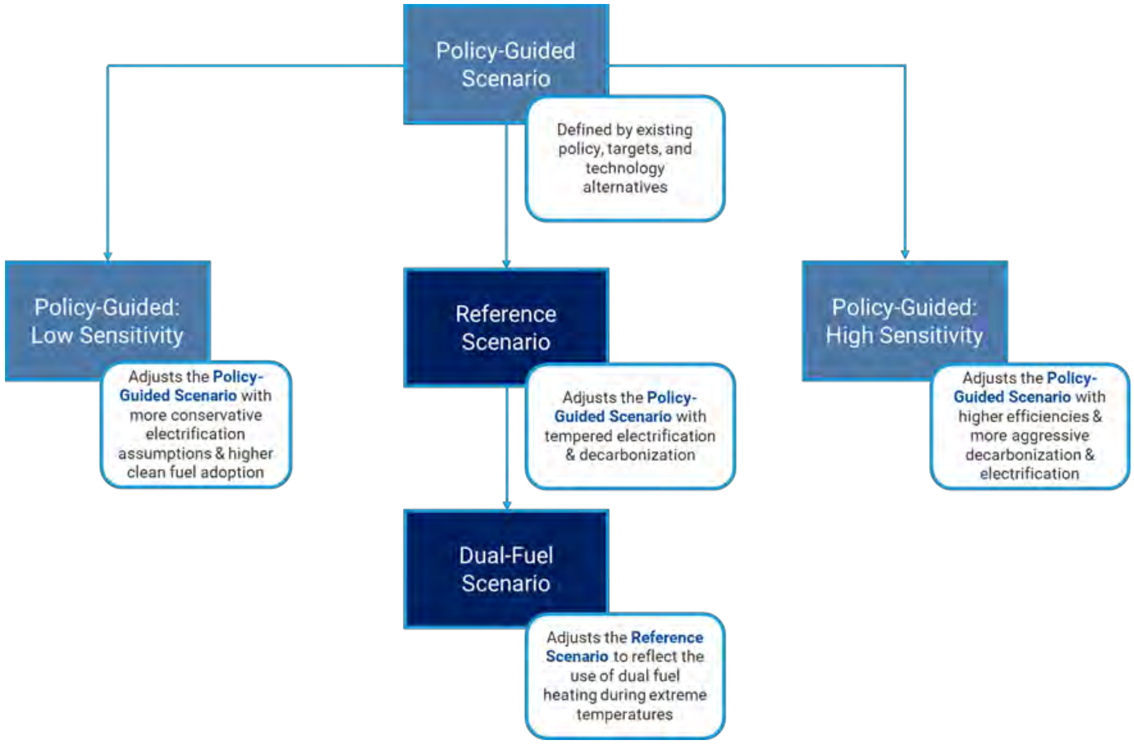
Substation-level Projection Methodology

To apply all new electrification assumptions to HOL substations, Black & Veatch conducted a thorough analysis of customer segmentation. Utilizing both publicly available and proprietary HOL data, Black & Veatch created an estimated customer segment breakdown for all 92 substations in HOL's distribution system. Customer segment-specific new electrification growth factors were applied proportionally based on these customer breakdown estimates. The end result was both system- and substation-level load projections for each load category for each scenario.

2.2 OVERVIEW OF LOAD SCENARIOS

In order to capture a range of possible outcomes to HOL's distribution system resulting from decarbonization, Black & Veatch developed one primary reference decarbonization scenario, two alternative decarbonization scenarios, and two sensitivities. This section defines each scenario, presents an overview of assumptions, and examines customer segment-level results. In Section 2.3 Results Summary and Comparison, system-level results for the three scenarios are presented and analyzed comparatively. Each scenario's development and influences are described below, along with the scenario-specific results of each load category. Figure 10 shows the logical flow of developing these scenarios.

Figure 10. Load Projection Scenario & Sensitivity High-Level Relationship & Descriptions



Leveraging inputs from ongoing decarbonization trends, existing policy, other published reports and subject matter expertise, the final scenarios and sensitivities evaluated are described in greater detail below.

- The **Policy-Guided Scenario**: characterized by strict adherence to Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. This scenario is defined by existing policy, targets, and technology alternatives. All future scenarios and sensitivities were adjusted off of this baseline scenario.
- The **Reference Scenario**: encapsulates the most likely scenario based on observed HOL load projection trends, electrification adoption trends, and subject matter expertise. These inputs lead Black & Veatch and HOL to assert this scenario, with tempered electrification in the short-term, is optimal to inform short-to-mid term investments required to maintain reliability on the HOL distribution power grid. For example, peak load on HOL's system has remained mostly flat for the past 15 years with a maximum of 1,518 MW in 2010, a minimum of 1,308 MW in 2014, and a most recent peak of 1,348 MW in 2022. In the mid- to long- term, this scenario assumes increasing policy-driven electrification.
- The **Dual-Fuel Scenario**: applies a space heating and water heating sensitivities during extreme temperatures to the Reference Scenario.
- The **High Case Sensitivity**: provides a sensitivity on more aggressive decarbonization and electrification than the Policy-Guided Scenario.

- The **Low Case Sensitivity**: provides a sensitivity on less aggressive decarbonization and electrification than the Policy-Guided Scenario.

Load Projection Assumptions

Each of these scenarios contain the *same baseload projection* but utilize levers of electric vehicle (EV) adoption, building heating and cooling, water heating, decarbonization curves, and distributed PV adoption to measure the impact of decarbonization policy on load modeling. This section describes the methodology used and variables accounted for to build each portion of the decarbonized load projections. A number of assumptions remained the same in each load projection scenario. A list of those shared common assumptions is provided in Table 1.

Table 1. Common Assumptions Across Scenarios

Load Category	Shared Assumptions (assumptions were identical in each scenario & sensitivity)
Baseload	• All baseload assumptions, including historical load profile, growth rates & energy efficiency
Residential	• Energy efficiency • Load profile • Space cooling & appliance electrification
Commercial	• Energy efficiency • Load profile • Space cooling & auxiliary equipment electrification
Federal	• Energy efficiency • Load profile
Transportation	• EV efficiency • Vehicles miles traveled • Charger efficiency • City bus electrification
Large Users	• All large user assumptions, including historical load profile, growth rates & energy efficiency
Distributed PV	• Generation profile • Capacity factor

Importantly, the five load categories used as levers for scenarios were Transportation Electrification (LDV specifically), Residential Electrification, Commercial Electrification, Federal Electrification, and Distributed

PV Generation. A summary of the scenarios and each level assumption is provided in Table 2. The baseload projection and Large Customer Electrification results are presented here outside individual scenarios, as they remained constant across all five scenarios and sensitivities.

Table 2. Scenario and Sensitivity Assumptions Comparison[27]

	Dual Fuel Scenario	Reference Scenario	Policy-Guided Scenario	High Sensitivity	Low Sensitivity
Scenario Description	Defined by adjusting the Reference Scenario with dual fuel heating during extreme temperatures	Defined by adjusting the Policy-Guided Scenario with tempered electrification & decarbonization	Defined based on existing policy, targets, and technological alternatives	Defined by greater efficiency and more aggressive decarbonization & electrification assumptions	Defined by more conservative decarbonization assumptions, with greater clean fuel adoption
Decarbonization Curves & Targets	Government of Canada Targets (tempered in short-term)	Government of Canada Targets (tempered in short-term)	Government of Canada Targets (2030 ERP, 2050 Net Zero Act)	City of Ottawa Climate Change Master Plan Community Target	Government of Canada Targets (tempered in short-term)
Electric Vehicles	EV adoption to meet federal targets	EV adoption to meet federal targets	EV adoption to meet federal targets	Faster EV adoption than federal targets	Slower EV adoption than federal targets
Residential, Commercial & Federal Buildings	Partial electrification with moderate heat pump adoption Dual-fuel heating assumptions Remaining pipeline gas assumed as low-carbon fuels	Partial electrification with moderate heat pump adoption Remaining pipeline gas assumed as low-carbon fuels	Complete electrification Second highest heat pump adoption	Most aggressive electrification Highest heat pump adoption, highest efficiency assumptions	Least aggressive electrification with higher remaining load served from low-carbon fuels Lowest heat pump adoption
Distributed PV	Moderate PV Growth	Moderate PV Growth	Moderate PV Growth	Most aggressive PV growth	Most conservative PV growth

Baseload Results

As described in Section 2.1, the baseload projection is driven by a combination of existing substation plans, population growth forecasts, and energy efficiency assumptions. After beginning at 1,348 MW in 2022 and increasing to 1,737 MW in 2030 baseload levels out and decreases on the back end of the study horizon due to energy efficiency projections outpacing load growth from the increasing population. By 2050 the baseload peak is 1,797 MW, only 3.4% higher than 2030 (0.17% annualized growth). As demonstrated in Figure 11, the baseload projection utilizes the same load profile as HOL's system today.

[27] Assumptions detailed are discussed in greater detail later in this section.

The baseload peak and load profile are identical across all scenarios. Figure 12 shows baseload peak demand projections.

Figure 11. Baseload Annual Load Profile

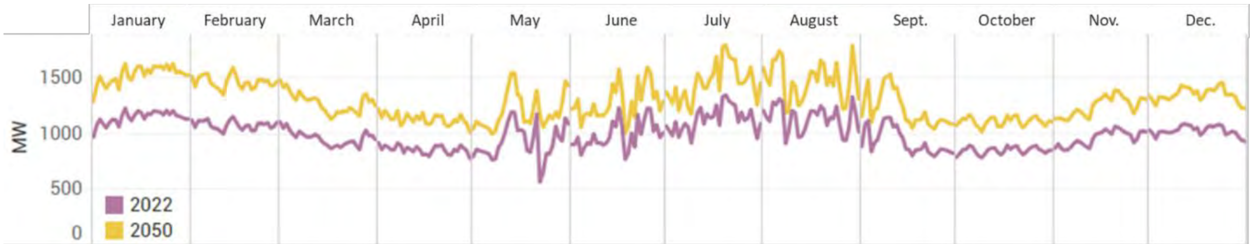
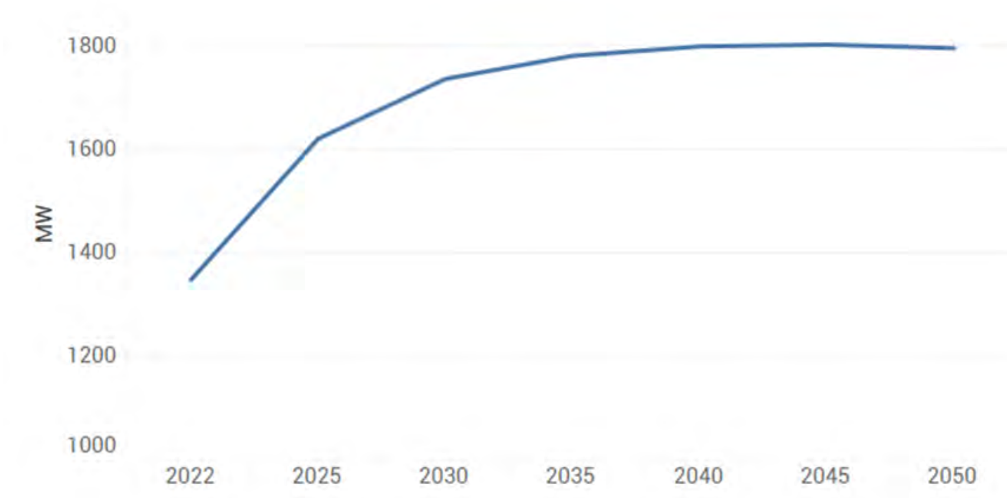


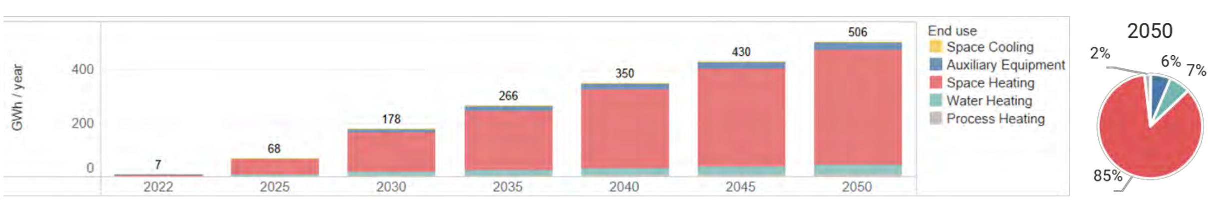
Figure 12. Baseload Peak Demand Projection



Large Customer Electrification

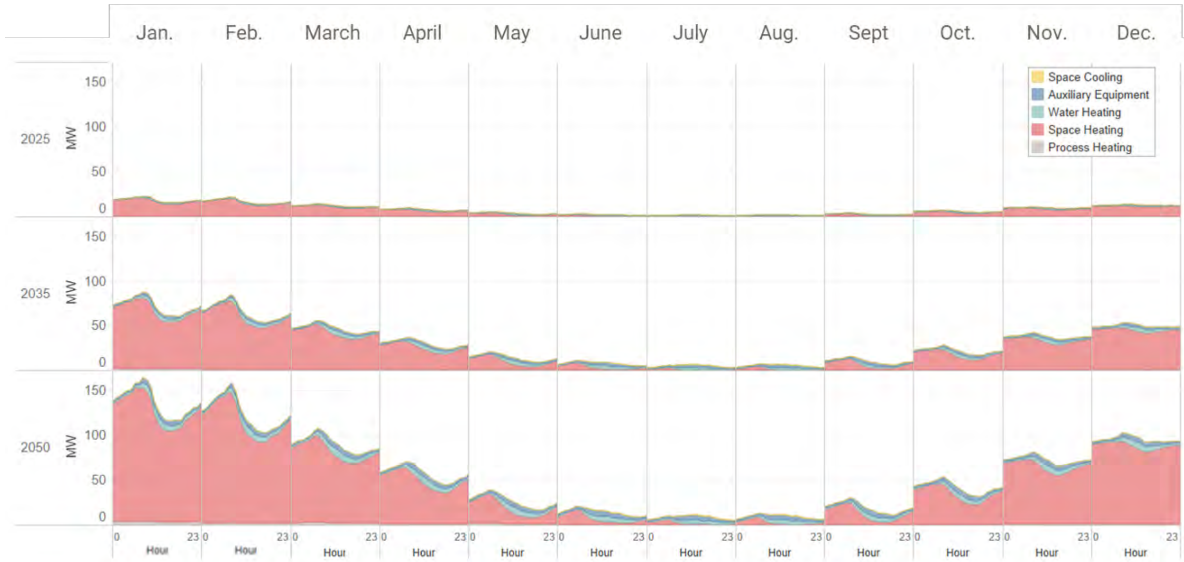
The Large Customer Electrification load projection (as seen in Figure 13) includes specific assumptions for each subsector of customer. Space heating electrification is the primary driver of this load projection, as seen by the increased load in winter comparative to summer months. By 2050, 85% of the 506 GWh consumed by large customers annually is for space heating. Overall, Large Customer electrification represents a relatively small proportion of system load (3% in the Reference Scenario) – outpaced by load growth in Residential, Commercial, and Transportation sectors. The Large Customer Electrification load projection did not vary across scenarios.

Figure 13. Large Customer New Electrification Load Projection by End-Use



As expected, space heating load is highly seasonal (as seen in Figure 14), dropping dramatically between winter months and summer months. Though noticeable in 2025, by 2035 and 2050 the seasonality and associated peaks will become increasingly severe. The associated increase of spacing heating related electricity demand is tied to a transition away from gas heating.

Figure 14. Large Customer Hourly Electricity Load Profile (Average Day Per Month)



Reference Scenario and Dual-Fuel Scenario

The Reference Scenario in this study reflects the most likely short-to-mid-term load projection expected in the HOL service territory. Based on historical data and existing trends, Black & Veatch and HOL believe this scenario is optimal to inform short-to-mid term investments required to maintain reliability on the HOL distribution power grid. Thus, the Reference Scenario is the decarbonization load projection in which distribution modeling and ROM investment estimates were performed. A narrative of those findings is provided in more detail in Section 3. Decarbonization Impacts to HOL's Distribution System.

In the Reference Scenario, the new electrification load projection is characterized by a tempered pace of decarbonization in the short-term but still meeting Canada's 2030 Emissions Reduction Plan and Canada's wider 2050 decarbonization goals. This curve was developed from the existing Government of Canada targets adjusted for slower electrification in the near-term informed by observed trends in HOL's service territory. Further, this scenario assumes full electrification of most buildings, with a minority continuing to utilize gas distribution networks by 2050. However, to meet decarbonization targets in this scenario, pipeline fuel is assumed to be decarbonized via adoption of low carbon fuels. While identical to the Policy-Guided Scenario in EV adoption and PV generation, these cases differ in the implementation and adoption of EV charging rate incentives.

Alongside the Reference Scenario, Black & Veatch assessed a Dual-Fuel Scenario in which all assumptions match the Reference Scenario except for space heating and water heating. In this sensitivity, it was assumed that the majority of buildings that adopt heat pumps also maintain their gas space heating and water heating as back-up allowing for the use of gas-fired heating during extreme cold weather.

Reference Scenario and Dual-Fuel Scenario: Transportation Electrification

Transportation Electrification assumptions for these two scenarios are shown in Table 3. From 2023 to 2030 a rate design similar to the Ontario Government's existing ULO rate is assumed.[19] Beyond 2030, Black & Veatch assumed charging rate incentives would be adapted to provide optimal load flattening (i.e., incentivizing charging during times when demand from other load sectors is low.) These scenarios assume a rate incentive adoption rate of 75%, informed by the reference case of BC Hydro's Optional Residential Time-of-Use 2023 Rate Application.[28] Charging profiles in the Reference Scenario were informed by the Electric Vehicle User Behavior: An Analysis of Charging Station Utilization in Canada report. [29]

Table 3. Reference Scenario Transportation Electrification Assumptions

METRIC	ASSUMPTION	INFORMED BY
% of New Electric LDV Sales	2026 – 20% of new LDVs 2030 – 60% of new LDVs 2035 – 100% of new LDVs	Canada Zero-Emission Vehicle Sales Targets
Charger Types	Residential L1 or L2 – 80% Public L2 – 17% Public DCFC – 3%	Dunsky & NRCan,[30] J.D. Power,[31] Black & Veatch analysis
Rate Incentive Adoption	75%	BC Hydro's Optional Residential Time-of-Use 2023 Rate Application[28]
MDV/HDV Load as a Percentage of total LDV load	2050 – 10% (increases incrementally up to 10% by 2050)	Black & Veatch analysis. MDV/HDV load should be assumed as an addition to LDV load

As expected, EV-related load increases dramatically over the study horizon, growing from approximately 492 GWh/year in 2030 to 3,624 GWh/year in 2050, as shown in Figure 15. Peak EV load sees similarly dramatic increases, from 55 MW in 2030 to 772 MW in 2050. LDV related load makes up the majority of this increase, as expected given the assumed compliance of Canada's Zero-Emission Vehicle Sales Target of reaching 100% of new LDVs by 2035. Annual consumption growth from Transportation Electrification averages 123% between 2025 and 2035 as federal EV sales mandates ramp up before slowing to 11% per year between 2035 and 2050.

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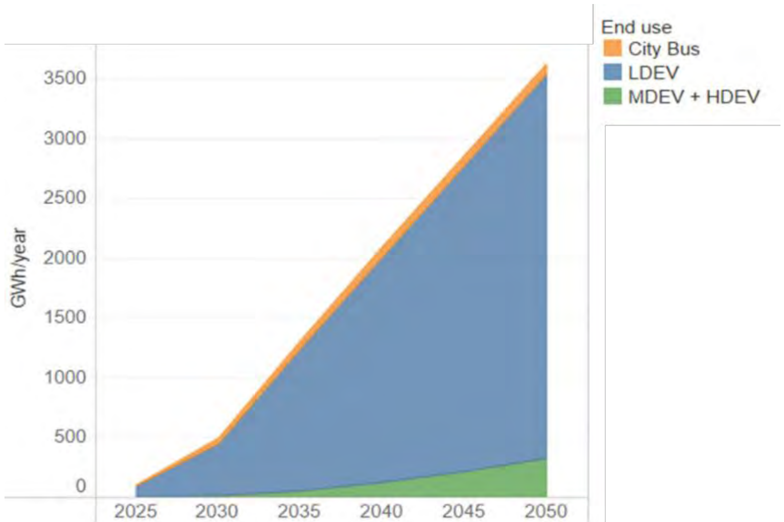
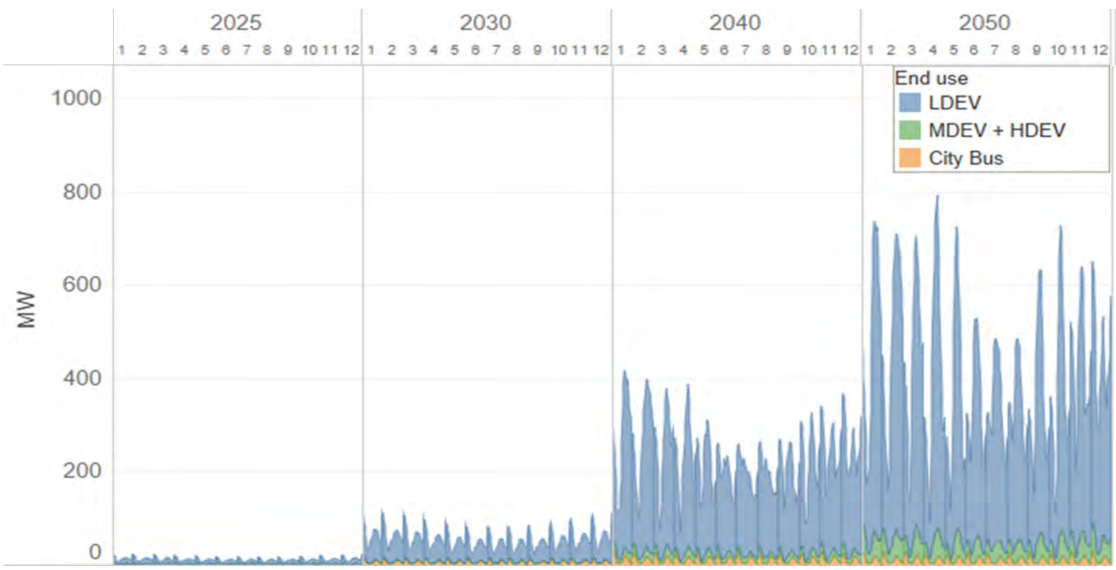
[28] BC Hydro Optional Residential Time-of-Use Rate Application, 2023.
[29] Electric Vehicle User Behavior: An Analysis of Charging Station Utilization in Canada, 2023.
[30] Dunsky & NRCan Updated Projections for Canada's Public Charging Infrastructure Needs, 2022.
[31] J.D. Power Electric Vehicle Experience Home Charging Study, 2023.

Figure 15. Reference Scenario Transportation Electrification Annual Load



The impact of a rate or other EV charging incentives is modeled as effective in shifting EV charging load from high-demand times (typically in early morning and evenings in the winter when heating load is at the highest) to lower demand hours. This trend is demonstrated in Figure 16.

Figure 16. Reference Scenario Transportation Electrification Load Profile



Reference Scenario and Dual-Fuel Scenario: Residential Electrification

Residential energy use in the Reference Case & Dual-Fuel Scenario was projected based on the adjusted decarbonization curve to account for slower progress in the near term while electrification technologies reach greater adoption in Ottawa. By 2050, the Reference Scenario assumes that residential buildings are mostly electrified, with space heating and water heating provided by heat pumps and electric resistance heating. However, roughly a quarter of heating needs are projected to be provided by gas distribution networks in 2050 (assumed to be low carbon such as RNG or hydrogen to meet Canada's decarbonization goals.) In the Dual-Fuel Scenario, a majority of households that adopt heat pumps also maintain their connection to gas distribution networks for use during extreme low temperatures. These technology forecasts were informed by CER's Canada's Energy Future report and collaboration with the team who authored the report.[23]

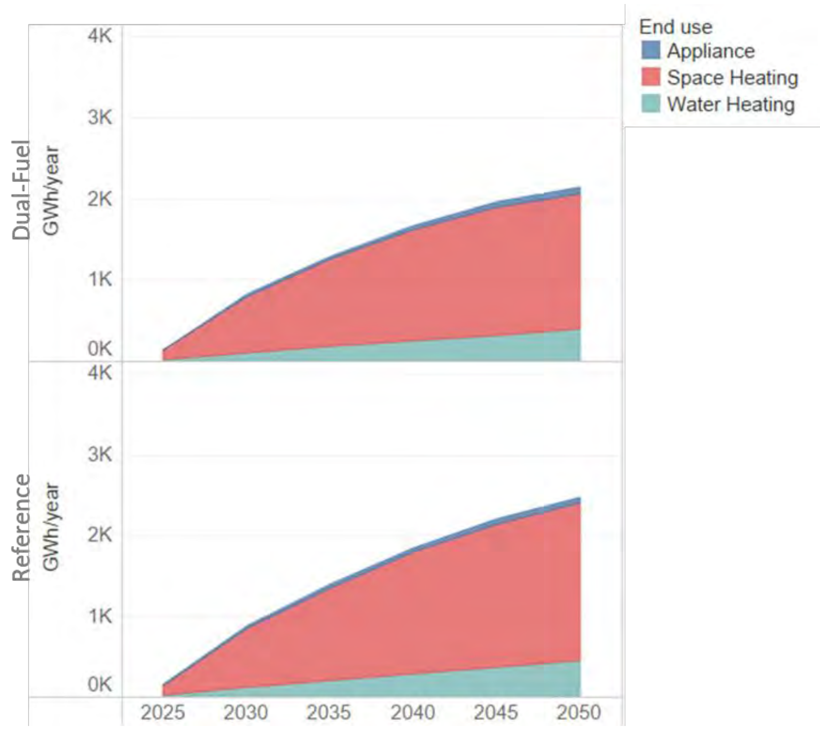
In both the Reference Scenario and the Dual-Fuel Scenario, space heating and water heating was assumed to be more efficient than in the Policy-Guided Scenario to accommodate expected technological advancement in heating technologies over the duration of the study horizon. During the hours in which temperatures remained above -10˚ C, water and space heating efficiencies remained the same between the Reference Scenario and the Dual-Fuel Scenario. During extreme cold hours (-10°C or lower), the efficiency of electric space heating was assumed to decline given the limitations of certain heat pumps technologies' ability to maintain efficiency during extreme cold temperatures. Table 4 provides a summary of the residential and commercial electrification assumptions used in each load scenario.

Table 4. Residential & Commercial Segment Electrification Assumptions

METRIC	REFERENCE SCENARIO	DUAL-FUEL SCENARIO	INFORMED BY
Space Heating Electrification Target (Achieved by 2050)	76% electric heating (combination of heat pumps and electric furnaces)	76% electric heating (combination of heat pumps and electric furnaces)	Canada's Energy Future report[23]
Heat Pump Space Heating COP	Residential - 3.94 Commercial – 3.65	Residential - 3.94 Commercial – 3.65	• Weighted average electric heating efficiencies • Canada's Energy Future report[23] • National Energy Code of Canada for Buildings[25]
Extreme Temperature (-10ºC) Space Heating COP	Space Heating – 1.36	Space Heating – 10.14	Black & Veatch & HOL analysis
Water Heating Electrification Targets	76% electric	76% electric	Canada's Energy Future report[23]

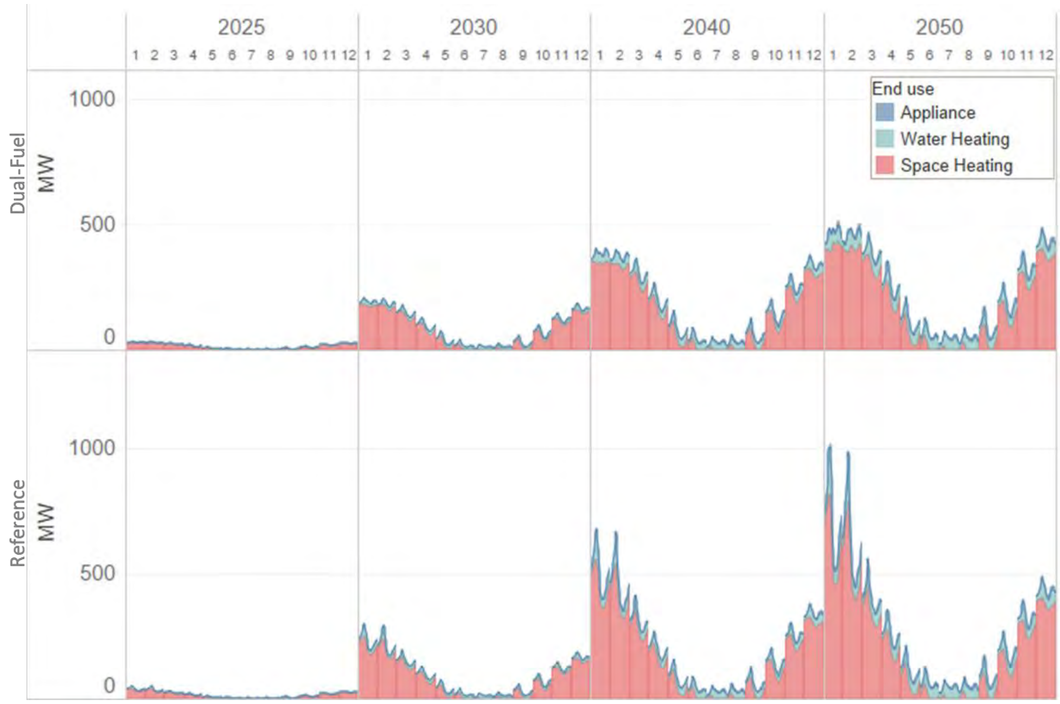
As demonstrated in Figure 17, the revised decarbonization curve slows load growth in the short-term when compared to the Policy-Guided Scenario (summarized in the Policy-Guided Scenario section). Lower space heating and water heating loads drive lower residential loads due to higher efficiency from increased heat pump penetration and continued use of low carbon gas in some buildings.

Figure 17. Reference Scenario Residential Electrification Annual Load



As shown in Figure 18, the use of dual-fuel systems significantly decreases load when comparing the sensitivity to the Reference Scenario. This trend becomes increasingly noticeable in 2035 when Reference Scenario customer electrification reaches 1,389 GWh per year, compared to 1,285 in the Dual-Fuel Scenario. By 2050 the gap increases to 2,472 GWh and 2,147 GWh in the Reference Scenario and Dual-Fuel Scenario, respectively. When extreme temperatures cause heat pump efficiency to drop below a certain threshold, gas-fired heating will ramp up, nearly eliminating electric space heating demand from households with these heating systems. For the purposes of this analysis, that extreme temperature was assumed to be at or below -10°C.

Figure 18. Reference & Dual-Fuel Scenarios Residential Electrification Load Profile

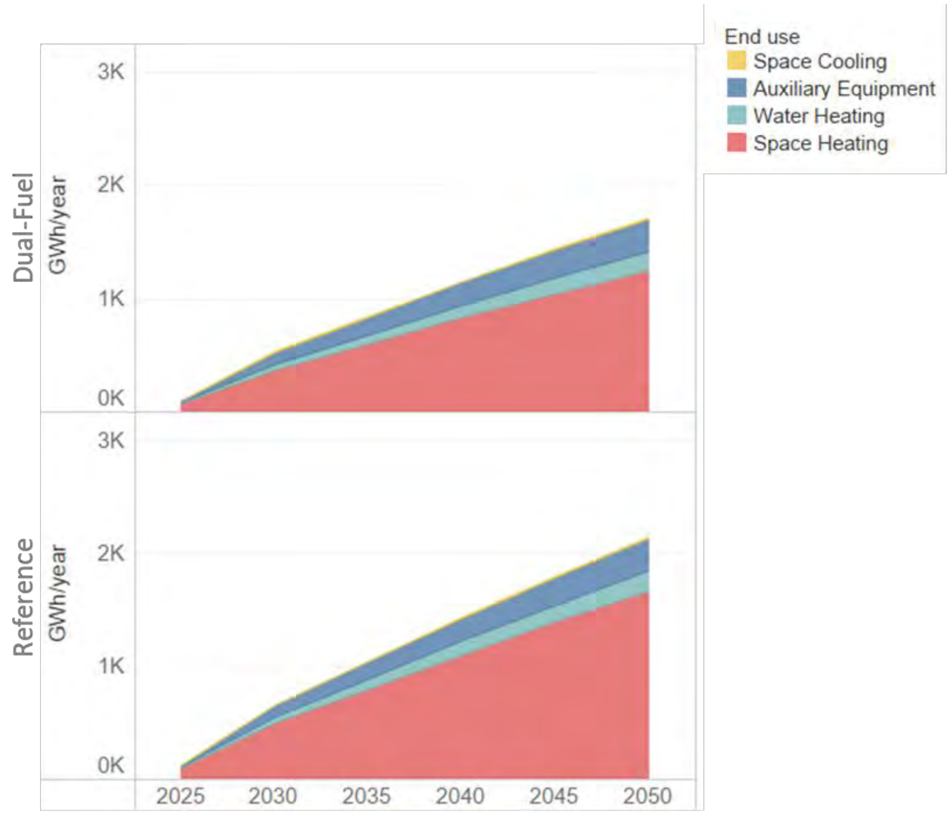


Seen in Figure 18, the seasonal impacts of dual-fuel heating compared to electric-only heating are clear. The most extreme examples occur in early January 2050, when Reference Scenario heating load exceeds 1,000 MW compared to 471 MW during that same hour in the Dual-Fuel Scenario.

Reference Scenario and Dual-Fuel Scenario: Commercial & Federal Building Electrification

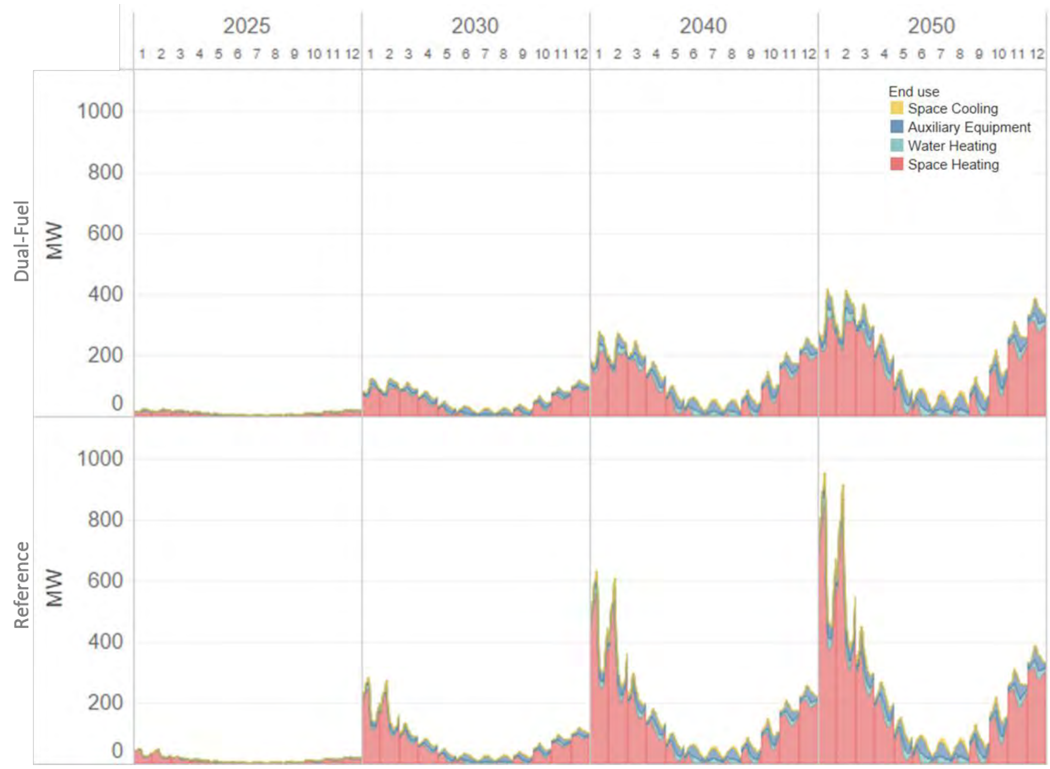
Commercial electrification in the Reference Scenario and Dual-Fuel Scenario follows similar assumptions as residential electrification. Like residential electrification, the adjusted short-term decarbonization curve was used to account for slower progress in the near term to align more closely to observed short-term trends. By 2050, buildings are assumed to be mostly electrified, with space heating and water heating provided by heat pumps and electric resistance heating. These trends are displayed in Figure 19. Roughly a quarter of heating needs are assumed to be provided by gas distribution networks in 2050 (assumed to be low carbon alternatives such as RNG or hydrogen to meet Canada's decarbonization goals). In the Dual-Fuel Scenario, most commercial buildings that adopt heat pumps are assumed to maintain their connection to gas distribution networks for use during extreme low temperatures. These technology forecasts were informed by CER's Canada Energy Future Net-Zero report and collaboration with the team who authored the report.

Figure 19. Reference & Dual-Fuel Scenarios Commercial Electrification Annual Load



The same trends projected in residential electrification are also exhibited in the commercial projections. As observed in Figure 19, the revised decarbonization curve slows load growth in the short term. Higher efficiency from increased heat pump penetration and some continued use of low carbon gas offset the load growth from electrification in later years. In the residential electrification sector, the use of dual-fuel systems significantly decreases load when comparing the sensitivity to the Reference Scenario, as can be observed in Figure 20. When extreme temperatures cause heat pump efficiency to drop below a certain threshold, gas-fired heating will ramp up, nearly eliminating electric space heating demand from buildings with these heating systems.

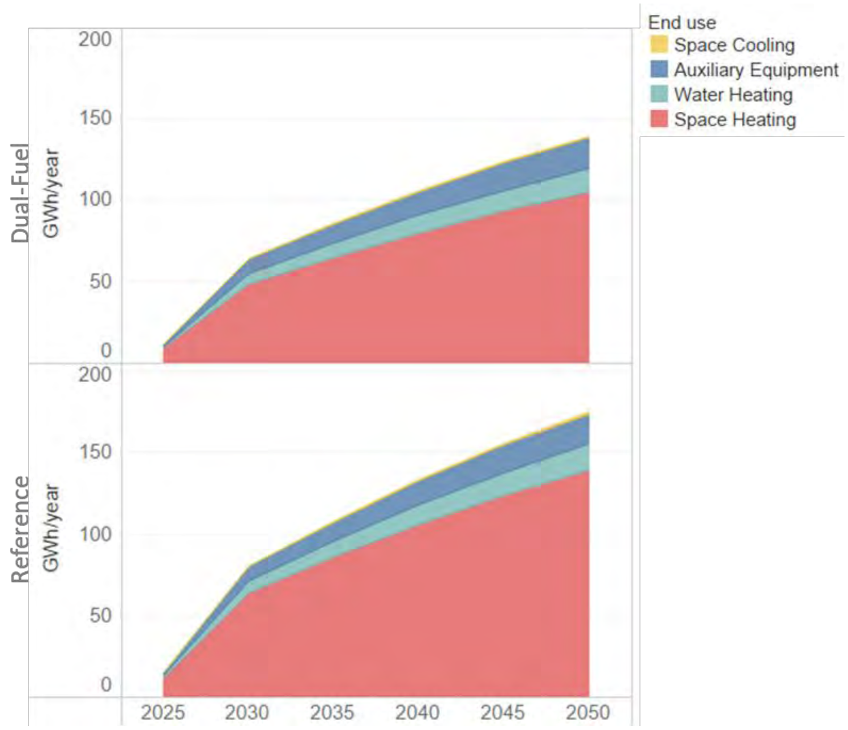
Figure 20. Reference & Dual-Fuel Scenarios Commercial Electrification Load Profile



As observed in the residential sector, seasonal impacts of dual-fuel heating compared to electric only heating are equally observed in the commercial sector. The most extreme examples occur in early January 2050, when Reference Scenario heating load exceeds 900 MW compared to 237 MW during that same hour in the Dual-Fuel Scenario.

Federal Building Electrification in the Reference Scenario and sensitivity utilized the same assumptions as Commercial Electrification, thus the results displayed in Figure 21 represent results consistent with that sector.

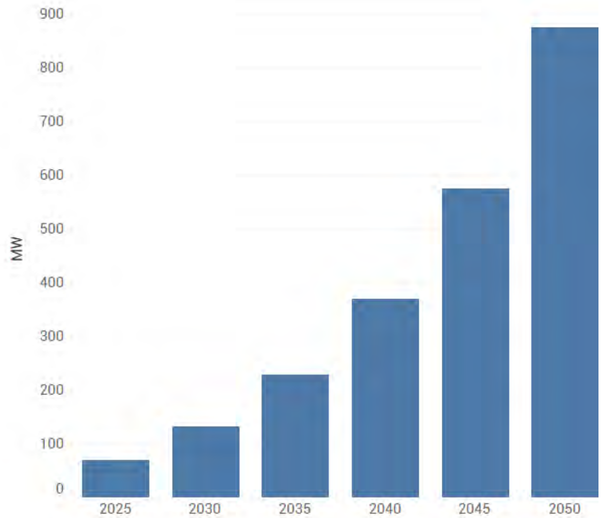
Figure 21. Reference Case Federal Electrification Annual Load



Reference Scenario and Dual-Fuel Scenario: Distributed PV Generation

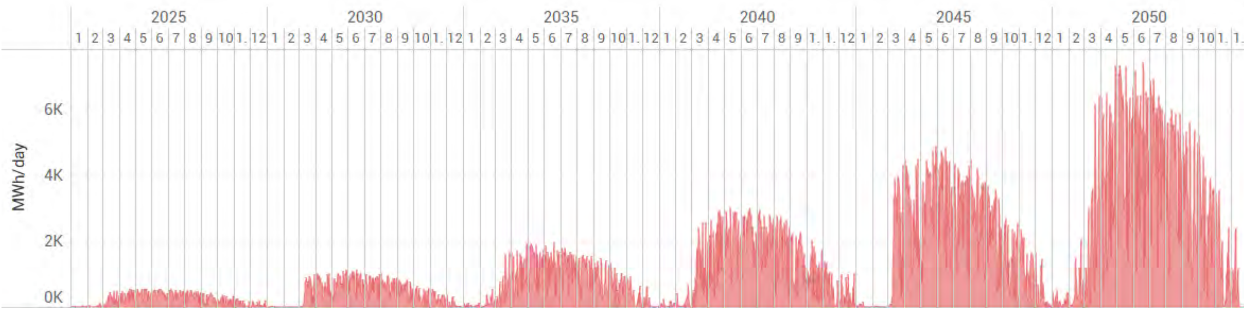
The moderate solar growth scenario from the City of Ottawa's Pathways Study on Solar Power was applied to project the Reference Scenario PV generation.[26] As a result, installed PV capacity grows incrementally throughout the projection horizon from 42 MW in 2022 to 875 MW in 2050, as shown in Figure 22. This same growth is observed in the Dual-Fuel Scenario given that this baseline assumption was unchanged.

Figure 22. Reference Case Distributed PV Installed Capacity



By 2050, distributed PV is projected to provide 5 to 6 GWh of generation on summer days. While this significantly offsets total load, it does not counteract evening peaks driven primarily from residential, commercial, and transportation electrification. Further, distributed PV generation also does little to offset winter evening peaks caused by space heating and water heating, as shown in generation profiles in Figure 23. This dynamic is important as HOL considers the impacts of NWS on the distribution system given that the system shifts from a summer peak to winter peak by 2030 in both the Reference Scenario and the Dual-Fuel Scenario. The role of solar and its ability to be paired with other NWS to increase reliability and resilience at substations is described in greater detail in Section 4.

Figure 23. Reference Scenario Distributed PV Generation Profile



Policy-Guided Scenario

The Policy-Guided Scenario was defined and projected assuming strict adherence to Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. Decarbonization curves and EV adoption curves in this scenario were built based on these policies and targets**.** In doing so, buildings across all sectors were projected to be fully electrified by 2050, phasing out natural gas use to reach zero emissions targets. This scenario represents significant potential impacts to HOL's grid if climate goals are successfully met and there is little done to address the electrification impacts.

Policy-Guided Scenario: Transportation Electrification

Table 5 provides a summary of the transportation electrification assumptions and the sources which informed such assumptions. Unlike the Reference Scenario and Dual-Fuel Scenario, no charging incentives were assumed, resulting in charging profiles that reflect no load-flattening effects driven from incentives. Charging profiles in the Policy-Guided Scenario were informed by the Electric Vehicle User Behavior: An Analysis of Charging Station Utilization in Canada report.[29]

Table 5. Policy-Guided Scenario Transportation Electrification Assumptions

METRIC	ASSUMPTION	INFORMED BY
% of New Electric LDV Sales	2026 – 20% of new LDVs 2030 – 60% of new LDVs 2035 – 100% of new LDVs	Canada Zero-Emission Vehicle Sales Targets
Charger Types	Residential L1 or L2 – 80% Public L2 – 17% Public DCFC – 3%	Dunsky & NRCan,[30] J.D. Power,[31] Black & Veatch analysis

METRIC	ASSUMPTION	INFORMED BY
Rate Incentive Adoption	0%	No load mitigation efforts in the Policy-Guided Scenario
MDV/HDV Load as a Percentage of total LDV load	2050 – 10% (increases incrementally up to 10% by 2050)	Black & Veatch analysis. MDV/HDV load should be assumed as an addition to LDV load

Annual consumption from transportation electrification increases at a compound annual growth rate (CAGR) of 29.5% between 2025 and 2035 as federal EV sales mandates ramp up before slowing to 7% CAGR between 2035 and 2050. Peak load occurs on average around 6:00 pm, driven by the existing trend of commuters getting home and plugging in for the evening. Energy consumed by electric vehicles is greater in the winter than in the summer because of decreased charging efficiency in colder months. This can be seen most pronounced in 2050 where winter peak approaches 1 GW while summer peak is about 650 MW. Figure 24 shows the amount of transportation electrification end use, followed by Figure 25 which shows the transportation load profiles over the study horizon.

Figure 24. Policy-Guided Scenario Transportation Electrification by End-Use

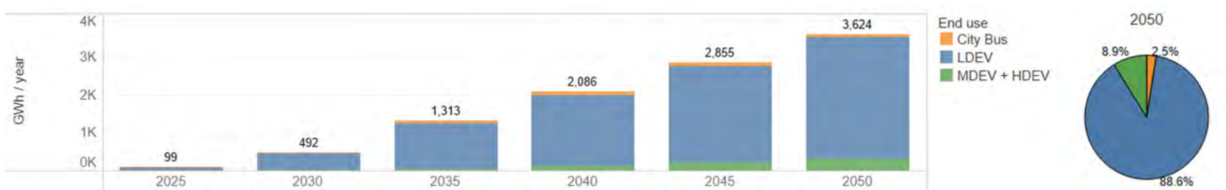
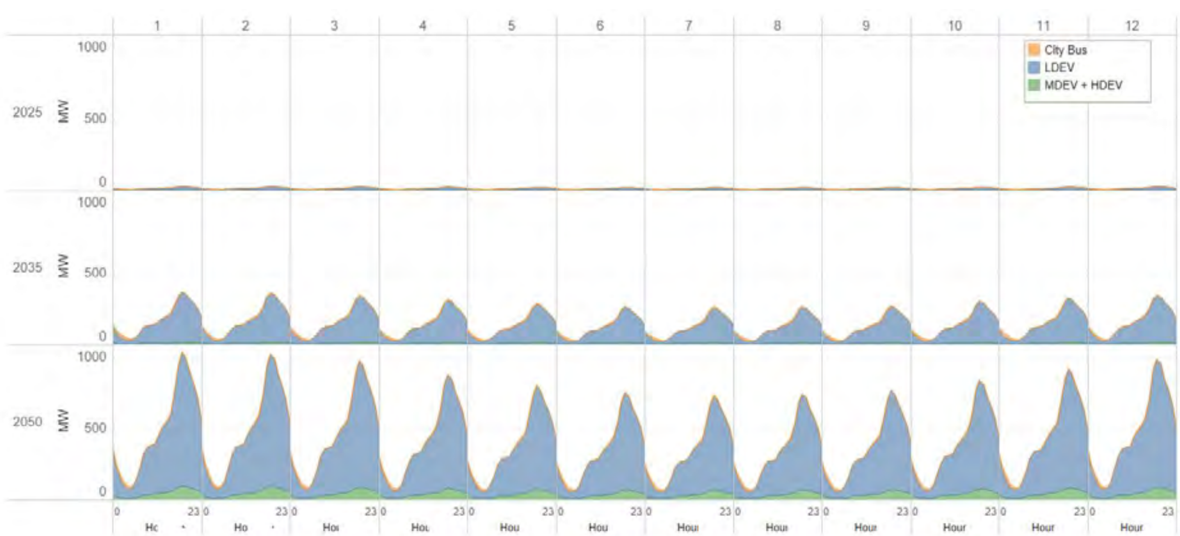


Figure 25. Policy-Guided Scenario Transportation Electrification Load Profile



Policy-Guided Scenario: Residential Electrification

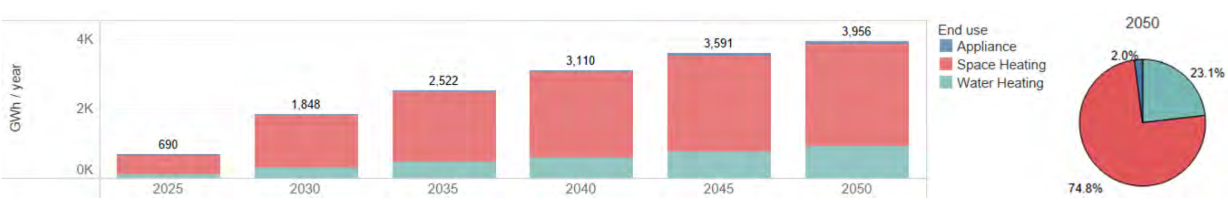
Residential energy use in the Policy-Guided Scenario was decarbonized based on Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. Buildings are assumed to be completely electrified, with space heating and water heating provided by heat pumps and electric resistance heating. Residential heating (both water heating and space heating) was projected to be 100% electrified by 2050, consistent with decarbonization targets leveraged in this scenario. Black & Veatch used a mix of publicly available sources to develop weighted average heating efficiencies. Coefficients of performance (COPs) of both water and space heating declined during hours in which temperature reached below -10°C. Table 6 provides a summary of the residential and commercial electrification assumptions incorporated in this scenario analysis.

Table 6. Residential & Commercial Segment Electrification Assumptions: Policy-Guided Scenario

METRIC	POLICY-GUIDED SCENARIO	INFORMED BY
Space Heating Electrification Target (Achieved by 2050)	100% electric heating (combination of heat pumps and electric furnaces	Scenario assumption that federal targets are met via full building electrification
Heat Pump Space Heating COP	Residential – 3.24 Commercial – 3.00	• Weighted average electric heating efficiencies • Canada's Energy Future study[23] • City of Ottawa Energy Evolution[22] • National Energy Code of Canada for Buildings[25]
Extreme Temperature (-10°C) Space Heating COP	Residential Space Heating – 1.76 Commercial Space Heating – 1.76	Black & Veatch & HOL analysis leveraging combination of datasets above
Water Heating Electrification Targets	100% electric	National Energy Code of Canada for Buildings[25]

Annual new electrification load from residential electrification increased to 1,848 GWh in 2030 and to 3,110 GWh in 2040, an increase of 68% in that 10-year period. While electrification-driven growth slows past 2040 it still grows a considerable 27%, reaching 3,956 GWh/year in 2050. The high electrification growth in the near- to mid-term is driven by the more aggressive decarbonization curve assumed in that period to meet interim Canadian emissions targets. Load growth, while still significant between the 2040 and 2050 period, slows due to a projected heating load comprised of more efficient heating technologies such as air- and ground-source heat pumps. Figure 26 shows residential electrification load increase by end-use over the study horizon.

Figure 26. Policy-Guided Scenario Residential Electrification by End-Use



Space heating and water heating dominate residential electrification, accounting for a combined 98% of new electrification residential load. Space heating drives early morning peaks while water heating has both an evening and early morning peak. This is due to typical residential behavior turning on heating and hot water first thing in the morning and at the end of the workday. Heating efficiency significantly impacts load, and the relatively high penetration of electric resistance heating causes higher residential values than other scenarios. Figure 27 shows residential electrification profiles by end-use.

Figure 27. Policy-Guided Scenario Residential Electrification by End-Use

Policy-Guided Scenario: Commercial Electrification & Federal Building Electrification

Similar to the residential sector, commercial energy use was decarbonized based on the Target for Buildings from the Government of Canada. In line with residential electrification assumptions, commercial buildings are assumed to be completely electrified, with space heating and water heating provided by various commercial technologies that meet the National Energy Code of Canada. Commercial heating (both water heating and space heating) was projected to be 100% electrified by 2050, consistent with decarbonization targets leveraged in this scenario. Black & Veatch leveraged a mix of publicly available sources to develop weighted average heating efficiencies. Coefficients of performance (COPs) of both water and space heating declined during hours in which temperature reached below -10°C.

Like the residential sector, commercial load is dominated by space heating and water heating, as displayed in Figure 28. However, auxiliary equipment such as dryers and ovens play a significant role as well, accounting for 10% of new load by 2050. Unlike residential load profiles, commercial electrification peaks only in the morning. This coincides with the beginning of the workday and trails off in the evening as the workday concludes, as shown in Figure 29.

Figure 28. Policy-Guided Scenario Commercial Electrification by End-Use

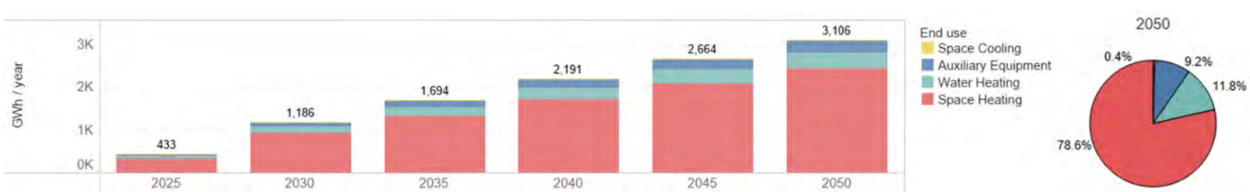
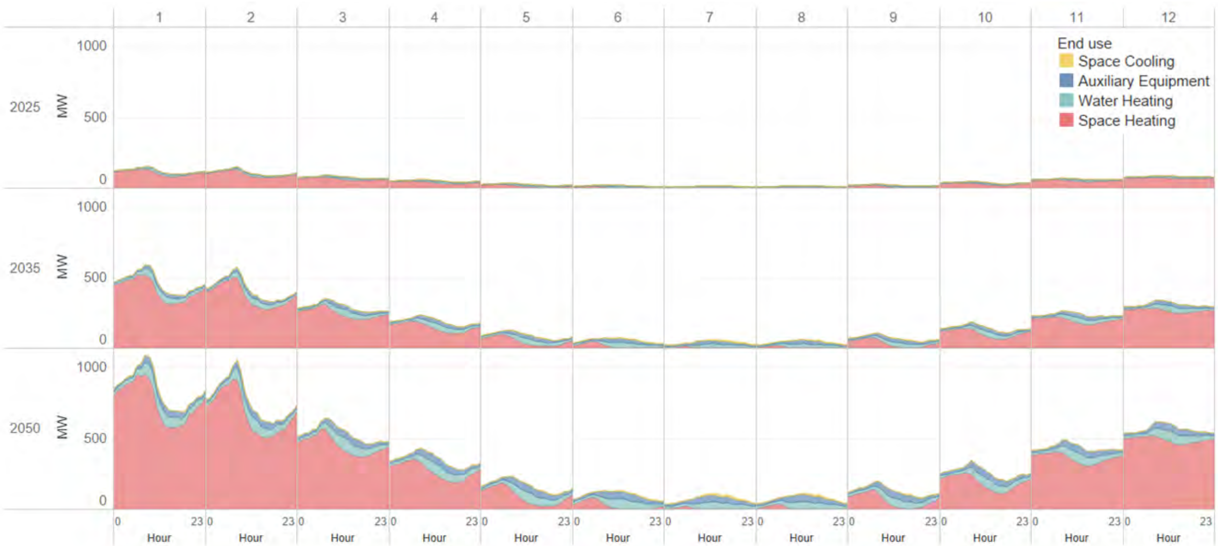
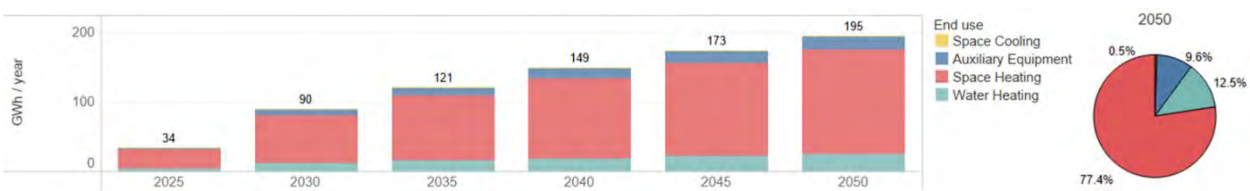


Figure 29. Policy-Guided Scenario Commercial Electrification Load Profile



The same decarbonization assumptions and energy uses for Commercial buildings were used for the 130 Federal buildings, however decarbonization targets were applied to each facility's estimated energy consumption rather than the sector's energy consumption as a whole. Because of these assumptions, results from Federal building electrification mirror those of commercial buildings, as shown in Figure 30.

Figure 30. Policy-Guided Scenario Federal Electrification by End-Use



Policy-Guided Scenario: Distributed PV Generation

The moderate growth scenario from the City of Ottawa's Pathways Study on Solar Power[26] was also applied to project the Policy-Guided Scenario PV generation. As a result, installed PV capacity increases incrementally throughout the horizon from 42 MW in 2022 to 875 MW in 2050, identical to the Reference and Dual-Fuel Scenarios, as shown in Figure 31 and Figure 32.

Figure 31. Policy-Guided Scenario Distributed PV Installed Capacity

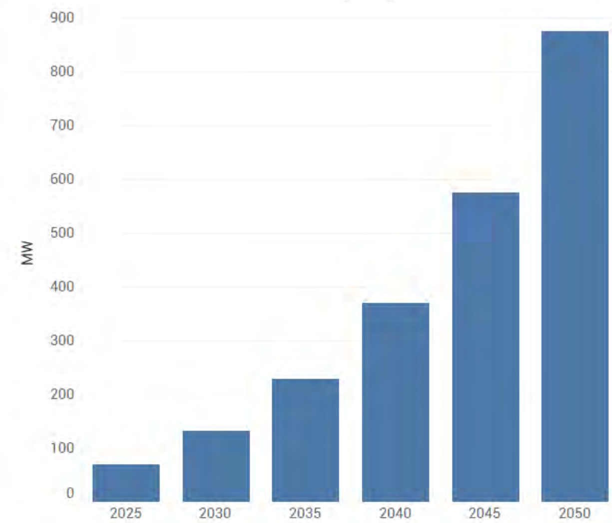
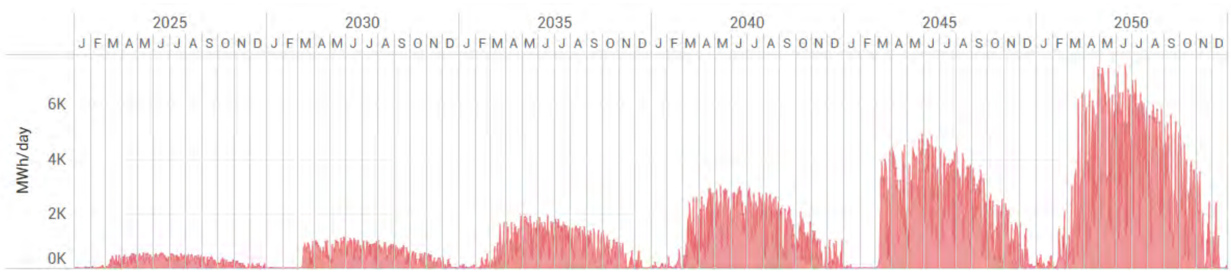


Figure 32. Policy-Guided Scenario Distributed PV Generation Profile



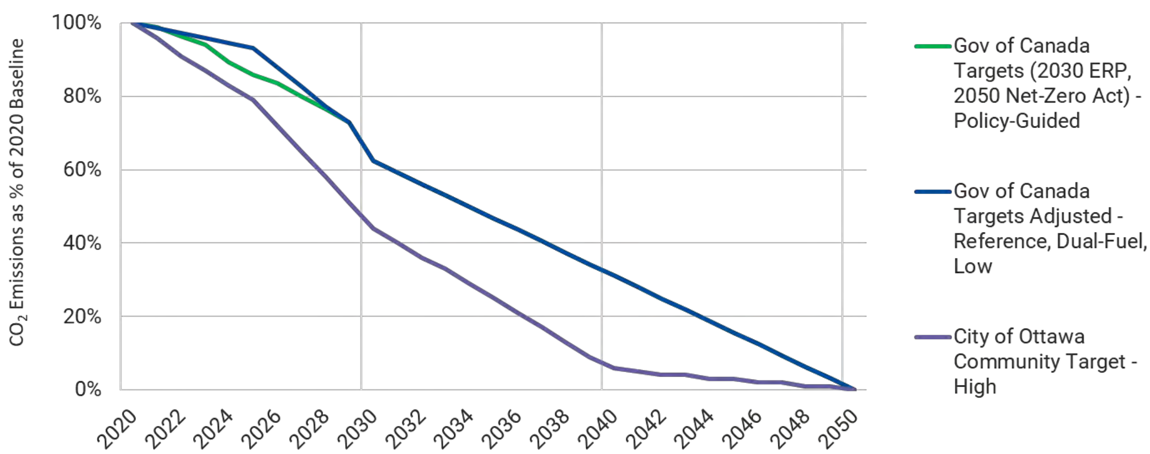
Given the use of the same solar projections and curves, solar projections in the Policy-Guided Scenario are identical to the Reference and Dual-Fuel Scenarios as summarized. By 2050, distributed PV contributes 5-6 GWh of generation on summer days. While this significantly offsets total load, it does not counteract evening peaks driven primarily from residential, commercial, and transportation electrification. Further, distributed PV generation also does little to offset winter evening peaks caused by space heating and water heating.

High & Low Sensitivities

The High Case Sensitivity and Low Case Sensitivity were developed to examine more aggressive and less aggressive decarbonization pathways, respectively, than current climate goals and expectations. Each sensitivity is meant to show possible high and low extremes in each customer segment and thus faster or slower progress towards climate goals.

To track with these trends, the High Case assumes a general societal shift towards a decarbonization mindset, where electrification not only happens faster but efficiencies of electrification technologies improve due to significant focus on research & development. Most notably, the High Sensitivity assumes the achievement of near-complete decarbonization by 2040, the most aggressive of all scenarios and sensitivities modeled in this study (see Figure 33). Conversely, electrification technologies are adopted slower in the Low Case and a higher proportion of households and commercial buildings continue to rely on decarbonized gaseous fuels.

Figure 33. Scenario & Sensitivity Decarbonization Profile Comparison



High & Low Sensitivities: Transportation Electrification

The primary differentiator in the sensitivities when compared to previously discussed transportation electrification is the rate of EV adoption (i.e., growth of new EV sales). In the High Sensitivity, EV adoption accelerates even faster than Canada's federal targets, reaching 90% of new vehicle sales by 2030 and 100% by 2035. Conversely, the Low Sensitivity models a significantly slowed pace of EV adoption, whether that be driven by societal resistance, lack of charging infrastructure build-out, or long-term supply chain issues. In the Low Sensitivity, EVs reach 40% of new sales by 2035 and 90% by 2050, indicating that a significant portion of the overall vehicle stock will remain gasoline or diesel powered past 2050. Table 7 shows the full list of assumptions specific to these sensitivities.

Table 7. High & Low Sensitivities Transportation Electrification Assumptions

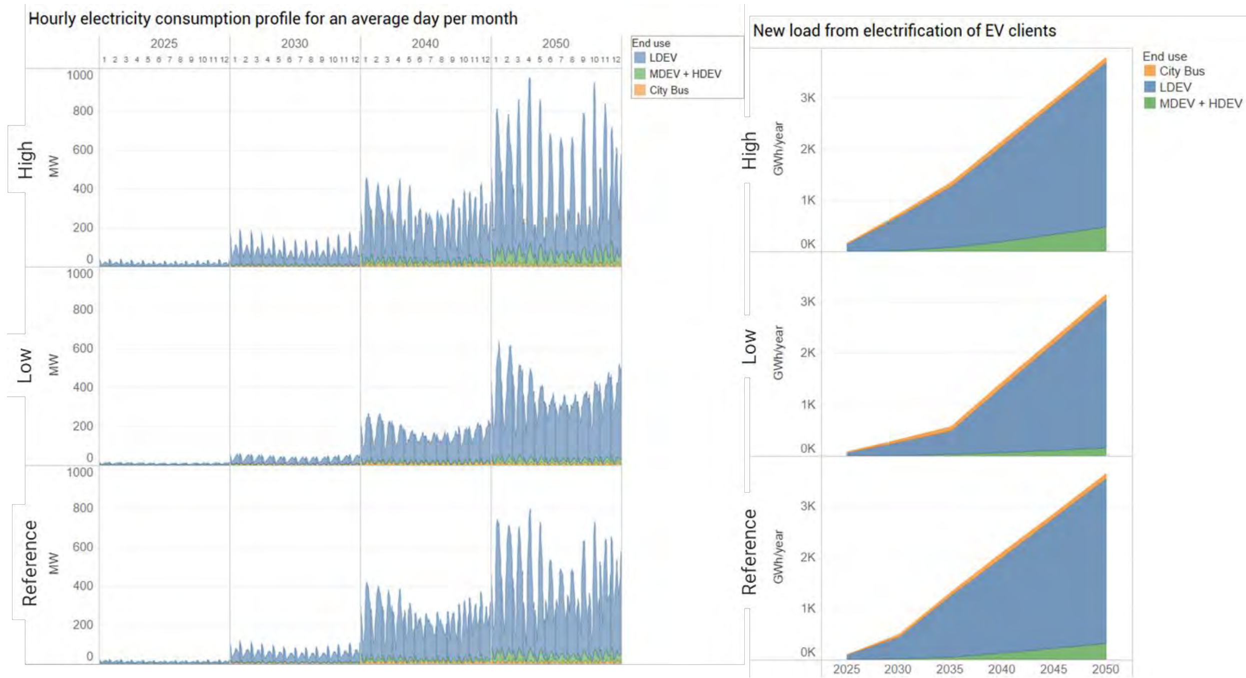
METRIC	HIGH SENSITIVITY	LOW SENSITIVITY	INFORMED BY
% of New Electric LDV Sales	2026 – 30% 2030 – 90% 2035 – 100%	2026 – 16% 2035 – 40% 2050 – 90%	High: Combination of City of Ottawa Energy Evolution[32] & Federal Targets Low: Sustainability Solutions Group's Pathway Study on Transportation in Ottawa[33]

[32] City of Ottawa Energy Evolution.
[33] Sustainability Solutions Group Pathway Study on Transportation in Ottawa, 2019.

METRIC	HIGH SENSITIVITY	LOW SENSITIVITY	INFORMED BY
Charger Types	Residential L1 or L2 - 85% Public L2 – 12% Public DCFC – 3%	Residential L1 or L2 – 80% Public L2 – 17% Public DCFC – 3%	Dunsky[30], JD Power[31], Black & Veatch analysis
Rate Incentive Adoption	90%	50%	High: BC Hydro TOU Rate Application High-End Sensitivity[28] Low: BC Hydro TOU Rate Application Low-End Sensitivity[28]
MDV/HDV Load as a Percentage of total LDV load	2050 – 15% (increases incrementally up to 15% by 2050)	2050 – 5% (increases incrementally up to 5% by 2050)	Black & Veatch & HOL analysis

As illustrated in Figure 34, adoption rates of both LDV and MDV/HDV significantly influence the rate at which EV load grows. From 2030-2040, the High Scenario outpaces the Reference Scenario because EVs have already reached 90% of new vehicle sales by 2030. The opposite can be seen in the Low Sensitivity, as EVs do not reach 40% of new sales until 2035 and have still not fully displaced ICE vehicles by 2050. Separate from the quantity of load, the transportation load profile changes drastically in the High and Low case due to the levels of rate incentive adoption. When compared to the Reference Scenario with 75% adoption, the High sensitivity (with 90% adoption) EV load shifted more towards midday hours when load is generally lower, potentially aiding in HOL load management. Conversely, the EV load in the Low sensitivity displays much less severe peaks than the other two shown because, with only 50% rate incentive adoption, fewer people are prioritizing charging at certain times of low demand during the day.

Figure 34. High & Low Sensitivity Transportation Electrification



Residential, Commercial, and Federal Electrification

In the building sectors for the High and Low Sensitivities, electrification rates, decarbonization timing, and efficiency of heating were all altered to reflect the more and less aggressive projection, respectively. Efficiencies were improved in the High Sensitivity to reflect a societal acceptance of electrification and the associated innovation to be expected with such a shift. The opposite logic was applied to the Low Sensitivity. Table 8 provides an overview of the residential and commercial electrification assumptions used in the high and low sensitivities.

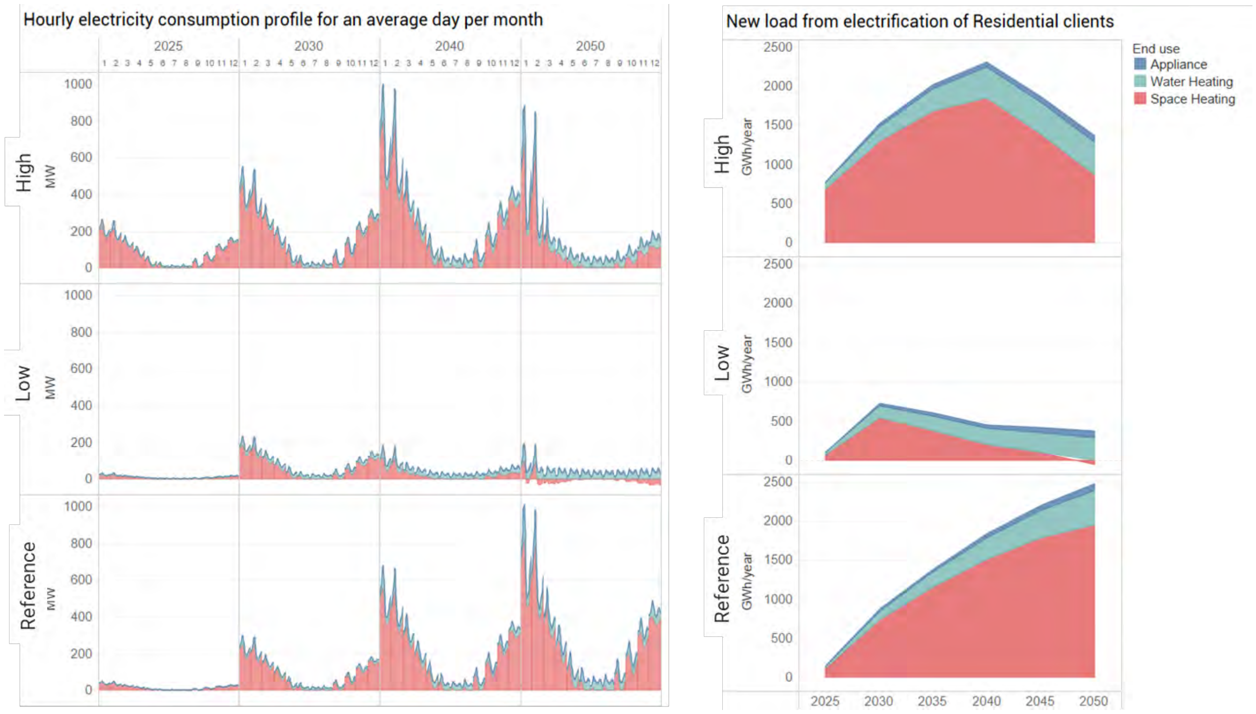
Table 8. Residential & Commercial Segment Electrification Assumptions: High & Low Sensitivities

METRIC	HIGH SENSITIVITY	LOW SENSITIVITY	INFORMED BY
Space Heating Electrification Target (Achieved by 2050)	85% electric heating	40% electric heating	High: Enbridge Pathways Study, Electrification Scenario[24] Low: Enbridge Pathways Study, Diversified Scenario[24]
Heat Pump Space Heating COP	Residential – 3.96 Commercial – 3.67	Residential – 3.24 Commercial – 3.00	• Weighted average electric heating efficiencies • Enbridge Pathways Study[24] • National Energy Code of Canada for Buildings
Extreme Temperature (-10°C) Space Heating COP	Residential Space Heating – 1.43 Commercial Space Heating – 1.43	Residential Space Heating – 1.76 Commercial Space Heating – 1.76	Black & Veatch & HOL analysis leveraging combination of datasets above

As expected, heating demand in the High Sensitivity and Reference Scenario shares more similarities when compared to the Low Sensitivity. However, the difference in the decarbonization curve between these two scenarios should be noted. The High Sensitivity assumes a more aggressive decarbonization curve compared to the more moderate curve assumed in the Reference Scenario. In the High Sensitivity, decarbonization is assumed to be nearly complete by 2040, compared to 2050 in the Reference Scenario. Further, residential heat pump adoption is assumed to be higher in the High Sensitivity compared to the Reference Scenario, resulting in overall more efficient heating loads in the later years in the horizon as adoption is increased. This is reflected in an observed decline in total electrification in the High Sensitivity post-2040 through the end of the horizon.

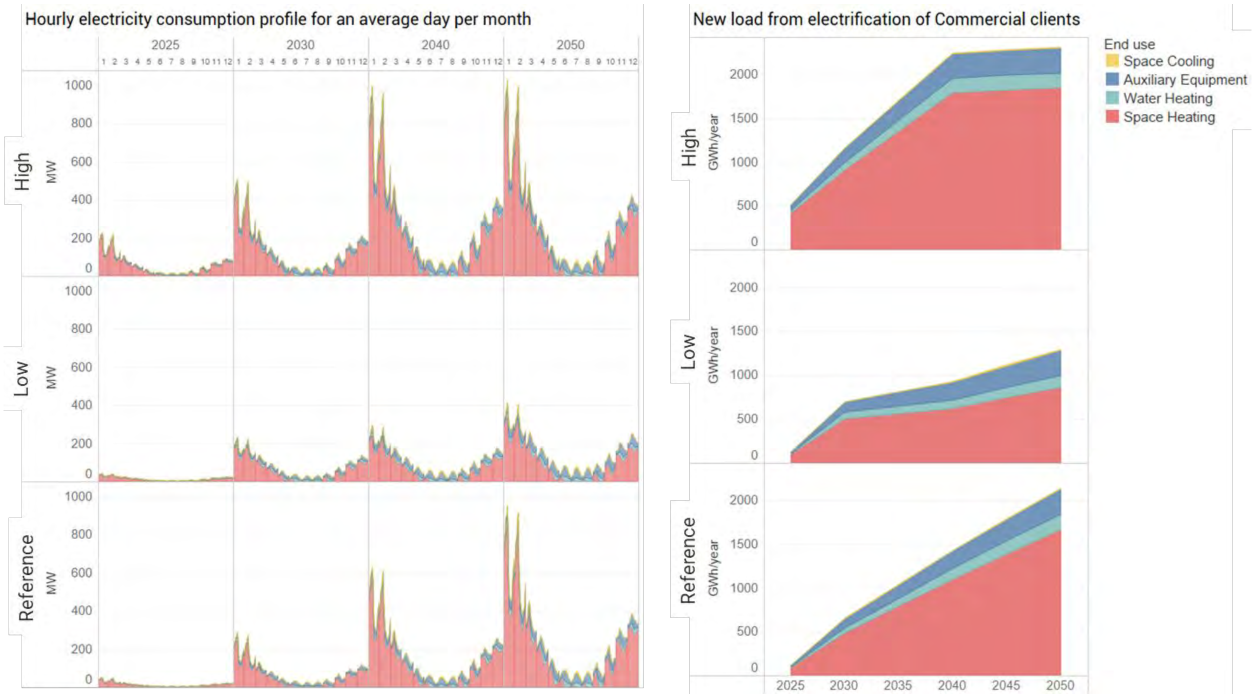
As an example, the Reference Scenario reaches over 1,000 MW of residential heating electrification in January on one day; during that same day, the High Scenario reaches 880 MW and the Low Scenario only 188 MW. This trend is more clearly shown in Figure 35. This trend is especially true for the period between 2040 and 2050 after full decarbonization is reached in the High Sensitivity. In the Low Sensitivity, space heating shows negative values at the end of the horizon as existing electric resistance space heating is converted to higher-efficiency heat pumps or low carbon gas.

Figure 35. High & Low Sensitivity Residential Electrification



The same trends observed in residential electrification are true for commercial electrification. As demonstrated in Figure 36, the High Sensitivity load increases driven by near-complete decarbonization by 2040 ramps up significantly towards 2040 compared to the Reference Scenario. After 2040, commercial, residential, and federal building electrification in the Reference Scenario catches up and then eventually outpaces the High Sensitivity.

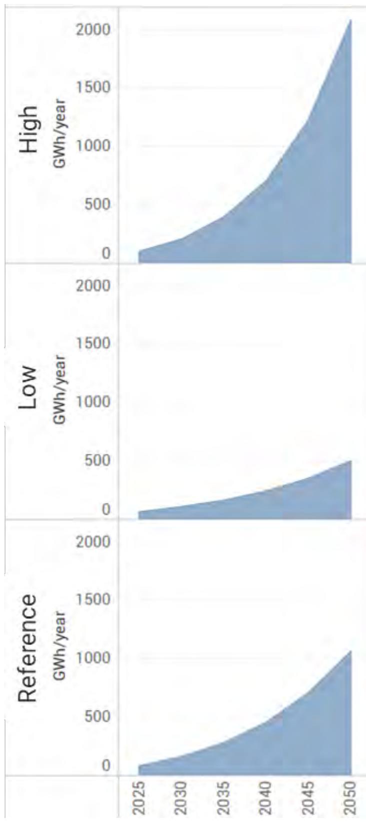
Figure 36. High & Low Sensitivity Commercial Electrification



Distributed PV Generation

The High & Low Sensitivities utilized the Aggressive Scenario and Conservative Scenario, respectively, from the City of Ottawa's Pathways Study on Solar Power (reflected in Figure 9).[26] The different growth rates across projections lead to significant differences in PV generation on HOL's grid. By 2050 PV in the High sensitivity generates 2,089 GWh per year, nearly twice as much as the Reference Scenario while the Low sensitivity generates 501 GWh – less than half the Reference Scenario. The resulting PV generation projection of each sensitivity is shown in Figure 37.

Figure 37. High & Low Sensitivity Annual Projected PV Generation



2.3 RESULTS SUMMARY & COMPARISON

Black & Veatch modeled system-level results for HOL's grid by compiling baseload and new electrification load across all customer segments for each of the three primary scenarios. This section summarizes key results for these scenarios and provides insights on the drivers of load growth and peak shifts throughout the study horizon. In all scenarios and sensitivities, load growth and peak demand are expected to increase dramatically. Projected building and heating electrification across all sectors paired with a shift from internal combustion engine vehicles (ICE) to EVs adds expected but considerable load increases to the HOL distribution system.

Impact on Peak Load and Peak Timing

All scenarios project significant peak load growth for HOL's grid (see Figure 38 and Figure 39). The Reference Scenario peak demand grows at a CAGR of 4.7% from 1,348 MW in 2022 to 4,947 MW in 2050. Policy-Guided Scenario peak demand grows at an annual rate of 5.2% to reach 5,573 MW in 2050 while Dual-Fuel Scenario peak grows at a slower CAGR of 3.1% per year, reaching 3,135 MW in 2050. This type of dramatic growth associated with the decarbonization of Ottawa's economy is an expected departure from the observed trend in the past decade-plus on HOL's system of flat or declining peak load (1,518 MW in 2010 and 1,308 MW in 2014.) This expectation is driven from the relatively aggressive decarbonization assumptions and existing initiatives supporting those assumptions for Canada to meet its aggressive emissions and net-zero targets in the mid-to-long term.

Figure 38. Scenario Peak By Year

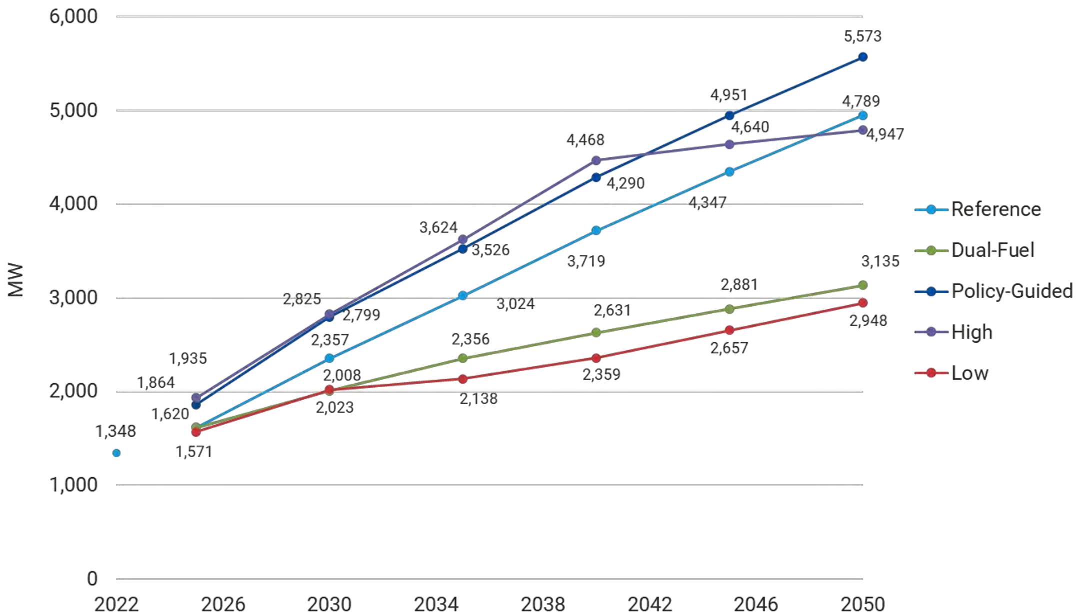


Figure 39. Scenario & Sensitivity Peak Timing Projections

Scenario	2022	2025	2030	2035	2040	2045	2050
Reference	17:00	15:00	18:00	18:00	18:00	18:00	18:00
	July 20	July 16	Jan 20	Jan 20	Jan 20	Jan 20	Jan 20
Dual-Fuel	17:00	15:00	18:00	18:00	18:00	18:00	13:00
	July 20	July 16	Jan 23	Jan 22	Jan 23	Jan 23	Mar 1
Policy-Guided	17:00	18:00	18:00	18:00	18:00	18:00	18:00
	July 20	Jan 21	Jan 20	Jan 20	Jan 20	Jan 20	Jan 20

Note: yellow indicates summer peak; blue indicates winter peak

In the Reference and Dual-Fuel Scenarios, HOL's system remains summer-peaking through 2025 (seen in yellow cells in Figure 39), as it is today. In all scenarios, the system-level peak shifts to winter by 2030 with the Policy-Guided Scenario becoming winter-peaking by 2025, as expected given that this scenario was modeled with the most aggressive decarbonization curve. Conversely, the delay in the switch to winter-peaking in the Reference and Dual-Fuel Scenarios is driven by the applied decarbonization curve which projects a tempered rate of decarbonization in the near term before decarbonization technologies such as heat pumps and electric vehicles reach widespread adoption in the mid-term.

The shift to winter peak timing is largely driven by space heating. This effect is especially pronounced in the Reference and Policy-Guided Scenarios, where higher electrification rates in buildings lead to spikes in space heating when temperatures are low and impact heating efficiency. Compounding this effect is the prevalence of electric resistance heating in the Policy-Guided Scenario, which has lower efficiency than heat pumps. The Dual-Fuel Scenario is much less exposed to these lower efficiencies due to high penetration of dual-fuel heat pump systems which switch to gas when efficiencies drop below a certain threshold.

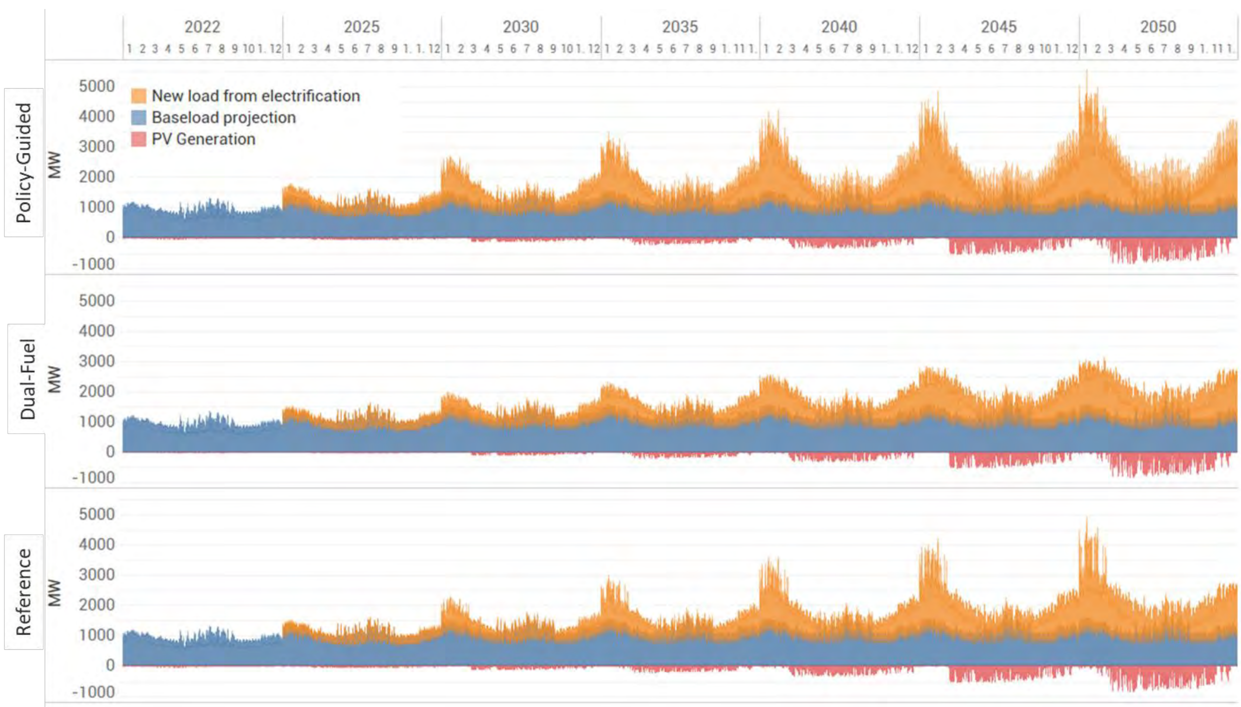
Peak demand in the Reference and Dual-Fuel Scenarios is also tempered by EV Charging incentives, which displace EV charging load from peak demand hours to low demand hours. These rate incentives are effective at lessening peak demand because they drive shifts in projected charging load away from the early evening when residents return from work, plug in their EV, turn the heat on, and begin cooking dinner.

Impact on Annual Electricity Consumption

Across the study horizon, new electrification load is the primary driver of load growth. Baseload consumption grows 10% between 2025 and 2050 while new electrification load grows over 2,000% in the same period in the Reference Scenario. In the summer months, EVs become the dominant source of new load for all scenarios as space heating and water heating become the dominant source of new load in the winter months.

The Policy-Guided Scenario projects the highest annual consumption of the three primary scenarios, 9% higher than the Reference Scenario and 10% higher than the Dual-Fuel Scenario in 2025. This trend continues and the gap widens through 2050, where it is 14% and 20% higher than the Reference and Dual-Fuel Scenarios respectively (see Figure 40). This higher annual load is driven by the full electrification of buildings across all customer segments in the Policy-Guided Scenario, while the other two scenarios maintain differing proportions of gas in the energy mix. While the Reference and Dual-Fuel Scenarios show similar annual consumption, the penetration of dual-fuel heating systems causes significantly different peak demand.

Figure 40. System-Level Annual Load Profile by Scenario



A detailed assessment of the implications of a decarbonization-driven electrification future on the HOL distribution system is outlined in the following section, specifically considering planning and systems upgrades for the HOL distribution system under a future in which the Reference Scenario is realized.

3.0 Decarbonization Load Impacts to HOL's Distribution System

3.1 METHODOLOGY & ASSUMPTIONS

Once the load was projected (approach and key findings by scenario in Section 2.0), a mitigation strategy to manage this increase in load was developed in two steps:

(1) an overload analysis to determine which substations are overloaded; and

(2) proposed strategies to manage the overload conditions at specific substations.

The methods for these tasks are described below.

Overload Analysis

The projected Reference Scenario load allocated to the existing 92 substations within HOL's service territory, as described in Section 2.1 Methodology and Assumptions, was utilized to assess if an overload condition was projected at each substation. HOL provided the characteristics for each of the 92 substations that was used as input into this analysis.[34] These inputs are included in Appendix A.

An initial screening was performed to evaluate if a substation needed to be included in the comprehensive overload analysis. Of the 92 existing HOL substations, 35 were excluded from the overload analysis if they met either of the following criteria. As such, only 57 substations are evaluated for overload[35]. Substations were not included for one of the following two reasons:

- If the substation is already planned for a voltage upgrade, or
- If the substation is planned to be decommissioned

Many of these planned voltage upgrades and decommissions are due to the load growth expected on HOL's existing 4kV system. Forecasts from HOL, further supported by this study, indicate the 4kV system will not be able to support expected load growth. As a result, the 4kV system is being upgraded to supported future load growth.

An overload condition is defined as when the allocated load from the Reference Scenario exceeds the station planning rating for each substation on an hourly basis. HOL provided the station planning ratings

[34] For the purposes of this analysis, Black & Veatch considered Bridlewood MS as two substations, one rated at 28kV and one at 8kV. If combined, the total substations is 92.
[35] Due to Bridlewood MS being modeled as 2 different substations with different characteristics, the overall results may vary resulting in 93 total substations being evaluated.

for each substation to be used in this analysis. Due to the effects of temperature on transformer capacity, separate planning ratings for summer and winter were used.[36]

The overload analysis compared the hourly projected load against the existing winter or summer planning rating depending on the month of the applied load. If the projected load exceeds the planning rating for the time of year the load occurs, the amount of overload was determined and an overload condition for that season is noted. If there is an overload for either winter or summer, then it is considered to be overloaded for that year.

The analysis was done for the years 2035 and 2050. These two years were selected as 2035 would indicate a lower, but more certain load case in the short term, where the 2050 load case would indicate a higher, but more uncertain load case in the long run. These two cases are used to set lower and upper bounds for needed investments to address the new load profiles on the distribution system.

Management of Overload Conditions

Once the overload conditions were established, two approaches were utilized to address the overload condition at each substation: evaluation of the potential to transfer the load from the overloaded substation to connected substations in the same grouping within the same distribution system and/or evaluation of the options for capital improvements to accommodate decarbonization load projections.

Potential to Transfer Load

HOL substations were organized in groupings that represent the potential capability of transferring load from one substation to another within the same grouping. This provides HOL flexibility in handling unusually high loads in times of peak stress or managing load when substations are unavailable for maintenance.[37] Given the new decarbonization projected load, these groupings could be utilized to distribute the load from the overloaded substation to connected substations in the same grouping. By doing so, this approach would allow HOL to avoid system modifications to address the overloaded condition and thus potentially avoid capital expenditure.

To evaluate whether the load that exceeds the planning ratings for equipment at each substation could be transferred, the amount of load above the planning rating (summer or winter, as appropriate given the time of year of the load) was compared to the available capacity in the connected substations within the same grouping. If there was available capacity in the connected substations based on their load at that same hour and their planning rating, then the potential to transfer the load was flagged. An illustrative example is shown in Figure 41. If not, it is not considered to be able to transfer the load. This is illustrated in Figure 42.

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[36] The winter planning rating was applied from November through March, and the summer planning rating was applied from April through October.
[37] These groupings are shown in Appendix A.

Figure 41. Potential to Transfer Overload Illustrative Example

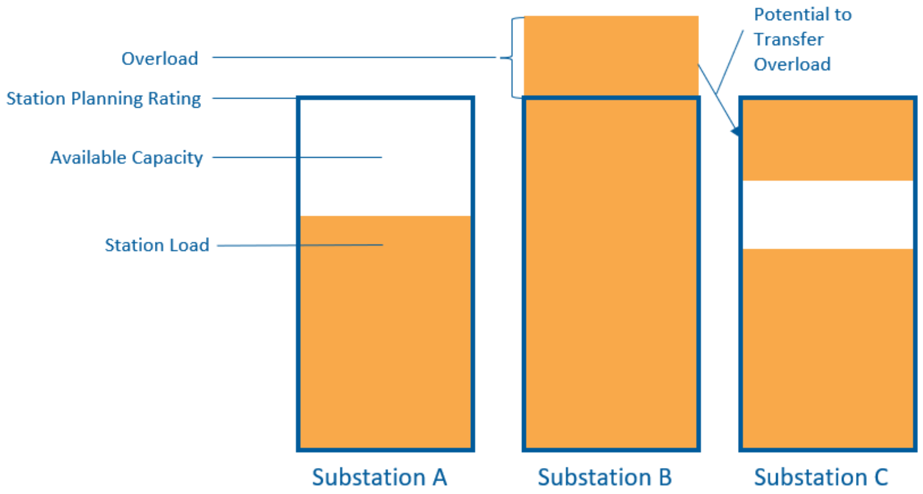
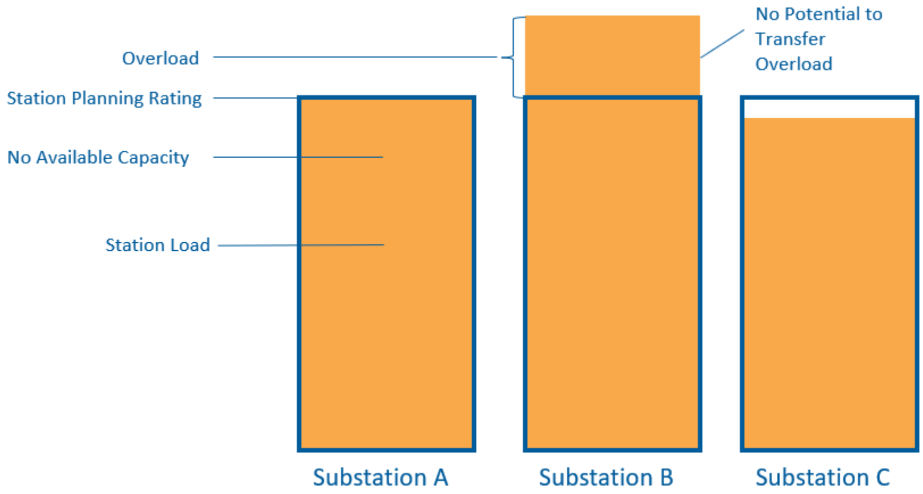


Figure 42. No Potential to Transfer Overload Illustrative Example



It should be noted that this evaluation only determines the potential to transfer the load as it evaluates the load against the substation planning ratings, but does not include the following considerations that would be required to do fully determine if a transfer is possible:

- Available feeder circuit capacity
- Available feeder tie circuit capacity
- Protection and coordination settings

A detailed system connected feasibility study and other distribution model studies are required to fully determine if a transfer can actually be performed. Because this evaluation only includes the potential to transfer the overload, this analysis was used to set upper and lower bounds on capital investment required to address the overload. Upgrades required for substations that cannot transfer the overload sets the minimum amount of capital investment needed to address the overload. The upper bound assumes that no substations can transfer the load and modifications are needed for all substations to handle the overload.

Capital Improvements to Accommodate Overload

The second approach to manage the new projected load in the Reference Scenario involved modifications to the existing distribution system, accomplished via either a wires only solution (i.e., traditional substation upgrades) or a non-wires solution. Examples of potential non-wires solutions (NWS) include solar, BESS, combustion turbines (CTs), RECIPS, fuel cells, and micronuclear. From these options, only BESS and RECIPs were considered. Solar was not included due to the large amount of land per MW required. Moreover, solar is least effective in winter when the new system peak occurs. CTs and fuel cells are not as effective in this use case due to significant dynamic and part load operation compared to RECIPs. Micronuclear was not considered due to technology maturity, cost, and schedule/licensing issues.

As a result of this NWS screening, the following technologies were evaluated for each of the overloaded substations:

- Wires Only Solutions – Consideration of only traditional wires solutions to addressed substation overload conditions. Wires only solutions include upgrades to existing substations and/or the addition of new substations.
- BESS – Evaluation of the role of BESS as an NWS to address substation overloads over the study horizon. If the substation had enough capacity during non-overload hours to sufficiently charge a BESS to discharge during an overload condition, the substation was determined to be eligible for a BESS. If there was not sufficient power available to charge a BESS prior to the overload, a BESS was not proposed, and the wires only was applied.
- RECIPs – Evaluation of the role of RECIPs as an NWS to address substation overloads. Each overloaded substation was evaluated to determine the required size and directional cost of the RECIP required.

The evaluation of each of these technologies only considers the required capacity to address the overload. No technical feasibility analysis was performed as part of the study. Items that were not considered but are recommended for future analysis include but are not limited to the following:

- Available footprint to upgrade existing transformers, add new transformers, add BESS or reciprocating engines to an existing substation.
- Available land to add new substations in the required service area.
- Ability of circuits outside of the substation to carry the additional load.
- Ability to provide sufficient natural gas to the reciprocating engines.

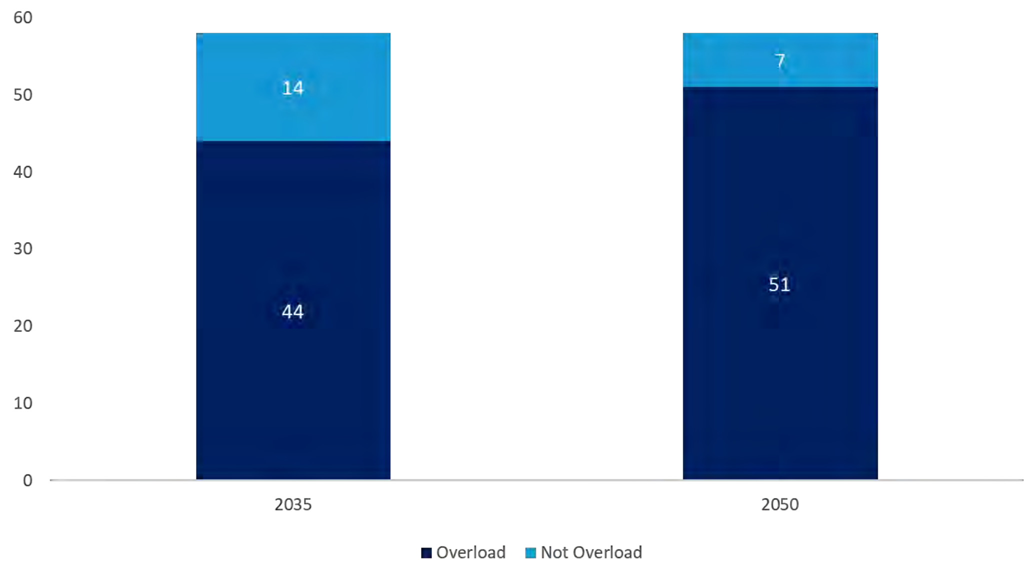
3.2 SUBSTATION OVERLOAD RESULTS & SOLUTIONS SCENARIOS

The results of the overload analysis are presented in two sections. The first section outlines the substation overloads that were identified and the second discusses the different wires and non-wires solutions assessed in this analysis to address substation overload. The second section provides a deep dive into the comparison of the two primary solution scenarios and compares the ROM cost of addressing the overload conditions to ensure future HOL system reliability.

Substation Overload Results

As discussed in Section 3.1, 35 of the 92 substations were excluded from this overload analysis. Of the remaining 58 substations, 44 of them are forecasted to experience an overload condition between 2025 and 2035, compared to 51 experiencing an overload condition between now and 2050.[38] Overloads were determined consistent with the methodology described in Section 3.1 Methodology and Assumptions. Figure 43 shows the cumulative number of overloaded substations of the 58 assessed substations, in 2035 and 2050 using the Reference Scenario load profiles. As shown in Figure 43, 44 of the 58 substations face their first overload condition by 2035, assuming Reference Scenario load profiles are realized this early in the study horizon. An additional 7 of the 58 substations reach overload conditions in 2040 or later. The remaining 7 substations do not reach overload conditions.

Figure 43. Cumulative Substation Condition in 2035 & 2050



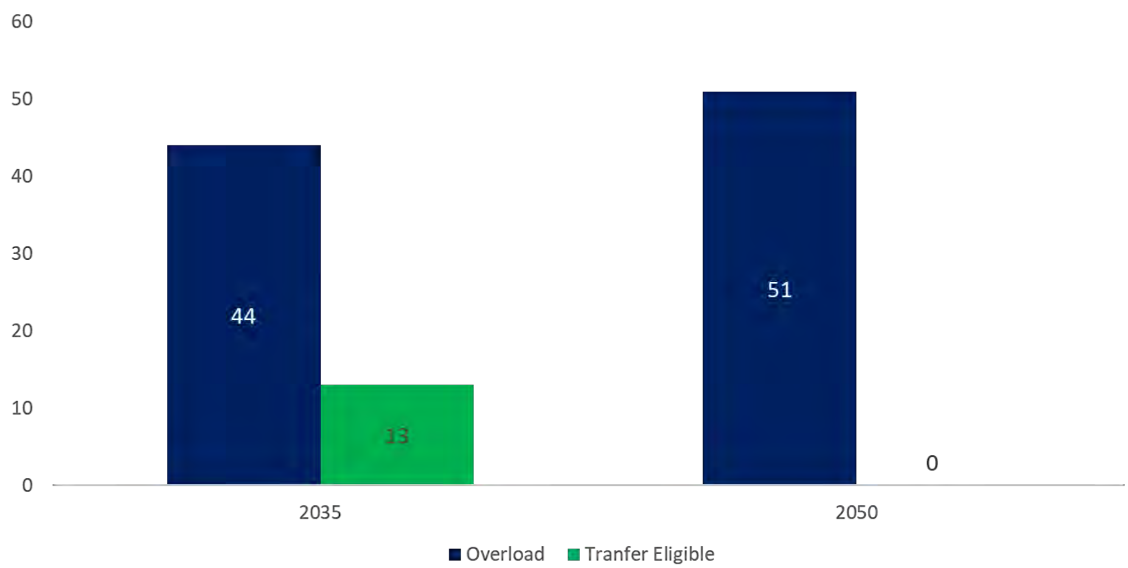
Though peak demand increases the most dramatically later in the study horizon, early horizon substation overload (overloads between now and 2035) are also very impactful, driving necessary investment of substation upgrades in the short-term. More simply, even in the near-term with tempered pace of electrification, HOL should expect that if projections actualize, significant investment will be required in the short- to mid-term to meet projected short-to mid-term load growth.

Though a number of overload conditions occur early in the study horizon, 13 substations may be able to leverage substation transfers to transfer load from the overloaded substation to other connected

[38] 58 Substations are evaluated due to Bridlewood MS being split into two separate substations for the analysis resulting in 93 total substations (35 excluded + 58 included).

substations. As an example, the Bayshore DS substation is projected to reach overload condition as early as 2025. However, this analysis determined there is available capacity in the connected substations to potentially transfer load. While a system impact study was outside of the scope of this assessment, load transfers during periods of overload conditions should be studied in greater detail to inform short-term investment strategies. Figure 44 shows the number of substations both facing overload and eligible for connected substation transfer. As an example. In 2025, of the 21 overload substations, 8 have enough available capacity at the connected substations that substation upgrades may not necessarily be required to prevent an outage.

Figure 44. Cumulative Substation Overloads with Transfer Eligibility in 2035 & 2050



Solutions Scenario Assessment and Findings

Investment Model Methodology

As part of the overload assessment, two NWS technology assessments were developed to measure the relative cost of non-wires solutions compared to traditional wires upgrades. As part of this assessment, an Excel-based directional ROM investment plan was developed to calculate non-wires solution capital expenses, operating expenses, and fuel requirements. Further, the investment plan compares the solutions scenario NPVs assuming transferable load (the low case) and assuming no transferable load (the high case).

This assessment does not take a position on behind-the-meter or utility scale assets. HOL can and should explore partnership opportunities with local organizations and solar, BESS, or RECIP owners to evaluate joint ownership models to reduce HOL total costs. While this assessment does contemplate the amount of NWS generation needed, deployment and alternative ownership strategies should be carefully considered and evaluated.

Wires and non-wires solution (BESS and RECIPs) capital costs were assumed to be incurred the year before required at the substation. Operating expenses were assumed on an ongoing annual basis from the point of investment. For the purposes of this assessment summary operating expenses were assumed, including annual substation OPEX, BESS OPEX, RECIP engine OPEX, BESS energy losses, and natural gas fuel costs.[39] The following financial assumptions were used as provided by HOL:

- Capital inflation rate: 5.3%
- Service inflation rate: 2.4%
- Discount Rate: 6.21%
- Borrowing costs: 6.5%
- NPV calculated on a 2026 CAD basis

Solution scenarios were evaluated in two separate horizons. The first is through 2035 and the second is from 2024 through 2050. When the 2035 NPV is provided, cash flow ends in 2035 to determine the short-to-mid-term NPV. In the 2050 horizon, cash flows end in 2050 for the long-term horizon NPV. All inputs are in 2024 CAD and cashflow NPV results are real values.

Costs were assessed and compared in two study horizons:

1. System-wide investments by 2035: This assessment evaluated the required capital infrastructure needed to address substation overload conditions between now and 2035. 2035 provides a lower but more certain decarbonization load projection.
2. System-wide investments by 2050: This assessment evaluated the required capital infrastructure needed to address substation overload conditions between now and 2050. Since Reference Scenario load continues to increase over the study horizon, substations overload and thereby capital investment is dramatically higher in this study horizon. 2050 provides a higher but less certain decarbonization load projection.

NWS Technology Assessment Summary Results

BESS were identified as a potential NWS to be considered given the technology's general power system flexibility, reliability services, and ability to potentially provide short-term deferment. For the purposes of this analysis, chemical BESS such as lithium-ion were assumed given that they are the most widely available and cost-effective technology on the market today. However, specific technology and chemistries are likely to evolve as technologies continue to advance and federal incentives promote the deployment of the BESS solutions. One limitation of the BESS when considering the Reference Scenario, specifically, is that BESS is typically most cost-effective in small to moderate overload conditions, which is generally not the case in the substation overloads identified.[40]

Substations with available capacity to charge the BESS were determined as feasible for a BESS. Aside from considerations of charging capacity, the general feasibility of the BESS including available land, specific

[39] Substation capital costs and operating expenses reflect proprietary HOL data. BESS and RECIP capital costs and operations expenses leverage Black & Veatch proprietary data and National Renewable Energy Laboratory (NREL) data. Natural gas cost forecasts are from Black & Veatch models in the Ottawa, Canada service territory.
[40] This analysis assumed a standard lithium-ion 4-hour BESS for cost assumptions. Additional BESS sizes and types should be considered in HOL's future required feasibility studies.

BESS types, etc. are not considered, as this phase of work is intended to provide a screen of BESS eligible substations. A detailed feasibility study should be completed to further evaluate the role of BESS technology at the eligible substations. BESS sizing was estimated based on the expected capacity needed to satisfy the highest overload hour at each eligible substation.

As a future phase of this study, a detailed feasibility study and due diligence of the BESS eligible substations should be considered. Given the pre-feasibility study phases of this assessment, the results of this scenario should not be interpreted as the optimal BESS strategy, but as a screen criterion of the substations in which BESS could be considered. Because of the magnitude of the overload conditions, the size of the BESS required at many of the substations is likely not feasible but highly informative to understand the limitation of this technology as a feasible solution during times of potentially extreme overload conditions.

The results of the BESS-eligible substations were used as an input into the cost optimized scenario (results which are summarized later in this section). In the 2035 horizon, four of the 44 substations did not have available capacity to charge the BESS and were therefore not considered eligible for BESS. Those four substations (Lisgar TL, Marchwood MS, Orleans TS, and Stafford Road DS) assumed the same wires upgrades considered in the wires only solution scenario. In the 2050 horizon, 21 of the 51 overloaded substations do not have the availability capacity to charge the BESS and therefore were not considered eligible for BESS.

RECIP engines are a common NWS as they provide numerous grid benefits and a reliable power supply during system overloads or grid interruptions. RECIPs offer comparatively low installed costs compared to other NWS and offer additional capabilities such as black start, peaking, and emergency power applications (typically greater than 98% availability) and can operate using low carbon fuels such as biogas, renewable natural gas, and hydrogen.[41]

Unlike BESS, RECIPs do not require available capacity to charge, so that step in the analysis was not required and therefore the estimated RECIP size and directional cost was evaluated for each of the 44 overloaded substations in 2035 and all 51 overloaded substations in 2050. The results of this level of analysis are intended to provide a screen of the required RECIP sizes and associated costs to serve the required load at each substation. However, like in the BESS technology assessment, a detailed feasibility study should be completed to further evaluate the role of RECIPs at the eligible substations. RECIP sizing was estimated based on the expected size needed to satisfy the highest overload hour and duration at each substation. All overloaded substations were evaluated.

As a future phase of this study, a detailed feasibility study and due diligence of the RECIP eligible substations should be considered. Given the pre-feasibility study phase of this assessment, the results of this scenario should not be interpreted as the optimal RECIP strategy, but as a screen criterion of the substations in which RECIPs could be considered. A future feasibility study should consider environmental

[41] This study assumed the use of natural gas powered RECIPs, but low carbon fuels should be considered in future feasibility studies.

considerations of RECIPs such as emissions and noise limitations, as well as fuel-availability, and environmental permitting.

Solution Scenario Results

Traditional Wires Only

As part of the wires only solution scenario it was assumed that only traditional wires upgrades would be available to ensure overloaded substations have the available capacity to meet the overload condition. Table 9 shows the wires upgrades considered for this analysis.

Table 9. Evaluated Substation Wires Upgrades

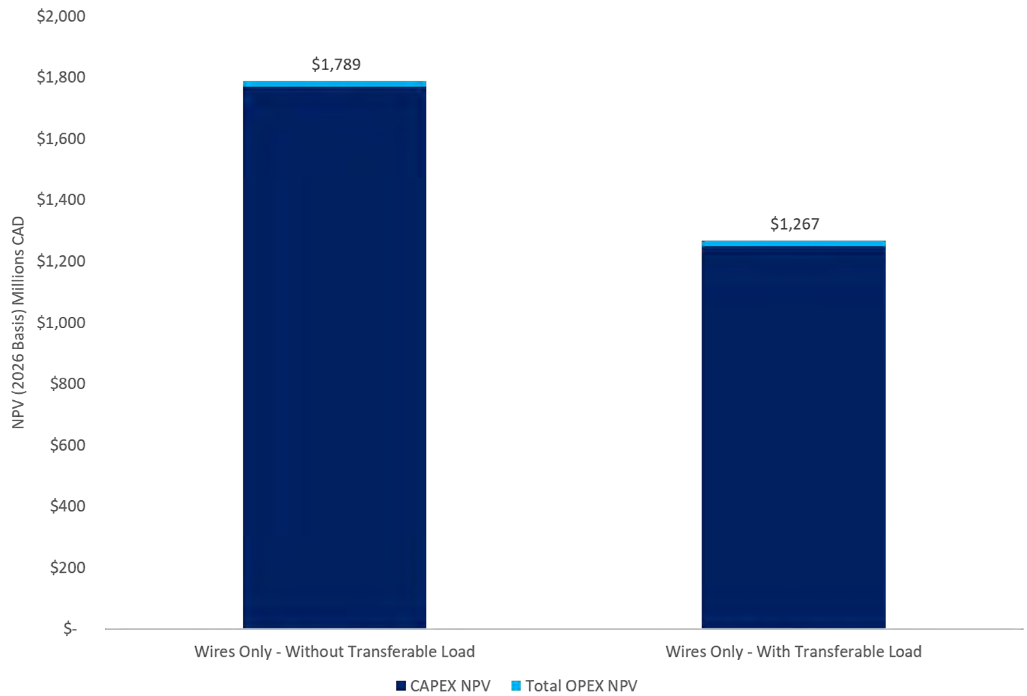
LOW SIDE VOLTAGE (KV)	NUMBER OF EXISTING TRANS-FORMERS	TYPE OF UPGRADE	NEW CAPACITY (MVA)	NEW SUMMER PLANNING RATING (MVA)	NEW WINTER PLANNING RATING (MVA)	COMMENTS
44	N/A	Add new substation (2 transformers)	2*100	120	130	Includes switchgear
44	2	Upgrade existing transformer(s), add one new transformer	3*100	240	260	Includes switchgear
44	2	Upgrade existing transformer(s)	2*100	120	130	
27.6	N/A	Add new substation (2 transformers)	2*100	120	130	Includes switchgear
27.6	4	Upgrade existing transformer(s)	4*100	360	390	
27.6	2	Upgrade existing transformer(s), add one new transformer	3*100	240	260	Includes switchgear
27.6	2	Upgrade existing transformer(s)	2*100	120	130	
27.6	1	Upgrade existing transformer(s), add one new transformer	2*100	120	130	Includes switchgear

27.6	1	Upgrade existing transformer(s)	1*100	100	100	If it continues to be a single transformer station, it cannot load to the LTR and will be restricted load to design rating.
13.2	N/A	Add new substation (2 transformers)	2*100	120	130	Includes switchgear
13.2	3	Upgrade existing transformer(s)	3*100	240	260	
13.2	2	Upgrade existing transformer(s), add one new transformer	3*100	240	260	Includes switchgear
13.2	2	Upgrade existing transformer(s)	2*100	120	130	

In the 2035 period, 44 substations reached overload conditions and required wires upgrades. Of the 44 substations, 13 could satisfy overload conditions through upgrades to the existing transformer(s) and nine require both upgrade of the existing transformer and the addition of a new transformer. 50% (22 substations specifically) are projected to require the addition of a new 27.6kV substation, the most capital intensive of the upgrades required.[42] Alternatively, if transferable load is considered, 13 of the 44 substations could potentially avoid costly substation upgrades. The estimated savings is shown in Figure 45, the wires only solutions scenario cash flow NPV drops by nearly $522 million CAD when assuming connective substations can absorb excess substation load to prevent and overload condition.

[42] Future system impact analyses could determine if fewer, but larger, new substations could address overload conditions rather than replacing every overloaded substation. For example, a new 100MVA station could support overloads from multiple other substations.

Figure 45. Wires Only Solutions Scenario Cashflow NPV (2035 Horizon): Comparison of Transferable & Non-Transferable Load

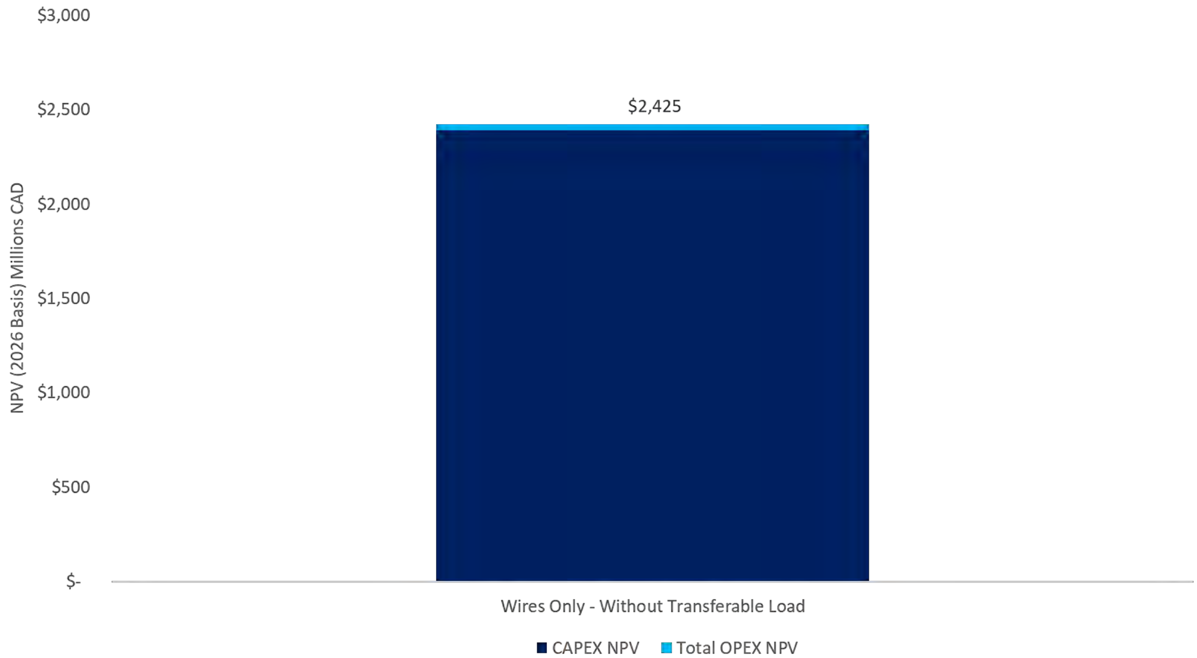


Given the projected increase in load the Reference Scenario and therefore CAPEX required in both scenarios, the required investment is considerable. Without transferable load, $1.77 billion CAD in wires investment is required, paired with an expected $18.5 million CAD in OPEX (in existing and incremental OPEX) to support new wires investment. Conversely, if considering transferable load CAPEX NPV reaches $1.25 billion CAD with $18 million CAD in supporting OPEX NPV in the 2035 horizon.

If HOL were to consider longer-term investment to meet 2050 load an additional $620 million CAD in CAPEX would be required, paired with an increase in OPEX of $16.3 million CAD (total CAPEX and OPEX as shown in Figure 46).[43] Transfers were not eligible during the long-term 2050 horizon study, given the lack of available capacity of connected substations, driven by the much larger increases in projected load later in the study horizon. The number of overloaded substations increased from 44 in the 2035 horizon to 51 in the 2050 horizon (assuming no transferable load).

[43] The comparison between 2035 and 2050 compares the NPV assuming no transferable load. If we compare the 2035 cashflow NPV with transferable load to the non-transferable load cashflow 2050 NPV, the increase is $1.14 billion CAD.

Figure 46. Wires Only Solutions Scenario Cashflow NPV (2050 Horizon)



Cost Optimized Solutions Scenario

The cost optimized solution scenario evaluates the lowest cost solution at each substation over the 2035 and 2050 periods. The lowest cost solution was identified by the lowest cashflow NPV (CAPEX NPV and OPEX NPV) over either the 2035 or 2050 horizon. It is important to note that the cost optimized solutions only contemplate the cost of distribution wires upgrades and not the associated upstream transmission or generation costs.[44] As a result, each substation within this solution scenario that realizes an overload condition is identified as addressing an overload with either a wires only solution, a BESS, or a RECIP. Table 10 shows the results of the cost optimization technology solution in the 2035 horizon for all 44 overloaded substations. BESS was the lowest cost solution at 2 substations, traditional wires was the lowest cost solution in 21 substations, and in the remaining 21 substation RECIPs were the cost optimized solution.

Table 10. Cost Optimized Substation Solutions: 2035 Horizon

SUBSTATION NAME	COST OPTIMIZED SOLUTION
HAWTHORNE TS	BESS
TERRY FOX MTS	BESS
BARRHAVEN DS	RECIP
BAYSHORE DS	RECIP
BEACONHILL MS	RECIP

SUBSTATION NAME	COST OPTIMIZED SOLUTION
BLACKBURN MS	RECIP
BORDEN FARM DS	RECIP
BRIDLEWOOD MS 8kV	RECIP
CASSELMAN MS	RECIP
CENTREPOINTE DS	RECIP

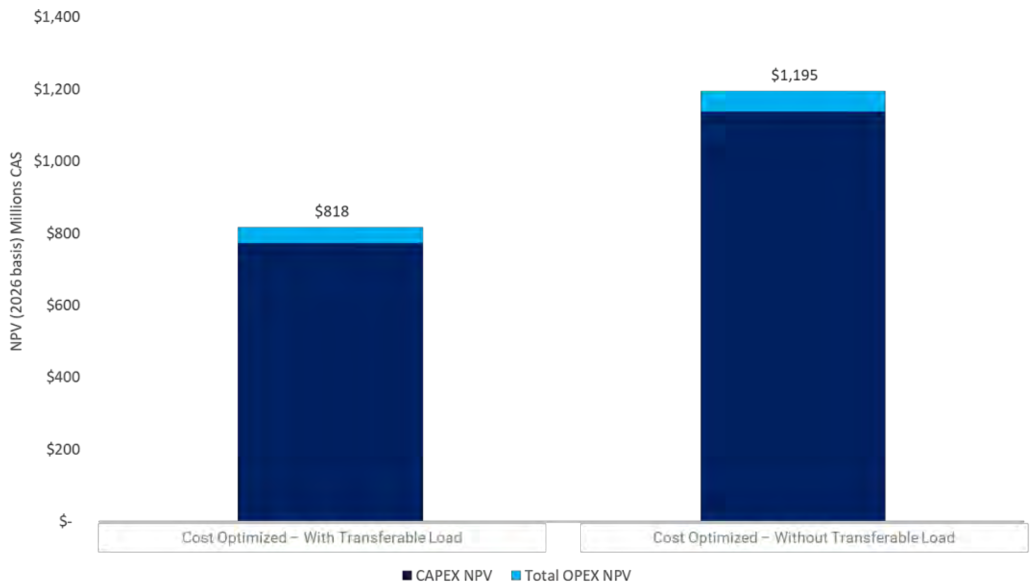
44 Further, the timing and feasibility of the implementation was not included in this study. Black & Veatch provides detailed recommended next steps, which include a future feasibility study, in Section 4.

SUBSTATION NAME	COST OPTIMIZED SOLUTION
EPWORTH DS	RECIP
JOCKVALE DS	RECIP
LONGFIELDS DS	RECIP
MOULTON MS	RECIP
PARKWOOD HILLS DS	RECIP
Q.C.H. DS	RECIP
RICHMOND NORTH DS	RECIP
BEAVERBROOK MS	RECIP
BECKWITH DS	RECIP
MANORDALE DS	RECIP
SOUTH MARCH DS	RECIP
STARTOP MS	RECIP
WOODROFFE DS	RECIP
BRIDLEWOOD MS 28kV	Wires Upgrade
CARLING TM	Wires Upgrade
Cyrville MTS	Wires Upgrade
Ellwood MTS	Wires Upgrade

SUBSTATION NAME	COST OPTIMIZED SOLUTION
FALLOWFIELD MTS	Wires Upgrade
HINCHEY TH	Wires Upgrade
JANET KING DS 28kV	Wires Upgrade
KANATA MTS	Wires Upgrade
KING EDWARD TK	Wires Upgrade
LEITRIM MS	Wires Upgrade
LIMEBANK MS	Wires Upgrade
LINCOLN HEIGHTS TD	Wires Upgrade
LISGAR TL	Wires Upgrade
MARCHWOOD MS	Wires Upgrade
NEPEAN TS	Wires Upgrade
OVERBROOK TO	Wires Upgrade
RIDEAU HEIGHTS DS	Wires Upgrade
RIVERDALE TR	Wires Upgrade
SOUTH MARCH TS	Wires Upgrade
ORLEANS TS	Wires Upgrade
STAFFORD ROAD DS	Wires Upgrade

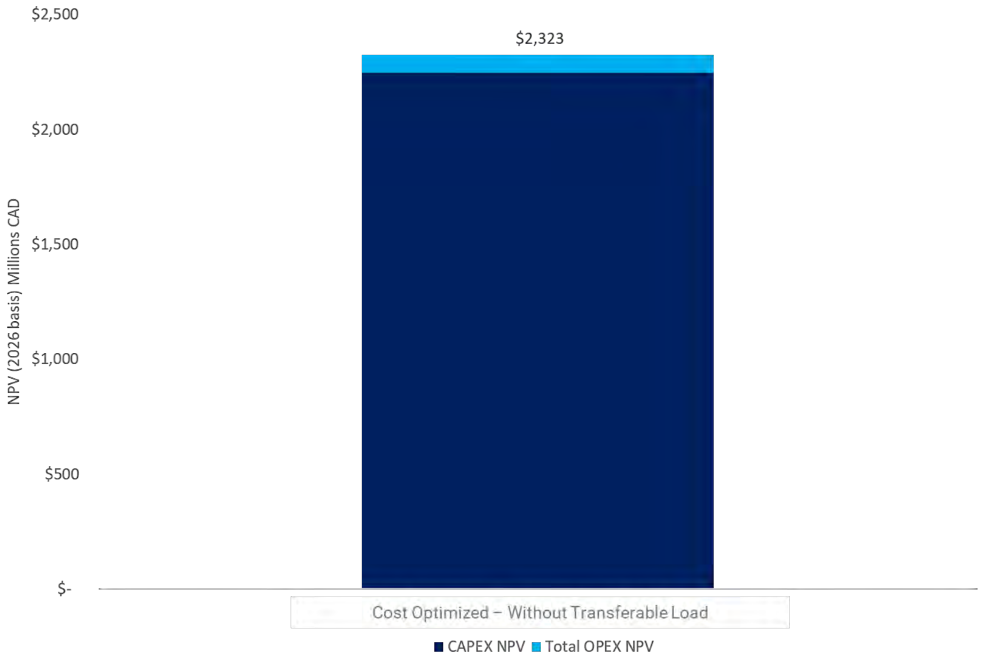
As expected, the cost optimized solution scenario has a lower scenario NPV compared to the wires only solution scenario, whether considering substation load transfer or not. If considering potential substation load transfers through 2035, the solution scenario cash flow NPV reaches nearly $818 million CAD. Conservatively, if not considering substation load transfers cashflow NPV through 2035, this increases to $1.2 billion CAD. The 2035 cashflow NPV for both transferable and non-transferable load are shown in Figure 47.

Figure 47. Cost Optimized Solution Scenario Cashflow NPV (2035 Horizon): Comparison of Transferable & Non-Transferable Load



When considering the most cost optimal solutions in the 2050 horizon, BESS was not the lowest cost option at any substation. Seven substations required no upgrades (Bells Corner DS, Janet King DS 8kV, Munster DS, Richmond South MTS, Slater TS, New 44, and Piperville). Of the 51 overloaded stations, RECIPs provided the lower cost solution in six (Bridlewood MS 8kV, Richmond North DS, Beaverbrook MS, Beckwith DS, South March DS, Woodroffe DS), and the remaining 45, wires only solutions provided the lowest cost upgrade. As expected even in the cost optimization solution scenario the 2050 cash flow NPV increased dramatically from the 2035 horizon, with the 2050 NPV exceeding $2.3 billion CAD as shown in Figure 48.

Figure 48. Cost Optimized Solution Scenario Cashflow NPV (2050 Horizon)



Solutions Scenario Comparison

The solutions scenarios present an opportunity for HOL to evaluate as it considers future feasibility studies to address substation overloads driven from Reference Scenario decarbonization load projections. Reviewing the required upgrades in the short- to mid-term 2035 horizon separately from the long-term 2050 horizon will allow HOL to make agile substation investments while future electrification driven load becomes realized.

The results of this analysis are intended to inform short and mid-term investment strategies for HOL as it evaluates both wires and non-wires solutions to address Reference Scenario decarbonization load projections. This section provides an analysis as to how each of the solution scenarios should be considered and evaluated, relative to each other, as HOL considers next steps in its system-wide upgrades.

If considering system-wide costs only, one scenario presents the most straight forward and optimal approach: the cost optimized scenario. As shown in Table 11 and Table 12, this scenario yields a lower solution cash flow and defers up to $594 million CAD in total cashflow NPV compared to the wires only solutions scenario. Table 11 and Table 12 display the projected deferred cost in the cost optimized solution scenario through both the 2035 and 2050 study horizon. Estimate deferred costs is represented as the total cash flow NPV difference between each solution scenario and the wires only solution scenario.

Table 11. Solutions Scenario Cashflow NPV Comparison (CAD) Assuming No Transfers

	WIRES ONLY	COST-OPTIMIZED
2035 NPV	1.78 billion	1.19 billion
2035 Deferred NPV	N/A	594 million
2050 NPV	2.43 billion	2.32 billion

	WIRES ONLY	COST-OPTIMIZED
2050 Deferred NPV	N/A	102 million

Table 12. Solutions Scenario Cashflow NPV Comparison (CAD) Assuming Transfers[45]

	WIRES ONLY	COST-OPTIMIZED
2035 NPV	1.27 billion	818 million
2035 Deferred NPV	N/A	449 million

To evaluate the solution scenarios, as well as the non-wires solutions developed in each scenario, five key measures were identified and evaluated. Each measure was scored on a scale of one to ten, with one being the least desirable and ten being the most desirable. The total score was calculated as the sum of all measure scores Black & Veatch applied quantitative cost metrics from its directional investment modeling results and a mix of qualitative and quantitative expertise to inform a high-level assessment of safety, reliability, resiliency, and environmental considerations. The intent of this scoring matrix is to review and evaluate the two primary solution scenarios against each other, outside of just cost considerations. The measures are defined as follows:

- Solutions Scenario Cost: Represented as the total net present value (NPV) of system-wide capital expenses (CAPEX) and operating expenses (OPEX). Rough order of magnitude (ROM) directional pricing estimates were developed for each solution scenario. The two solutions scenario NPVs were compared against one another, and the lowest cost solution was evaluated as the most desirable.
- Safety: Evaluated as how safe the proposed solutions is and potential risk it could pose to the surrounding area.
- Reliability: Evaluated as to how much power and for how long an overload could be mitigated by the evaluated solutions. Scenario solutions leveraging dispatch limited solutions were measured as less favorable.
- Resiliency: Evaluated as the total capacity of the wires or NWS assets, as well as vulnerabilities to external pressures, such as grid outages or fuel limitations.
- Environmental: Evaluated considering greenhouse gas (GHG) considerations, noise, and land use considerations.

Both solution scenarios were evaluated through both the mid-term and long-term lens. As an example, via the mid-term lens, solution scenarios and NWS were sized to meet substation load requirements through 2035. This mid-term lens is appropriate to evaluate the investments that HOL should consider in

[45] There was not enough transfer capacity in the 2050 year, so 2050 values are the same as shown in the 2050 year in Table 10.

the short-term to maintain reliability through the mid-term. Alternatively, the long-term lens (substation upgrades to meet reliability through 2050), presents larger and most costly substation upgrades. The solutions scenario heatmap was applied to the 2035 findings to inform shorter-term investment strategies.

According to the results of this analysis and known uncertainties and risks, the two solutions scenarios were compared according to the above 5 factors, and then a composite score was calculated. As description of the comparison is provided the narrative following this comparison in Figure 49.

Figure 49. Solution Scenario Comparison Matrix[46]

	WIRES ONLY	COST OPTIMIZED
Measures		
Cost	5	9
Safety	10	7
Reliability	10	9
Resiliency	5	8
Environmental	5	5
Total Score (Sum)		
Overall Score	35	38

Measures Scoring

1	2	3	4	5	6	7	8	9	10

Least Desirable → Most Desirable

Measure 1: Cost

Cost was scored and compared based on the relative cash flow NPV of each solution scenario. The wires only solutions scenario is considered the baseline, thus reflecting a score of 5. The cost optimized solution was rated as a 9, consistent with its name. As part of future studies, it is reasonable to assume that both solution scenario costs could decline.

46 Individual measures were scored on a scale of one to ten. The overall score is the sum of all scores.

Measure 2: Safety

For the purposes of this measure the relative safety of each solution scenario is considered. Of important note is the recognition that not all of these solutions and technologies are 100% safe, but some have objectively more risks than others. Though safety considerations must be considered even in the wires only scenario, comparatively this solution scenario was measured as the safest. Albeit a safe technology, BESS leveraged in the 2035 cost optimized scenario reduced the score to a six given the low but existing concerns of fires and considerations of safety setbacks for this technology.

Measure 3: Reliability

The wires only solution scenario was considered the most reliable for the purposes of this analysis, given that wires upgrades are assumed to always be oversized to handle the required amount of load on the system. BESS use lowered the cost optimized scenario score, purely because of the limitation to the length of period that a BESS can provide backup support and the required availability capacity to charge. RECIPs are highly reliable but require access to natural gas fuels.

Measure 4: Resiliency

Reliance on fuels outside of grid electricity were measured as more desirable than the solutions scenarios relying on 100% of grid electricity. The mix of RECIPs, BESS, and wires in the cost optimized scenario makes this scenario highly favorable from the resiliency perspective, secondary only to the RECIPs only scenario.

Measure 5: Environmental

Unique to Canada, and Ottawa specifically, is the amount of zero-carbon energy generation powering the grid. However, during times of peak demand, gas-fired generation is utilized to address incremental demand. Because of this, the wires only scenario is rated equally to the cost optimized scenario given the BESS will likely be charged from the grid and the RECIPs will likely run on natural gas. HOL should carefully consider the use of carbon-intensive fuels (such as natural gas) in a non-wires solution. While natural gas fired RECIPs will certainly address substation overload challenges and are a highly commercial and reliable technology, the use of low carbon fuels (such as hydrogen and RNG) should be considered in future as hydrogen and RNG costs continues to decline. This would provide HOL with both a reliable and low carbon system.

4.0 Next Steps and Future Studies

This study has evaluated the potential for increases in system load in the HOL distribution system based on various decarbonization and end use electrification scenarios. Additionally, impacts to the system were assessed and potential methods to mitigate those impacts were developed. It has been demonstrated that the electrification of energy end use cases such as transportation and heating will result in a significant increase in system load and is projected to require significant expenditures to address. This analysis provides a thorough examination of potential adjustments needed between now and 2050 for the HOL system to effectively address future decarbonization-driven load impacts. Though this study provides robust and comprehensive analysis into the possibility of the impact of decarbonization initiatives in the HOL service territory, additional considerations, studies, and analyses should be considered. The analysis performed in this study should be leveraged and built upon to further assess and finalize mitigation strategies to optimize capital investment. The following actions are recommended for consideration as next steps by HOL.

- Assess Load Increases Compared to Reference Case Decarbonization Load Projections: On an ongoing annual basis, substation level and system-level load projections should be assessed and compared to load growth actuals. Changes in electrification incentives and standards should be carefully monitored to revisit and adjusted load projections as necessary. As with all load projections, this assessment should be monitored and updated to incorporate the most up-to-date assumptions and baseline consideration.
- Confirm Potential for Load Transfers: This study evaluated whether there was the *potential* to transfer loads from an overloaded substation to a connected substation in the same grouping. When available, future system connectivity and impact studies should be performed to confirm whether projected load transfers can actually occur by evaluating all other system constraints, including, but not limited to, available feeder capacity, available feeder-feeder tie capacity, and protection and coordination schemes.
- Evaluate Potential Combinations of Wires and NWS for Selected Substations: In the 2050 horizon evaluation specifically, 8 substations were overloaded to the extent that a new substation was required as well as an upgrade to the existing substation. A system connectivity study and a technology feasibility study should be completed to determine if it would be more cost effective to utilize an NWS such as a BESS or RECIP. This evaluation would determine the most cost-effective approach for handling these substations.
- Technical Feasibility: The scope of this study determined only the required capacity for wires and non-wires solutions to address the overloaded substation and did not address technical feasibility for the proposed solutions. It is recommended complete a detailed Pre-Front-End Engineering and Design Study as well as a detailed feasibility be completed to evaluate the lowest cost investment option for each site, considering substation specific constraints. Technical feasibility studies should evaluate the following at a minimum:
    - Available footprint to upgrade existing transformers, add new transformers, add BESS or RECIPs to an existing substation
    - Available land to add new substations or other NWS in the required service area
    - Ability of circuits outside of the substation to carry the additional load
    - Ability to provide sufficient natural gas to the RECIPs
    - Availability of other fuel alternatives such as hydrogen or renewable natural gas
    - Ability to permit NWS
- Determine the Capital Investment Horizon for Each Site: Because the 2050 projected Reference Scenario load was far higher than the 2035 projection, the amount of overload is higher for 2050 than 2035, which resulted in higher capital expenditure to address the overload. It is recommended to evaluate the load conditions for each site and the difference in capital investment to make a final decision on which year to base an investment decision.

5.0 References

The following public sources were reviewed or referenced to inform this study. All references are linked to the associated assumptions via a footnote in main narrative of the report.

British Columbia Utilities Commission

BC Hydro Optional Residential Time-of-Use Rate Application, 2023.

Canada Energy Regulator

Canada's Energy Future: Energy Supply and Demand Projections to 2050, 2023.

City of Ottawa

Ottawa Climate Change Master Plan, 2020.

Energy Evolution, 2024.

Growth Projections for the New Official Plan, 2019.

Leidos Canada Pathway Study on Solar Power in Ottawa, 2017.

Solutions Group Pathway Study on Transportation in Ottawa, 2019.

Enbridge

Pathways to Net-Zero Emissions in Ontario, 2022.

Government of Canada

Canada's Changing Climate Report, 2019.

Canada's 2030 Emissions Reduction Plan: Clean Air, Strong Economy, 2022.

Greenhouse Gas Pollution Pricing Act (S.C. 2018, C. 12, S. 186), 2019.

National Energy Code of Canada for Buildings, 2020.

Updated Projections for Canada's Public Charging Infrastructure Needs, 2022.

IESO

IESO Annual Planning Outlook, 2022.

IESO Pathways to Decarbonization, 2022.

East Ontario Bulk Planning: Gatineau Corridor End-of-Life Study, 2022.

J.D. Power

Electric Vehicle Experience Home Charging Study, 2023.

MDPI

Electric Vehicle User Behavior: An Analysis of Charging Station Utilization in Canada, 2023.

Natural Resources Canada
Commercial/Institutional Sector – Ontario Energy Use, 2024.

Residential Sector - Ontario Energy Use, 2024.

Ontario Energy Board
Ontario Ultra-Low Overnight Rate, 2024.

Ottawa Energy Evolution
Modelling Ottawa's Greenhouse Gas Emissions to 2050, 2020.

Hydro Ottawa Station Table

The following Hydro Ottawa and Hydro One owned stations in the table below are used to supply Hydro Ottawa's customers. The stations are herein referenced by the nomenclature (Hydro Ottawa Station Name) used by Hydro Ottawa.

Hydro Ottawa Station Name	Designation	Owner	Primary/Secondary Voltage (kV)
Albion TA	HVDS	Hydro One-Hydro Ottawa	230/13.2
Albion UA	DS	Hydro Ottawa	13.2/4.16
Augusta UD	DS	Hydro Ottawa	13.2/4.16
Bantree AL	DS	Hydro Ottawa	13.2/4.16
Barrhaven DS	DS	Hydro Ottawa	44/8.32
Bayshore DS	DS	Hydro Ottawa	44/8.32
Bayswater UJ	DS	Hydro Ottawa	13.2/4.16
Beaconhill MS	DS	Hydro Ottawa	44/8.32
Beaverbrook	DS	Hydro Ottawa	44/12.43
Beckwith DS	DS	Hydro One	44/27.6
Beechwood UB	DS	Hydro Ottawa	13.2/4.16
Bells Corner DS	DS	Hydro Ottawa	44/8.32
Bilberry TS	HVDS	Hydro One-Hydro Ottawa	115/27.6
Blackburn MS	DS	Hydro Ottawa	44/8.32
Borden Farm DS	DS	Hydro Ottawa	44/8.32
Bridlewood MS 28kV	HVDS DS	Hydro Ottawa	115/27.6 44/27.6
Bridlewood MS 8kV	HVDS DS	Hydro Ottawa	115/8.32 44/8.32
Bronson SB	DS	Hydro Ottawa	13.2/4.16
Brookfield AF	DS	Hydro Ottawa	13.2/4.16
Cahill AN	DS	Hydro Ottawa	13.2/4.16
Cambrian MTS	HVDS	Hydro Ottawa	115/27.6 230/27.6
Cambridge AM	DS	Hydro Ottawa	13.2/4.16
Carling SM	DS	Hydro Ottawa	13.2/4.16
Carling TM	HVDS	Hydro One-Hydro Ottawa	115/13.2
Casselman MS	DS	Hydro Ottawa	44/8.32
Centrepointe DS	HVDS	Hydro Ottawa	115/8.32

Church AA	DS	Hydro Ottawa	13.2/4.16
Clifton UL	DS	Hydro Ottawa	13.2/4.16
Clyde UC	DS	Hydro Ottawa	13.2/4.16
Cyrville MTS	HVDS	Hydro Ottawa	115/27.6
Dagmar AC	DS	Hydro Ottawa	13.2/4.16
Eastview UT	DS	Hydro Ottawa	13.2/4.16
Edwin UV	DS	Hydro Ottawa	13.2/4.16
Ellwood MTS	HVDS	Hydro Ottawa	230/13.2
Epworth DS	HVDS	Hydro Ottawa	115/8.32
Fallowfield MS	HVDS	Hydro Ottawa	115/27.6
Fisher AK	DS	Hydro Ottawa	13.2/4.16
Florence UF	DS	Hydro Ottawa	13.2/4.16
Gladstone UX	DS	Hydro Ottawa	13.2/4.16
Hawthorne TS	HVDS	Hydro One	230/44
Henderson UN	DS	Hydro Ottawa	13.2/4.16
Hillcrest AH	DS	Hydro Ottawa	13.2/4.16
Hinchey TH	HVDS	Hydro One-Hydro Ottawa	115/13.2
Holland SH	DS	Hydro Ottawa	13.2/4.16
Janet King DS 28kV	DS	Hydro Ottawa	44/27.6
Janet King DS 8kV	DS	Hydro Ottawa	44/8.32
Jockvale DS	DS	Hydro Ottawa	44/8.32
Kanata MTS	HVDS	Hydro Ottawa	230/27.6
King Edward SK	DS	Hydro Ottawa	13.2/4.16
King Edward TK	HVDS	Hydro One-Hydro Ottawa	115/13.2
Langs AP	DS	Hydro Ottawa	13.2/4.16
Leitrim MS	DS	Hydro Ottawa	44/27.6
Limebank MS	HVDS	Hydro Ottawa	115/27.6
Lincoln Heights TD	HVDS	Hydro One-Hydro Ottawa	115/13.2
Lisgar TL	HVDS	Hydro One-Hydro Ottawa	115/13.2
Longfields DS	DS	Hydro Ottawa	44/27.6
Manordale DS	HVDS	Hydro Ottawa	115/8.32
Marchwood MS	HVDS	Hydro Ottawa	115/27.6
McCarthy AQ	DS	Hydro Ottawa	13.2/4.16
Merivale MTS	HVDS	Hydro Ottawa	115/8.32
Moulton MS	HVDS	Hydro Ottawa	115/27.6
Munster DS	DS	Hydro Ottawa	44/8.32
Nepean AB	DS	Hydro Ottawa	13.2/4.16

Nepean TS	HVDS	Hydro One	230/44
Orleans TS	HVDS	Hydro One	230/27.6 115/27.6
Overbrook SO	DS	Hydro Ottawa	13.2/4.16
Overbrook TO	HVDS	Hydro One-Hydro Ottawa	115/13.2
Parkwood Hills DS	DS	Hydro Ottawa	44/8.32
Playfair AJ	DS	Hydro Ottawa	13.2/4.16
Q.C.H. DS	DS	Hydro Ottawa	44/8.32
Queens UQ	DS	Hydro Ottawa	13.2/4.16
Richmond North DS	DS	Hydro Ottawa	44/8.32
Richmond South DS	HVDS	Hydro Ottawa	115/8.32
Rideau Heights DS	DS	Hydro Ottawa	44/8.32
Riverdale SR	DS	Hydro Ottawa	13.2/4.16
Riverdale TR	HVDS	Hydro One-Hydro Ottawa	115/13.2
Russell TB	HVDS	Hydro One-Hydro Ottawa	115/13.2
Shillington AD	DS	Hydro Ottawa	13.2/4.16
Slater SA	DS	Hydro Ottawa	13.2/4.16
Slater TS	HVDS	Hydro One-Hydro Ottawa	115/13.2
South Gloucester DS	HVDS	Hydro One	115/8.32
South March TS	HVDS	Hydro One	230/44
South March DS	DS	Hydro Ottawa	44/12.43
Stafford Road DS	DS	Hydro Ottawa	44/8.32
Startop MS	DS	Hydro Ottawa	44/8.32
Terry Fox MTS	HVDS	Hydro Ottawa	230/27.6
Uplands MTS	HVDS	Hydro Ottawa	115/27.6
Urbandale AE	DS	Hydro Ottawa	13.2/4.16
Vaughan UG	DS	Hydro Ottawa	13.2/4.16
Walkley UZ	DS	Hydro Ottawa	13.2/4.16
Woodroffe DS	DS	Hydro Ottawa	44/8.32
Woodroffe TW	HVDS	Hydro One-Hydro Ottawa	115/13.2

CAPITAL EXPENDITURE PLAN

1. OVERVIEW

This schedule summarizes Hydro Ottawa's capital expenditures over the 2021-2023 Historical Period, the 2024-2025 Bridge Years, and across the 2026-2030 Forecast Period. The capital expenditure plan for the Forecast Period was prepared through the asset management and capital expenditure planning processes described in Section 3 of Schedule 2-5-4 - Asset Management Process. Hydro Ottawa confirms that there are no expenditures for non-distribution activities in the capital expenditure plan.

The Hydro Ottawa 2026-2030 Capital Expenditure Plan focuses on four key investment priorities:

1. **Growth & Electrification - Powering the Growing Community**, which focuses on expanding grid capacity to serve a growing community and ensure a reliable, resilient electricity system capable of meeting increasing demand driven by new customer connections and distributed energy resources (DERs);
2. **Renewing Deteriorating Infrastructure**, which prioritizes mitigating reliability risk by strategically upgrading or replacing aging and critical infrastructure based on condition assessments;
3. **Grid Modernization - Enabling the Energy Transition**, which focuses on modernizing the grid through strategic technology adoption and infrastructure upgrades to facilitate customer participation and optimize DER integration; and
4. **Enhancing Resilience**, which proactively upgrades infrastructure and implements measures to protect against increasingly frequent and intense severe weather events and cyber threats.

Relative to Hydro Ottawa's previous Distribution System Plan (DSP), the 2026-2030 Capital Expenditure Plan includes new programs and budgets, as well as a commitment to evaluating Non-Wires Solutions (NWSs) in accordance with OEB guidelines. In addition, Hydro Ottawa has analyzed past spending, forecasted future needs, and considered the impact on Operations and Maintenance (O&M) costs.

Hydro Ottawa's gross capital expenditure plan for 2026-2030 totals $1.4B, averaging $281.7M annually (gross expenditures) or $239.1M (net after deducting capital contributions). This represents a near doubling of the $762.4M spent during the 2021-2025 period. The top three focus areas are capacity expansions (new station construction, station upgrades, and Non-Wires Solutions), accommodating new customer connections (residential and commercial), and renewing aging assets (transformers, switchgear).

System Access gross spending, driven by customer and third-party requests, is expected to average $73.9M over the 2026-2030 period as shown in Table 1 below. This represents an increase from the $58.5M average annual investment during the 2021-2025 period, which exceeded the OEB-approved budget by 44%, detailed in Table 8 of Section 5.1 - System Access Expenditures. This variance was primarily due to the surge in the volume and complexity of customer connection requests, severe inflationary pressures on material and labor costs, and unforeseen large-scale system expansion projects, as detailed in Section 4.1 - Historical Variance Overview. The 2026-2030 investments will be driven by continued growth in commercial and residential connections, including major projects for new labs and hospitals, and the ongoing transition to electrification and Distributed Energy Resource (DER) adoption. Customer contributions are also expected to increase, to average $39.3M annually over the 2026-2030 period compared to an average of $31.7M annually during the 2021-2025 period.

System Renewal investments are expected to average $86.3M over the 2026-2030 period as shown in Table 1 below. This represents an increase from the $46.5M average annual investments during the 2021-2025 period, which despite material deferred expenditures, exceeded the OEB-approved budget by 11%, as detailed in Section 5.2 - System Renewal Expenditures. Unforeseen System Renewal expenditures during the historical period included material emergency spending in the aftermath of the 2022 Derecho, other higher-than forecast emergency renewal work and a period of significant inflation. Deferred expenditures included significant Station Major Rebuild projects and Capacity Voltage Conversion work, detailed in Section 4 - Historical and Forecast Expenditure Overview. The increased investment in 2026-2030 is driven by station asset renewal (including voltage conversion), along with substantial increases in overhead and underground asset renewal. Metering renewal will see a significant percentage increase due to the Advanced Metering Infrastructure 2.0 (AMI 2.0) initiative.

System Service investments are expected to average $94.7M over the 2026-2030 period as noted in Table 1 below. This represents an increase from the $32.2M average annual spend during the 2021-2025 period, which materially exceeded the OEB-approved budget by 31%, as detailed in Section 5.3 - System Service Expenditures. Incremental spending was required during the historical period due to a combination of factors including escalating costs for key stations equipment and incremental unbudgeted work required by updated regional planning with external stakeholders. The significant increase in spending in 2026-2030 is primarily driven by Capacity Upgrades and Distribution Enhancements (resiliency and observability projects). Additionally, to strengthen communication infrastructure, the Field Area Network capital program has been expanded to include new budget programs: Wireless Communication, Intelligent Electronic Device Management, and Optical Transport Network (OTN) Cyber Security. Furthermore, a dedicated Control and Optimization program has been established to focus on Advanced Distribution Management System (ADMS) enhancements. Both the expanded Field Area Network program and the new Control and Optimization program have been incorporated into the 2026-2030 System Service Investments, demonstrating Hydro Ottawa's commitment to grid modernization.

General Plant net spending is projected to average $24.2M over the 2026-2030 period which is an increase from the $14.6M average annual spend during the 2021-2025 timeframe. The 2021-2025 period investment was under the approved budget by 9%, as detailed in Table 32 of Section 5.4 - General Plant Expenditures. The 2026-2030 spending increases are driven by Connection Cost Recovery Agreement (CCRA) payments, fleet and tool replacements, building improvements, grid technology upgrades, AMI and CIS system upgrades, and increased cyber security needs.

Hydro Ottawa's Capital Expenditure Plan considers the impact of investments on System O&M costs as outlined in Section 6 - Impact on Operation and Maintenance Costs. Asset expansion, technological advances, and lifecycle management all play a significant role in the level of System O&M. Specifically, increased System Access investments will lead to higher O&M costs due to the expansion of the asset base, necessitating increased maintenance requirements. Similarly, while substantial system renewal investments prioritize replacing high-risk assets to mitigate immediate failures, they also require increased O&M spending on testing, inspection, and maintenance for remaining high-risks assets. This includes advanced inspection technologies like drones and specialized techniques for underground asset maintenance. Additionally, station preventative maintenance will also increase to improve asset health assessments and extend asset lifecycles. Finally, System Service investments, which support grid expansion and the integration of new technologies, will inherently increase O&M costs due to the greater number of assets and specialized maintenance needs associated with advanced technologies.

As detailed in Section 4.1 - Historical Variance Overview, the 2026-2030 Capital Expenditure Plan follows a period marked by significant disruptions to Hydro Ottawa's business. These disruptions, stemming from global and local external factors, included unprecedented supply chain challenges, a surge in complex customer connections, unforeseen externally-driven projects, increased emergency renewal work due to severe storms and equipment failures, and substantial investments in new stations to address growing electricity demand as identified in the Ottawa Integrated Regional Resource Plan (IRRP) as noted below:

(i) Unprecedented Supply Chain Disruption: The 2021-2025 period witnessed an unprecedented confluence of global events, severely disrupting supply chains and driving inflationary pressures. The COVID-19 pandemic initiated widespread logistical challenges, exacerbated by surging demand for essential electrical equipment. Subsequent economic factors and shipping bottlenecks compounded these issues. Critically, the war in Ukraine also introduced a significant constraint on the availability of grain-oriented electrical steel, a vital component for transformer cores, further impacting material availability and costs. As noted in Schedule 1-2-5 - Impacts of Inflationary Pressure, Canada's inflation rate in the 2020-2024 period as measured by CPI was the highest in 40 years.

(ii) Customer Connections Volume, Complexity, and Cost: an unprecedented increase in the volume and complexity of non-discretionary residential subdivision customer connections due to a combination of residential intensification and a growing demand for electricity

(iii) Unforeseen Externally-Driven Projects: during the Historical Period, Hydro Ottawa was required to execute three major, externally-driven, non-discretionary projects that, despite the existence of a budget for one unforeseen large-scale initiative, these were not specifically anticipated and significantly exceeded budget projections;

(iv) Increased Emergency Renewal Work due to Major Storms and Equipment Failure: Emergency Renewal capital expenditures that significantly exceeded historical levels, due to a combination of the devastating 2022 Derecho (which became the 6th costliest natural disaster in Canada's history), other major storms, and a general increase in the amount and cost of equipment that needed to be replaced on an emergency, reactive basis, and

(v) New Stations Investments to Address Growing Electricity Demand as Identified in the Ottawa Integrated Regional Resource Plan (IRRP): Hydro Ottawa made significant investments in two new Municipal Transformer Stations (MTS) over the historical period (Mer-Bleue MTS and Piperville MTS) in response to the growing demand and need for resiliency identified in the Ottawa Area IRRP, which was released by the Independent Electricity System Operator (IESO) in late 2020. As a consequence of this timing, Mer-Bleue MTS was not included in the 2021-2025 forecasts approved by the OEB, and the actual costs related to Piperville MTS materially exceeded the amounts forecast in the prior application.

In response to these challenges, Hydro Ottawa implemented proactive financial management strategies, notably deferring planned projects, resulting in a budget adjustment of approximately $44.2M. This prioritization, detailed in Section 4.1 - Historical Variance Overview, impacted key capital investments such as Major Station Rebuilds, Voltage Conversions, ERP Upgrades, and Underground Switchgear Renewals. Furthermore, Hydro Ottawa's labor productivity initiatives, as described in Schedule 1-3-4 - Facilitation Innovation and Continuous Improvement, played a crucial role in mitigating the overall financial impact. Without these initiatives, the net capital expenditure variance of $102.8M against the OEB-approved budget would have been considerably higher. It is also worth noting that Hydro Ottawa did not apply for a Z factor during the 2021-2025 period.

2. INTRODUCTION

This document provides a snapshot of Hydro Ottawa's capital expenditures over a 10-year period, encompassing five historical years (2021-2025) and five forecast years (2026-2030). While projects and programs may serve multiple purposes, for this summary, the entire cost of each is allocated to one of four investment categories. These investment decisions are derived from the planning process, as described in Schedule 2-5-4 - Asset Management Process.

Schedule 2-5-6 - System Access Investments through Schedule 2-5-9 - General Plant Investments provides the material investment plans and detailed justification for its proposed capital expenditures over the forecast period. Asset-related Operations and Maintenance (System O&M) expenditures are summarized in Section 6 - Impact on Operation and Maintenance Costs and discussed in more detail in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

The document is outlined under the following structure:

Section 3: Forecast Expenditures Outlines the 2026-2030 Capital Expenditures by Investment Category.

Section 4: Historical and Forecast Expenditure Overview: Outlines the variance between the 2021-2025 actuals and OEB Approved amounts, as well as comparisons to the 2026-2030 Capital Expenditure plan by Investment Category.

Section 5: Capital Expenditure Summary: Outlines the following details by Investment Category, and further divided by Capital Program and Budget Program:

- Analysis of Historical Capital Expenditure Performance: An analysis of Hydro Ottawa's capital expenditure performance during the DSP's historical period is provided. This includes an explanation of variances, comparing actuals to OEB-approved/planned amounts from Hydro Ottawa's last DSP. The variance analysis also includes variances in planned and actual work volume where applicable. Particular attention is given to explaining variances in any given year that significantly deviate from the historical trend.
- Analysis of Forecasted Capital Expenditures**:** An analysis of Hydro Ottawa's capital expenditures for the DSP's forecast period is included.

Section 6: Impact on Operation and Maintenance Costs: Outlines the impacts of capital expenditures on routine System O&M. System O&M expenditures, driven by maintenance, compliance, and increasing work complexity, are essential for reliable electrical distribution, with capital investments influencing these costs.

2.1. CAPITAL EXPENDITURE STRUCTURE

Hydro Ottawa's Capital Expenditure Plan is broken into four Investment Categories in alignment with OEB Chapter 5 filing requirements. Please refer to Section 5.3.1.1 of Schedule 2-5-4 - Asset Management Process.

- **System Access -** Modifications (including asset relocation) to a distributor's system to provide customers (including generator customers) with access to electricity services via the distribution system.
- **System Renewal -** Replacing and/or refurbishing system assets to extend their original service life, maintaining the ability of the distribution system to provide customers with reliable and safe electricity services
- **System Service -** Modifications to the distribution system to ensure that it continues to meet the distributor's operational objectives while addressing anticipated future customer electricity demand and service requirements.
- **General Plant -** Modifications, replacements or additions to a distributor's assets that are not part of its distribution power delivery system; including land and buildings; tools and equipment; rolling stock and electronic devices and software used to support day to day business and operations activities.

Each of the Investment Categories are further broken down into Capital Programs, which are further divided into Budget Programs. Each Budget Program is described for System Access, System Renewal, System Service and General Plant in Tables 7, 14, 26 and 31, respectively, in Section 5 - Capital Expenditure Summary.

2.2. CHANGES SINCE THE LAST DSP

This section outlines the key changes that impact Hydro Ottawa's Capital Investment Structure since the previous DSP submission in the 2021-2025 rate application.

System Access

Investments under System Access are needed to support growth and electrification. Within this investment category, a minor structural adjustment has been implemented related to the associated Capital Programs. Specifically, the Residential, Commercial, and Infill & Upgrade Capital Programs (previously delineated in the 2021-2025 DSP) have been consolidated into the Customer Connections Capital Program. This consolidation is based on the shared forecasting assumptions previously utilized for these programs, resulting in a streamlined approach to the Material Investment Plans and the elimination of redundant information.

System Renewal

System Renewal investments support the renewal of deteriorating infrastructure. Hydro Ottawa has made significant advancements to its asset management framework, including the implementation of predictive analysis, refined inspection programs, and comprehensive asset health indexing. These enhancements, part of Hydro Ottawa's continuous improvement efforts, support a data-driven approach to asset management. This approach uses Predictive Analytics in its asset risk assessment methodology (as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process) to inform program development in this investment category.

Furthermore, the End-of-Life (EOL) Voltage Conversion program has been added to this investment category for 2026-2030 in place of the former 2021-2025 Station Decommissioning Program, which was budgeted in System Service in the Distribution Enhancements program. This program will address the required replacement of 4kV stations through both decommissioning and voltage conversion to support system growth.

System Service

Hydro Ottawa's System Service capital investment category for 2026-2030, is designed to ensure the distribution system's capacity, reliability, resilience, and modernization, effectively addressing evolving energy demands and climate-related challenges.

The main change to the Capacity Upgrades Capital Program is the introduction of the Non-Wires Capacity Upgrade program. This program signifies a commitment to innovative grid enhancement through the implementation of alternative solutions, such as utility-owned battery storage, reflecting a proactive approach to technological advancement.

The Distribution Enhancements Capital Program has been expanded to include new budget programs: the Distribution System Observability program and Distribution System Resilience program. These two programs underscore a dedication to leveraging real-time data for optimized grid management and fortifying infrastructure against increasing climate vulnerabilities.

To reinforce communication infrastructure, the Field Area Network (FAN) capital program has been expanded to incorporate dedicated budget programs for Wireless Communication, Intelligent Electronic Device Management, and OTN Cyber Security. This expansion establishes a robust and secure communication framework essential for advanced grid operations. Furthermore, a dedicated Control and Optimization program has been established, focusing on the enhancement of the Advanced Distribution Management System (ADMS). The integration of the expanded FAN program and the new Control and Optimization program into the 2026-2030 System Service Investments demonstrates a resolute commitment to grid modernization.

Hydro Ottawa remains steadfast in its core objectives, which encompass the fortification of cyber security, the seamless integration of Distributed Energy Resources (DER), and the deployment of advanced grid technologies. Through these strategic adjustments and sustained investments, Hydro Ottawa ensures its infrastructure is robust, adaptable, and capable of meeting the region's future energy requirements.

General Plant

General plant investments are required to support day to day business and operations activities. The capital programs within this investment category have been redesigned since the last DSP to better align with the way the business operates and manages its financial performance. The last DSP presented 9 General Plant capital programs. Of these, 5 have been dissolved and replaced with 6 new capital programs. The projects within the dissolved capital programs have been redistributed to the new capital programs. Additionally, the former “Facilities Management" capital program has been renamed to “Buildings - Facilities” and modified to no longer include the Dibblee and Maple Grove Operations Centres as they have been reclassified to the System

Renewal Investment Category for better alignment with regulatory reporting requirements. Lastly, the capital program formally titled, "Hydro One Payments" has been renamed to "CCRA" to reflect the possibility of connection cost recovery agreements with entities other than Hydro One Networks Inc. (Hydro One). The "Tools Replacement" and "Fleet Replacement" capital programs remain consistent with the last DSP.

The capital programs from the last DSP that have been dissolved are: Enterprise Resource Planning (ERP) System, IT Life Cycle & On-Going Enhancements, Customer Service, and Operation Programs. The new capital programs are Enterprise Solutions, Infrastructure and Cyber Security, Meter to Cash, Customer Engagement Platform, Grid Technology and Data and System Integrations. See Section 5.4 - General Plant Expenditures for descriptions of each capital program.

2.3. NON-DISTRIBUTION ACTIVITIES

In March 2024, the OEB updated its "Non-Wires Solutions Guidelines for Distributors"[1] (previously known as the "CDM Guidelines for Distributors") to reflect "the fact that Non-Wires Solutions to address system needs can encompass a broader range of solutions than traditional conservation and demand management, including, but not limited to, third-party distributed energy resources such as energy storage and distributed (embedded) generation". Section 9.2 of Schedule 2-5-4 - Asset Management Process describes Hydro Ottawa's approach to evaluating and leveraging Non-Wire Solutions.

3. FORECAST EXPENDITURE

The proposed investment plan for 2026-2030 is driven by a comprehensive investment strategy that aligns with customer expectations and addresses the evolving needs of Hydro Ottawa's electricity grid. This incorporates key improvements, including enhanced asset management processes, expanded grid modernization and resilience planning, updated system capacity assessments, and refined long-term forecasting based on customer feedback and system

[1] OEB. (March 28, 2024). Non-Wire Solutions Guidelines for Electricity Distributors [EB-2024-0118].

needs. This process is outlined in Schedule 2-5-4 - Asset Management Process. Hydro Ottawa's investment strategy is broken down into the following four investment priorities.

1. **Growth & Electrification - Powering the Growing Community**
2. **Renewing Deteriorating Infrastructure**
3. **Grid Modernization - Enabling the Energy Transition**
4. **Enhancing Grid Resilience**

These four investment priorities address Hydro Ottawa's key distribution system planning challenges and opportunities, supported by two foundational focuses: Managing Rising Costs and Investing in the Workforce. Further details on this strategy are explained in Section 1.1 of Schedule 2-5-1 - Distribution System Plan Overview.

Table 1 below outlines the 2026-2030 forecasted expenditures by investment category . Hydro Ottawa's capital expenditures over the 10-year period can also be found in Appendix 2-AB - Capital Expenditure Summary. Details on the forecasted expenditures are outlined in Section 4.2 - Forecast to Historical Variance Overview.

Table 1 – Capital Expenditure Test Years Summary ($'000s)

Investment Category	Test Years					Average
	2026	2027	2028	2029	2030	2026-2030
System Access	$ 86,169	$ 78,690	$ 66,190	$ 66,978	$ 71,472	$ 73,900
System Renewal	$ 85,348	$ 83,396	$ 80,714	$ 86,903	$ 95,343	$ 86,341
System Service	$ 99,276	$ 125,311	$ 76,050	$ 85,922	$ 86,912	$ 94,694
General Plant	$ 38,325	$ 23,583	$ 33,025	$ 27,872	$ 11,026	$ 26,766
GROSS CAPITAL EXPENTIDURES	**$ 309,118**	**$ 310,981**	**$ 255,979**	**$ 267,675**	**$ 264,752**	**$ 281,701**
Capital Contributions	$ (50,947)	$ (50,591)	$ (38,447)	$ (32,197)	$ (41,052)	$ (42,647)
NET CAPITAL EXPENDITURES	**$ 258,171**	**$ 260,390**	**$ 217,532**	**$ 235,478**	**$ 223,700**	**$ 239,054**

System Access

Hydro Ottawa's System Access Capital Investments are strategically allocated across five key programs: Plant Relocation & Upgrade, Customer Connections, System Expansion, Generation Connections, and Metering. This budget was derived through an analysis of historical trends, forecasted growth, regulatory requirements, and customer service demands, ensuring alignment with Hydro Ottawa's mandate for safe, reliable, and sustainable electricity delivery. Refer to Section 5.1 - System Access Expenditures. The Customer Connections program reflects the ongoing expansion of residential and commercial developments. The System Expansion program addresses capacity constraints driven by increasing customer load requests. The Plant Relocation & Upgrade program supports infrastructure adjustments necessitated by third-party projects, primarily the City of Ottawa's development initiatives. The Generation Connections program facilitates the integration of distributed energy resources (DERs), while the Metering program focuses on Suite Metering retrofits. These investments collectively aim to support growth and a sustainable energy future.

Detailed information regarding System Access capital investments can be found within the Material Investment Plans outlined in Schedule 2-5-6 - System Access Investments.

System Renewal

Hydro Ottawa's System Renewal Capital Investments are strategically directed towards five core programs: Stations and Buildings Infrastructure Renewal, Overhead (OH) Distribution Asset Renewal, Underground (UG) Distribution Asset Renewal, Metering Renewal, and Corrective Renewal. This budget was developed through a rigorous process that combines Predictive Analytics, risk assessment modeling, and age-based prioritization to identify and address deteriorating infrastructure. Refer to Section 5.2 - System Renewal Expenditures. Condition-based assets, such as transformers and switchgear, are prioritized using Predictive Analytics and a risk assessment model that considers age, reliability, safety, financial, environmental, and compliance factors. Non-condition based assets, including RTUs and building facilities, are prioritized based on age. These investment programs are designed to proactively address risks by replacing aging and deteriorating infrastructure, ensuring the sustained delivery of safe and reliable electricity

Detailed information regarding System Access capital investments can be found within the Material Investment Plans outlined in Schedule 2-5-7 - System Renewal Investments.

System Service

Hydro Ottawa’s planned System Service capital investments are strategically allocated across six key programs: Capacity Upgrades, Distribution Enhancements, Station Enhancements, Grid Technologies, Field Area Network (FAN), and Control and Optimization (which is a new capital program). Refer to Section 5.3 - System Service Expenditures. This comprehensive budget was derived through a detailed analysis of forecasted demand, grid modernization needs, and climate change impacts, ensuring alignment with Hydro Ottawa's commitment to safe, reliable, and sustainable electricity delivery. The Capacity Upgrades program addresses system capacity needs through station, distribution, and non-wires upgrades. The Distribution Enhancements program focuses on modernizing the grid and enhancing resilience through reliability improvements, DER integration, strategic undergrounding and hardening of critical overhead sections, and enhanced grid observability. The remaining programs, including Station

Enhancements, Grid Technologies, Field Area Network, and the new Control and Optimization, address critical aspects of grid modernization, cyber security, and DER management. These investments collectively aim to increase distribution system capacity, improve reliability and resilience, and advance grid modernization to meet the evolving needs of Hydro Ottawa's customers.

Detailed information regarding System Access capital investments can be found within the Material Investment Plans outlined in Schedule 2-5-8 - System Service Investments.

General Plant

The General Plant category encompasses investments essential for maintaining and advancing Hydro Ottawa's infrastructure, operational capabilities, and customer service excellence. These investments are allocated across ten key programs: Connection and Cost Recovery Agreements (CCRA), Fleet Replacement, Tools Replacement, Buildings - Facilities, Grid Technology, Meter to Cash, Customer Engagement Platform, Enterprise Solutions, Infrastructure and Cyber Security, Data and System Integrations. These programs support strategic goals like grid modernization, sustainability, and workforce readiness while promoting efficiency, innovation, and resilience in Hydro Ottawa's operations.

Investments in CCRAs with Hydro One are included in the System Service planning process. These projects are carefully chosen based on several factors, including recommendations from the IRRP and aligned with supporting distribution and NWSs programs. This ensures that capacity upgrades are implemented strategically and in a way that maximizes benefits for the overall system. General Plant investments in Tools Replacement are projected using historical costs per employee and applied to expected employee levels. Fleet Replacement, and Building - Facilities and the remaining technology, data and infrastructure programs follow a similar approach to the distribution asset management processes. These investments are typically large replacement or enhancement initiatives for assets reaching the end of their useful life. As such, they generally span several years. Therefore, they are initiated and justified with detailed business cases.

Detailed information regarding General Plant capital investments can be found within the Material Investment Plans outlined in Schedule 2-5-9 - General Plant Investments.

4. HISTORICAL AND FORECAST EXPENDITURE OVERVIEW

4.1. HISTORICAL VARIANCE OVERVIEW

4.1.1. Overview of Historical Variance

Hydro Ottawa expects that its net capital expenditures will exceed the OEB-approved budget by approximately $102.8M in aggregate over the 2021-2025 historical period as outlined in Table 2. The variance by year is further detailed by investment category in Table 3.

Table 2 – Capital Expenditure Historical 5 yr Variances (Net) ($'000s)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
System Access	$ 84,300	$ 134,193	$ 49,892	59%
System Renewal	$ 209,978	$ 232,321	$ 22,343	11%
System Service	$ 123,089	$ 161,048	$ 37,959	31%
General Plant	$ 80,193	$ 72,827	$ (7,367)	(9)%
TOTAL CAPITAL EXPENDITURES	**$ 497,561**	**$ 600,388**	**$ 102,827**	**21%**

1 **Table 3 - Capital Expenditure Historical Annual Variances (Net) ($'000s)**

Capital Program	2021	2022	2023	2024	2025
	OEB-Approved (Net of Contribution)				
System Access	$ 17,820	$ 17,879	$ 17,720	$ 15,626	$ 15,255
System Renewal	$ 45,421	$ 44,414	$ 40,594	$ 39,436	$ 40,114
System Service	$ 25,436	$ 26,168	$ 23,434	$ 24,654	$ 23,398
General Plant	$ 31,540	$ 10,874	$ 6,208	$ 15,343	$ 16,228
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 120,217**	**$ 99,335**	**$ 87,956**	**$ 95,058**	**$ 94,995**
	Historical Years			Bridge Years	
System Access	$ 21,638	$ 19,723	$ 24,987	$ 32,625	$ 35,220
System Renewal	$ 43,249	$ 65,469	$ 40,266	$ 42,334	$ 41,003
System Service	$ 23,938	$ 13,825	$ 16,585	$ 47,157	$ 59,543
General Plant	$ 23,273	$ 11,262	$ 12,146	$ 13,967	$ 12,179
TOTAL HISTORICAL/BRIDGE NET CAPITAL EXPENDITURES	**$ 112,097**	**$ 110,278**	**$ 93,984**	**$ 136,082**	**$ 147,945**
	Variance ($)				
System Access	$ 3,817	$ 1,844	$ 7,267	$ 16,999	$ 19,965
System Renewal	$ (2,172)	$ 21,054	$ (327)	$ 2,899	$ 889
System Service	$ (1,498)	$ (12,343)	$ (6,849)	$ 22,503	$ 36,145
General Plant	$ (8,267)	$ 388	$ 5,938	$ (1,376)	$ (4,049)
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ (8,120)**	**$ 10,943**	**$ 6,029**	**$ 41,024**	**$ 52,951**

As noted in the Overview Section, the 2021-2025 period presented Hydro Ottawa with a series of unprecedented disruptions. These disruptions, stemming from global and local external factors, included unprecedented supply chain challenges, a surge in complex customer connections, unforeseen externally-driven projects, increased emergency renewal work due to severe storms and equipment failures, and substantial investments in new stations to address growing electricity demand as identified in the Ottawa Integrated Regional Resource Plan (IRRP) as noted below:

I. Unprecedented Supply Chain Disruption

In the 2021-2025 period, Hydro Ottawa faced severe supply chain disruptions caused by a complex interplay of global events that converged to create an unprecedented procurement challenge. The COVID-19 pandemic initiated the crisis with widespread manufacturing shutdowns and severe logistics bottlenecks, disrupting the flow of essential materials and equipment, as detailed in Schedule 1-2-4 - Impact of COVID-19 Pandemic. This was compounded by a surge in global demand for electrical equipment. Further exacerbating the situation, the Russian war in Ukraine introduced significant geopolitical instability, disrupting the supply of critical materials, including grain-oriented electrical steel for transformer cores. Consequently, as detailed in Schedule 1-2-5 - Impact of Inflationary Pressures, Hydro Ottawa also experienced dramatic price increases for essential equipment, including transformers, cables, switchgear, wood poles, and meters, forcing budget adjustments and project deferrals to help mitigate the impact of these external cost factors. The combined effect of these disruptions resulted in longer lead times for procurement, further complicating project execution and necessitating strategic decisions regarding resource allocation and prioritization. As noted in Schedule 1-2-5 - Impacts of Inflationary Pressure, Canada's inflation rate in the 2020-2024 period was the highest in 40 years.

II. Customer Connections Volume, Complexity, and Cost

Hydro Ottawa faced an unprecedented surge in customer connection requests, escalating from an annual average of 3,190 (OEB-approved budget) to an annual average of 6,067 (over the 2021-2023 period), a consequence of the municipal and provincial policy push towards intensified housing and a pandemic-fueled housing boom. Customer connections over the historical period presented not only a quantitative increase but also a significant qualitative shift, becoming notably more complex and costly. The average cost per connection increased materially, from $934 to $1,350, reflecting the inflationary pressures impacting material and labour costs, as well as the intricate electrical infrastructure demanded by higher-density developments. The impacts of the inflationary pressures on Hydro Ottawa are detailed in Schedule 1-2-5 - Impact of Inflationary Pressures. This surge placed a considerable strain on Hydro Ottawa's resources, stretching beyond initial budget projections. Further details related to the impacts to Hydro Ottawa's workforce and the associated growth requirements are presented in Attachment 4-1-3(C) - Workforce Growth.

III. Unforeseen Externally-Driven Projects

While Hydro Ottawa had budgeted for one major unforeseen project, a series of additional externally-mandated projects caused significant cost pressures, notably the delays of LRT Phase II, the City of Ottawa's Zero Emission Bus initiative, and the DND's Dwyer Hill Road project. These initiatives, despite carrying a budget for one large project, substantially exceeded initial scope projections, and necessitated substantial, unanticipated expenditures. Hydro Ottawa was required to absorb these incremental costs, which were partially offset by deferred expenditures in other programs. Beyond the immediate financial impact, these projects also caused significant strain on internal resources. The cascading effects of these unforeseen projects extended to the company's long-term strategic planning, forcing a reassessment of future infrastructure needs and budgetary allocations. While Hydro Ottawa actively collaborates with stakeholders to align forecasts (refer to Schedule 2-5-2 - Coordinated Planning with Third Parties), the timing and scope of critical projects are ultimately determined by external entities, which can lead to significant budget fluctuations.

IV. Increased Emergency Renewal Work due to Major Storms and Equipment Failure

Hydro Ottawa experienced a significant increase in emergency renewal expenditures, totaling $33M above historical levels, during the period of 2021-2025. This surge was primarily driven by a series of unprecedented weather events, most notably the catastrophic 2022 Derecho storm. This singular event resulted in a $15.3M overspend in emergency renewals, as detailed in

Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report. The storm's extensive damage to critical infrastructure necessitated an immediate and substantial mobilization of resources, exceeding typical operational parameters.

In addition to the Derecho, a sequence of subsequent severe weather events further strained Hydro Ottawa's System Renewal capital program. These Major Event Days, detailed in Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement, contributed to a sustained increase in emergency repair workloads. As a residual effect of the extreme weather, general equipment failures increased due to infrastructure deterioration and heightened system stress, leading to further cost escalation. This confluence of factors created a continuous cycle of emergency repairs, diverting resources from planned maintenance and capital improvement projects. Consequently, the capital investment budget was significantly impacted, and customer outages increased, highlighting the electrical grid's vulnerability to extreme weather and the critical need for proactive infrastructure resilience.

V. New Stations Investments to Address Growing Electricity Demand

Hydro Ottawa made significant investments in two new Municipal Transformer Stations (MTS) over the historical period: Mer-Bleue MTS and Piperville MTS. These investments were in response to the needs related to growth and resilience identified during the Regional Planning Process outlined in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties. As the capacity requirements for the Mer-Bleue MTS project were identified through the regional planning process following the approval of the 2021-2025 OEB budget, the project was not incorporated, resulting in $13.8M of unbudgeted expenditures. Concurrently, the Piperville MTS project, while accounted for in the initial budget, experienced cost overruns attributed to unforeseen escalations in material and labour costs. This discrepancy underscored the volatility of market prices, particularly in specialized electrical equipment, and the challenges of accurately forecasting expenditures over extended periods. The impacts of the inflationary pressures on Hydro Ottawa are detailed in Schedule 1-2-5 - Impact of Inflationary Pressures. These investments, while crucial for bolstering grid resilience and expanding capacity to meet the region's growing energy needs, placed a considerable strain on Hydro Ottawa's financial resources.

4.1.2. Major Contributing Factors to Historical Period Variances

This section examines the major contributing factors leading to the significant financial variances experienced relative to the 2021-2025 OEB-approved budget, which resulted in a net capital expenditure variance of $102.8M. To mitigate these cost pressures, Hydro Ottawa implemented proactive financial management strategies, notably deferring planned projects, resulting in a budget adjustment of approximately $44.2M as noted in Table 4. This prioritization impacted key capital investments such as Major Station Rebuilds, Voltage Conversions, ERP Upgrades, and Underground Switchgear Renewals. Furthermore, Hydro Ottawa's labor productivity initiatives, as described in Schedule 1-3-4 - Facilitation Innovation and Continuous Improvement, played a crucial role in mitigating the overall financial impact. Without these initiatives, the net capital expenditure variance of $102.8M against the OEB-approved budget would have been considerably higher. It is also worth noting that Hydro Ottawa did not apply for a Z factor during the 2021-2025 period.

Table 4 presents a comprehensive overview of the major projects and events that contributed to increased spending and the major deferrals by Investment Category. Refer to Section 5 - Capital Expenditure Summary for further details of the historical variances by Capital Program. It is important to note that Table 4 below has inflation embedded in each of the variances as it is impossible to isolate inflation on every line item budget. As discussed in Schedule 4-1-1 - Operations, Maintenance, and Administration Summary, the level of operations, maintenance and administration (OM&A) included in Hydro Ottawa’s rates over the 2021-2025 period was increased by the OEB’s inflation factor, less the stretch factor, plus a growth factor. However, with respect to capital costs, the approved plan did not include any amounts forecast for inflation, nor did it include any cost escalation adjustment mechanisms. Essentially, the capital plan assumed that a modest level of inflation would continue and that the impact of any inflation would be offset by productivity and efficiency savings. The revenue requirement for planned capital spending was further reduced by an annual 0.6% capital stretch factor.

1 **Table 4 – Major Variance Contributors ($'000s)**

Projects/Events	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)
Major Overspend Contributors			
Residential Subdivisions	$ 14,930	$ 38,911	$ 23,981
New Commercial Development	$ 9,593	$ 26,491	$ 16,898
Large Externally Driven Projects	$ 21,498	$ 39,483	$ 17,985
SubTotal - System Access	$ 46,021	$ 104,885	$ 58,864
2022 Derecho	-	$ 15,294	$ 15,294
Other Emergency Renewal	$ 24,534	$ 42,219	$ 17,685
Storm Hardening Pole Renewal	-	$ 2,360	$ 2,360
Cable Replacement	$ 44,414	$ 54,318	$ 9,904
SubTotal - System Renewal	$ 68,948	$ 114,191	$ 45,243
Capacity Upgrades	$ 75,849	$ 108,196	$ 32,347
Advanced Distribution Management System	$ 14,928	$ 22,760	$ 7,831
SubTotal - System Service	$ 90,777	$ 130,956	$ 40,179
My Account	-	$ 6,789	$ 6,789
ServiceNow	-	$ 2,669	$ 2,669
Facilities Projects	-	$ 3,640	$ 3,640
SubTotal - General Plant	-	$ 13,097	$ 13,097
Total Major Overspend Contributors	**$ 205,746**	**$ 363,128**	**$ 157,383**
Major Deferrals			
Major Station Rebuild and Voltage Conversion	$ 27,274	$ 3,982	$ (23,291)
Other Distribution Asset Renewal	$ 21,697	$ 16,218	$ (5,479)
SubTotal - System Renewal	$ 48,971	$ 20,201	$ (28,770)
Capacity Voltage Conversion	$ 5,864	$ 1,739	$ (4,125)
SubTotal - System Service	$ 5,864	$ 1,739	$ (4,125)
Meter to Cash AMI Program	$ 1,557	-	$ (1,557)
Enterprise Resource Planning Upgrade	$ 9,740	-	$ (9,740)
SubTotal - General Plant	$ 11,297	-	$ (11,297)
Total Major Deferrals	**$ 66,131**	**$ 21,939**	**$ (44,192)**
Other			
CCRAs	$ 26,658	$ 16,964	$ (9,695)
Remaining Capital Expenditure	$ 199,026	$ 198,357	$ (669)
Total Other	**$ 225,684**	**$ 215,320**	**$ (10,364)**
Total Capital Expenditures	**$ 497,561**	**$ 600,388**	**$ 102,827**

The amounts in "Remaining Capital Expenditure" listed in Table 4 contain all other capital expenditures not categorized as associated with the major contributing factors. The associated variance results in an underspend of $0.7M. It is the result of several overages and underages across various programs. For a comprehensive understanding of the variances within each capital program please refer to Section 5 - Capital Expenditure Summary. Additionally, the 'Other' category included the variance on Connection Cost Recovery Agreements (CCRAs), which was largely beyond Hydro Ottawa's control.

4.1.3. 2021-2025 Major Deferrals

During the 2021-2025 period, Hydro Ottawa faced a series of unprecedented challenges that tested its operational resilience. These included the COVID-19 pandemic and its associated supply chain disruptions, inflationary pressures, a historic Derecho storm in May 2022 that caused extensive damage to the electricity grid, eleven other major weather events requiring emergency response, and an 84-day labor strike in 2023 (following a near strike in 2021).

In response, Hydro Ottawa adopted a flexible and pragmatic approach to capital expenditure management. Faced with significant budgetary pressures from these unforeseen events, the utility strategically deferred certain capital investments to mitigate the impact of unavoidable increases in other programs. These decisions, guided by principles of responsible financial stewardship, represented a deliberate and calculated response to immediate budgetary constraints, aimed at ensuring operational stability and minimizing ratepayer impact. Furthermore, Hydro Ottawa implemented specific cost avoidance measures by evaluating program progress and actively reducing asset replacements across various programs to further mitigate cost impacts.

The identification and prioritization of deferrals and cost avoidance measures were conducted with a focus on maintaining the integrity of the electrical infrastructure. Recognizing the potential implications of delaying critical projects, Hydro Ottawa adhered to a rigorous portfolio optimization process, as detailed in Section 5.3 of Schedule 2-5-4 - Asset Management

Process. This process involved a comprehensive assessment of project criticality, asset condition, and associated risks, ensuring that deferrals were implemented in a manner that judiciously balanced the financial limitations with infrastructure integrity.

4.1.3.1. System Renewal Deferrals ($28.8M)

During the 2021-2025 period, Hydro Ottawa implemented System Renewal capital investment deferrals totaling $28.8M. This encompassed $23.3M in Large Station Rebuild and Voltage Conversion projects, and $5.5M in Other Distribution Asset Renewals. Leveraging asset condition assessments and advanced analytical tools, the company strategically prioritized projects, deferring rebuilds at Rideau Heights and Shillington AD, while pursuing voltage conversions at Fisher AK and Dagmar to address both asset conditions and capacity constraints. Additionally, deferrals were applied to various asset renewal programs, including underground switchgear and metering assets. The following detailed account of these deferrals illustrates Hydro Ottawa's data-driven approach to balancing financial constraints with the imperative of maintaining system reliability and minimizing ratepayer impact.

Large Station Rebuild and Voltage Conversion Projects ($23.3M)

Station project work described below was deferred in order to accommodate budget overruns and to manage cash flow in response to the unforeseen challenges of the historical period. Hydro Ottawa implemented a rigorous assessment process, utilizing enhanced inspection methodologies, to evaluate the feasibility of deferring select infrastructure renewal projects. Employing advanced analytical tools and comprehensive asset condition data, the company made informed, data-driven decisions regarding infrastructure upgrade deferrals. This strategic approach ensured the optimal allocation of capital resources, prioritizing critical projects and minimizing the financial impact on ratepayers while maintaining acceptable levels of system reliability.

- The Rideau Heights station rebuild ($3.2M of budgeted capital investment) was deferred based on a detailed asset condition assessment. This assessment confirmed that the rebuild could be postponed without compromising reliability. Ongoing monitoring and maintenance, combined with proactive O&M, will ensure timely response to any changes. This data-driven, risk-informed approach facilitated an evidence-based decision to defer the capital investment.

- The Shillington AD station rebuild was deferred ($2.5M of budgeted capital investment) following an assessment based on the enhanced inspection of the asset condition. The analysis of the condition data confirmed that it would be possible to delay the project temporarily while maintaining an acceptable level of operational risk. Further, the continuous monitoring of the Shillington AD station through O&M activities ensures that if conditions change, the necessary work can be scheduled promptly.
- The planned rebuild of the Fisher AK station, initially driven by asset conditions, was deferred in favor of a voltage conversion project, resulting in a $5.7M deferral of budgeted capital investment. This decision was based on a re-evaluation of the project in light of emerging capacity constraints. An updated planning analysis demonstrated that 4kV to 13kV voltage conversion would better address immediate capacity needs while also effectively eliminating the original rebuild requirement arising from asset conditions. Consequently, the voltage conversion project has superseded the planned rebuild scope, rather than representing a temporary substitute of the station rebuild scope. The strategic adjustment underscores Hydro Ottawa's commitment to proactive adaptation to evolving operational requirements and optimization of resource allocation. By re-scoping the project, Hydro Ottawa ensures the delivery of essential infrastructure upgrades while minimizing the financial impact on ratepayers, thereby aligning capital investments with long-term strategic objectives.
- The planned rebuild of the Dagmar station, originally necessitated by asset condition, was also deferred in favor of a voltage conversion project, resulting in a $11.9M deferral of budgeted capital investment. This decision followed a comprehensive re-evaluation of the project in response to emergent capacity constraints. An updated planning analysis demonstrated that 4kV to 13kV voltage conversion would better address immediate capacity needs while also effectively eliminating the original rebuild requirement arising from asset

conditions. Consequently, the voltage conversion project has superseded the planned rebuild scope, rather than representing a temporary substitute of the station rebuilt scope. The adjusted project scope is planned execution for 2026-2030. This strategic adjustment underscores Hydro Ottawa's commitment to proactive adaptation to evolving operational requirements and optimization of resource allocation.

Other Distribution Asset Renewal ($5.5M)

Deferrals in various capital programs were implemented following comprehensive risk and condition evaluations. Work in the programs described below was deferred in order to accommodate budget overruns and to manage cash flow in response to the unforeseen challenges of the historical period. Each of these deferrals was made after careful consideration of the asset condition, potential risks, and the overall impact on system reliability. These decisions demonstrate Hydro Ottawa's commitment to dynamically adjusting its capital expenditure plans to minimize the financial impact on ratepayers while maintaining infrastructure integrity, and minimizing incremental system performance risk for customers.

- Hydro Ottawa deferred $5.5M in budgeted capital investments related to Underground Switchgear Renewals, Overhead Switch/Recloser Renewals, Metering Asset Renewals, System Renewal Investments (excluding station investments), and Vault Renewals. Each deferral was predicated on a comprehensive evaluation of asset condition, potential risks, and the overall impact on system performance. This meticulous assessment process ensured that deferrals were implemented prudently, minimizing incremental system performance risk for customers.

4.1.3.2. System Service Deferrals ($4.1M)

Deferrals in System Service investments were implemented in order to accommodate budget overruns and to manage cash flow in response to the unforeseen challenges of the historical period.

Capacity Voltage Conversion ($4.1M)

Hydro Ottawa deferred two planned capacity voltage conversion projects at West 12kV and Navan Road, resulting in a $4.1M deferral. These projects, while essential for long-term capacity enhancement, were deemed suitable for postponement based on current operational conditions and risk assessments.

4.1.3.3. General Plant Deferrals ($11.3M)

For the 2021-2025 period, Hydro Ottawa deferred $11.3M in planned General Plant capital investments. This encompassed the $9.7M Enterprise Resource Planning (ERP) upgrade deferral, attributed to evolving software portfolio requirements, infrastructure spending demands, and external disruptions such as the pandemic and severe weather events. Additionally, $1.6M of the Meter to Cash AMI program was deferred, influenced by pandemic-related resource constraints and a strategic re-evaluation of AMI modernization. The following details provide insight into Hydro Ottawa's strategic resource allocation during a period of significant operational and financial challenges, and the proactive planning for future technology upgrades.

Enterprise Resource Planning Upgrade ($9.7M)

As noted in Section 5.4.2 - Historical Variance below, the deferral of the $9.7M Enterprise Resource Planning (ERP) project deployment was driven by a variety of factors, including evolving requirements for Hydro Ottawa's overall enterprise software portfolio, increased spending demands for critical infrastructure, disruptions from the COVID-19 pandemic, and other unforeseen events, such as the 2022 Derecho and the 2023 strike. In addition, Oracle extended support for the current version. Ultimately, the decision was made to defer the project in order to reduce overall capital expenditure and focus limited resources on maintaining essential services during these challenging periods. While the ERP project was initially proposed for the 2026-2030 timeframe, given competing spend priorities, Hydro Ottawa will continue to leverage its current JD Edwards ERP version for that period, focusing instead on improving Enterprise Asset Management processes and technology as noted in Attachment 4-1-1(A) - Transition to Cloud Computing.

Meter to Cash AMI Program ($1.6M)

$1.6M of the Meter to Cash capital program budget was deferred due to external factors and the evolving AMI landscape. The COVID-19 pandemic and the 2022 Derecho strained resources while the need for enhanced grid modernization capabilities led to a reevaluation of the project's scope and objectives. It was decided to defer investment in the 2021 - 2025 period and prioritize the development of a comprehensive AMI 2.0 Metering Renewal Program for the 2026-2030 period.

4.1.3.4. Cost Containment Measures

To address extraordinary financial pressures, notably the 2022 Derecho storm, Hydro Ottawa implemented strategic cost containment measures during 2021-2025. These measures, detailed below, extended beyond project deferrals to include proactive adjustments in capital expenditure, revisions to cable and pole replacement programs, and productivity enhancements resulting in labor savings.

- Following the unprecedented impact of the 2022 Derecho storm, Hydro Ottawa undertook a comprehensive review of its capital expenditure plans. Recognizing the need to balance immediate recovery efforts with long-term financial sustainability, a strategic decision was made to reduce the overall sustainment (System Service and System Renewal) capital expenditures by $1M per year for the years 2023, 2024, and 2025.
- Hydro Ottawa implemented a strategic adjustment to its cable replacement program for the 2021-2025 period, revising the target from the initially planned 130 km to approximately 74 km. This risk-based decision to adjust the target, supported by the asset condition analysis, was made due to significant unit rate increases in the Cable Replacement Program as detailed in Section 5.2.1 - Historical Expenditures. The revised target was not merely a

risk-based decision to reduce the volume but a calculated adjustment to avoid an estimated $49.5M in capital expenditures.

- Subsequent to the 2022 Derecho which resulted in the unanticipated replacement of over 400 poles, Hydro Ottawa strategically reduced its 2021-2025 pole renewal target from 2,000 to 1,732 poles. It's important to note that the poles replaced due to the Derecho were distinct from those targeted in the planned pole renewal program. This target reduction was taken solely to mitigate cost overruns overall. The decision on which pole replacement projects to defer was a risk-based decision , based on detailed asset conditions as detailed Section 5.2.1 - Historical Expenditures. Separately, Hydro Ottawa implemented productivity measures that resulted in $2.1M in capital savings in the pole renewal program. Specifically, Hydro Ottawa implemented operational changes, including team realignment, dedicated construction technicians, and seasonal shift adjustments, to enhance collaboration, efficiency, and productivity. Additionally, cost containment strategies to manage planned overtime were also deployed. The productivity savings coupled with the strategic decision to reduce the pole renewal target resulted in an estimated $8.6M in avoided capital expenditures.
- The efforts undertaken to achieve the productivity savings in the pole renewal program also translated to labour savings in the remainder of the distribution overhead capital programs. These savings amounted to an additional $14.8M of capital avoidance over the historical period. Further detail of the productivity savings, totaling approximately $14.5M, are summarized in Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement.

4.1.3.5. Commitment to Infrastructure Integrity and Future Planning

Hydro Ottawa prioritized the maintenance of electrical system integrity throughout the 2021-2025 period, even as it implemented strategic deferrals and cost avoidance measures. Recognizing the potential impact of delaying critical projects, the company adhered to a rigorous portfolio optimization process, as detailed in Section 5.3 of Schedule 2-5-4 - Asset Management Process. This process involved a comprehensive, risk-informed assessment of project criticality and asset condition, ensuring that financial limitations were balanced with the imperative of infrastructure integrity.

While the deferrals and cost avoidance measures employed during the 2021-2025 period were implemented as short-term strategies to address budgetary limitations and immediate financial pressures, Hydro Ottawa acknowledges the necessity of addressing deferred work. The company is committed to the reintegration of the deferred work into the 2026-2030 capital expenditure plan, thereby ensuring the long-term reliability and resilience of the electrical infrastructure. This commitment reflects Hydro Ottawa's dedication to balancing immediate economic needs with the sustained integrity of the electrical system. The substantial shifts in spending across all investment categories during the 2021-2025 period underscore the material impact of these strategic decisions and affirm the company's commitment to prudent financial management.

4.2. FORECAST TO HISTORICAL VARIANCE OVERVIEW

This section analyzes the variance in expenditures between the historical period of 2021-2025 and the projected period of 2026-2030. Table 5 presents a comparative overview of expenditures across Investment Categories for both periods. Figure 1 depicts the percent contributions of each investment category to the net total for 2021-2025 and 2026-2030 respectively.

1 **Table 5 – Historical, Bridge and Test Years Expenditures by Investment Category ($'000s)**

Investment Category	2021-2025 Historical/ Bridge	2026-2030 Test Years	Var ($)	Var (%)
System Access	$ 292,570	$ 369,500	$ 76,930	26%
System Renewal	$ 232,333	$ 431,704	$ 199,371	86%
System Service	$ 161,104	$ 473,472	$ 312,368	194%
General Plant	$ 76,405	$ 133,830	$ 57,425	75%
GROSS CAPITAL EXPENDITURES	**$ 762,412**	**$ 1,408,505**	**$ 646,093**	**85%**
Capital Contributions	$ (162,024)	$ (213,234)	$ (51,210)	32%
TOTAL NET CAPITAL EXPENDITURES	**$ 600,388**	**$ 1,195,271**	**$ 594,883**	**99%**

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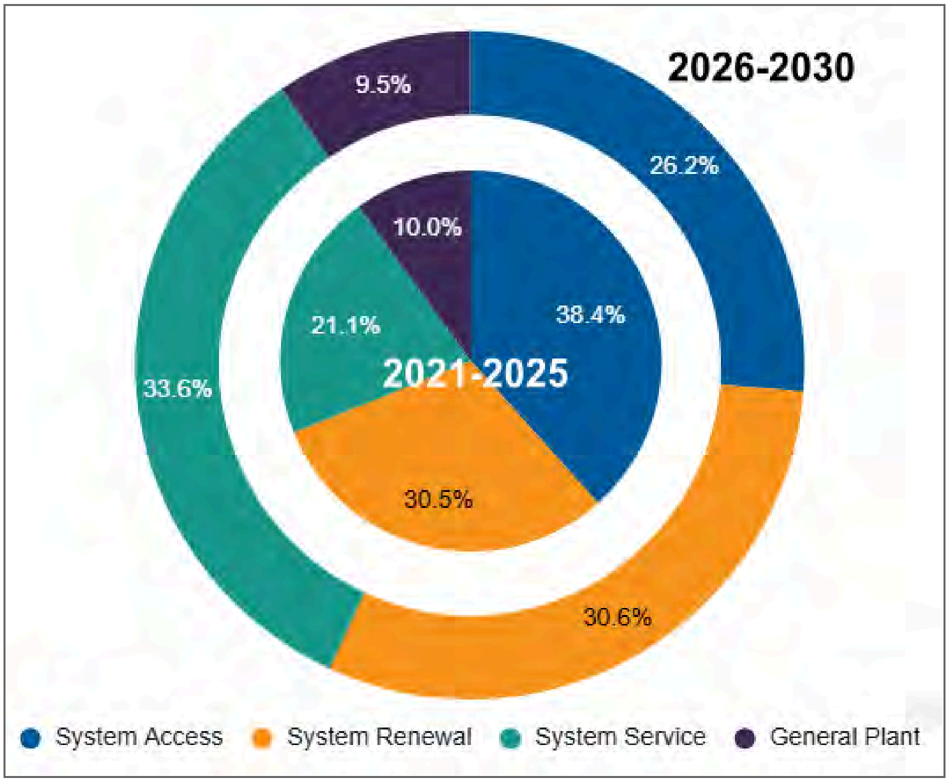
Figure 1 – Percentage Contribution of Investment Categories to Total Expenditures 2021-2025 and 2026-2030



System Access

While System Access shows a 12.2% relative decrease in contributions as a result of the increases in other Investment Categories, the gross expenditures within this category, which are necessary to support growth and electrification, are projected to increase by 26% compared to the 2021-2025 period. Projected capital expenditures are expected to rise from $293M in the 2021-2025 period to $369M in the 2026-2030 period, excluding Capital Contributions as shown in Table 5. This increase is primarily attributed to the growing number and complexity of customer connections, reflected in the higher expenditures for the Customer Connections and System Expansion Capital programs. This growth in expenditures is partially offset by a projected decrease in Plant Relocation costs as a result of the long-standing City of Ottawa LRT project being largely complete. Further details of forecasted System Access expenditures by capital program are provided in Section 5.3.1 - Historical Expenditures.

System Renewal

Expenditures in the System Renewal category are expected to continue to make up approximately 30% of the overall spend and increase by 86%, from $232M in the 2021-2025 period to $432M in the 2026-2030 period. This increase is substantiated by improvements to the asset condition and system risk models through the implementation of Predictive Analytics and updates to failure curves which have provided Hydro Ottawa a much more accurate and thorough understanding of the failure risk due to deteriorating asset condition, as detailed in Section 2.1.1 of Schedule 2-5-4 - Asset Management Process. Specifically, the need for incremental investments is targeted at the renewal of high-risk station assets, followed by underground and overhead. A further breakdown of the forecasted expenditures by capital program is provided in Section 5.2.3 - Forecast to Historical Variance by Capital Program.

System Service

As can be noted from Figure 1 above, System Service makes up a greater proportion of the 2026-2030 DSP compared to the 2021-2025 DSP, rising from 21% to approximately 34%. The associated investment in this category is forecast to increase by 194% from $161M in the 2021-2025 period to $473M in the 2026-2030 timeframe. This reflects Hydro Ottawa's need to expand the capacity of the grid in order to connect new customers and serve customers' growing demand for electricity, as well as the utility's commitment to modernize the grid and make it more resilient to withstand extreme weather. The increase is primarily driven by the Capacity Upgrades program, which addresses growing capacity needs due to customer growth and electrification. Increased spending in the Distribution Enhancements program also contributes, with a focus on two new budget programs for Distribution System Observability and Distribution System Resilience.

Finally, the Field Area Network Program drives further increases with investments in fiber extensions to ensure real-time data sharing from grid-edge devices and wireless communication capabilities necessary to support the enhanced number of automated field devices and metering infrastructure. Further details related to the forecasted expenditures in System Service by capital program are provided in Section 5.3.3 - Forecast to Historical Variance by Capital Program.

General Plant

Expenditures under the General Plant investment category are projected to increase by 75% from $76M in the 2021-2025 period to $134M the 2026-2030 period and remain at approximately 10% of the overall expenditures. The primary factor for this increase is due to increased funding under the CCRA program required to support the increased number of transmission upgrades required to service new and upgraded stations. An increase in the Fleet Replacement program is driven by the need to replace vehicles that have reached end of useful life and for additional vehicles required to support the increase in planned workforce. Further details of the forecasted expenditures by capital program are provided in Section 5.4.3 - Forecast to Historical Variance by Capital Program.

5. CAPITAL EXPENDITURE SUMMARY

5.1. SYSTEM ACCESS EXPENDITURES

System Access investments are mandated by provincial legislation and while Hydro Ottawa makes every effort to ensure projects in this Investment Category are completed as timely and efficiently as possible, the inherent nature of customer-driven and third-party-initiated work means that the project timeline and associated budgets are not entirely within Hydro Ottawa's control. The System Access Investment Category is broken down into five Capital Programs as described in Table 6.

Table 6 - System Access Capital Programs

Capital Program	Description
Plant Relocation & Upgrade	This program relocates and/or upgrades Hydro Ottawa's overhead and underground equipment, including jointly owned assets, to accommodate third-party infrastructure projects and maintain safe clearances around energized facilities.
Customer Connections	This program invests in electrical infrastructure upgrades to connect new residential, commercial, and infill developments to the distribution grid, ensuring capacity for current and projected electricity demands.
System Expansion	This program ensures reliable electrical service to new and upgraded customer connections by strategically upgrading infrastructure like feeders, transformers, and substations to accommodate increased demand from new developments and large loads and support future growth.
Generation Connections	This program facilitates the integration of customer-owned embedded generation projects into the distribution grid, including metering, service connections, and the necessary protection and control systems.
Metering	This program modernizes metering infrastructure in commercial and multi-residential buildings, primarily on residential retrofits, which includes suite metering for both new customer connections and upgrades for existing customers.

Budgeting is informed by historical expenditures, confirmed major projects (including committed customer and large load requests), and evolving government policy, notably the City of Ottawa's intensification policies. The community's continued growth and expanding electricity demand are key drivers, resulting in a sustained increase in customer connection requests. The Capital Programs under System Access are further broken down into Budget Programs described in Table 7 along with the primary driver. The program drivers are detailed in Section 5.3.1.1 of Schedule - 2-5-4 Asset Management Process.

Table 7 – System Access Expenditure Categories

Capital Program	Budget Program	Primary Driver	Description
Plant Relocation & Upgrade	Plant Relocation & Upgrade	Third Party Requirements	• Relocation or upgrade of Hydro Ottawa owned or joint-use overhead or underground equipment; • Equipment relocations or upgrades to ensure safe limits of approach from energized electrical plant is maintained
Customer Connections	Residential Subdivision	Customer Service Request	• To connect new residential subdivisions consisting of townhomes, semi-detached, single, or any combination of housing units; • Includes trunk, primary & secondary distribution infrastructure .
	New Commercial Development	Customer Service Request	• New developments serviced via padmounted equipment (switchgear and/or transformers) or via a vault.
	Infill (Res & Small Com)	Customer Service Request	• Infill service or service upgrade for residential or small commercial developments(i.e. services that do not require pad mounted equipment or vault installations).
	ESA Flash Notice	Mandated Service Obligation	• Corrective actions associated with specific historical grounding configurations
System Expansion	System Expansion Demand	Customer Service Request	• A demand driven expansion/upgrade to the distribution system in response to a customer request (i.e., a line extension).
	Asset Transfer	Third Party Requirements	• Ownership transfer and upgrade of customer-owned equipment
Generation Connections	Embedded Generation	Customer Service Request	• Connection of customer driven embedded generation projects; • Includes metering, service connection and protection and control as required.
Metering	Suite Metering	Customer Service Request	• Retrofit of suite meters (retrofit of bulk meters) for commercial and multi-residential buildings; • Focus of the program is on residential retrofits

5.1.1. Historical Expenditures

The following tables present Hydro Ottawa's System Access Capital Expenditures from 2021 through 2025 compared to the OEB Approved amounts. Table 8 details this spending on a five-year total basis, while Table 10 provides the annual spending and variances.

Because System Access is driven primarily from customer requests, its associated costs are partially covered by customer contributions. Table 9 provides the details on customer contributions compared to OEB approved budgets.

Table 8 - System Access Historical & Bridge Spending versus OEB Approved ($'000s)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
Plant Relocation	$ 37,905	$ 44,584	$ 6,679	18%
System Expansion	$ 48,818	$ 88,680	$ 39,862	82%
Customer Connections	$ 110,591	$ 157,061	$ 46,470	42%
Generation Connections	$ 1,578	$ 525	$ (1,053)	(67)%
Metering	$ 4,767	$ 1,720	$ (3,047)	(64)%
TOTAL GROSS CAPITAL EXPENDITURES	**$ 203,660**	**$ 292,570**	**$ 88,910**	**44%**
Capital Contributions	$ (119,360)	$ (158,377)	$ (39,018)	33%
TOTAL NET CAPITAL EXPENDITURES	**$ 84,300**	**$ 134,193**	**$ 49,892**	**59%**

Hydro Ottawa uses the OEB prescribed economic evaluation methodology to calculate the customer contribution associated with System Access projects. The capital contributions include Contributed Plant (non-cash contributions) and Contributed Capital (cash contributions). Table 9 details historical capital contributions received by Hydro Ottawa, broken down by Capital Program within the System Access Investment Category.

Table 9 - System Access Historical Contributions versus OEB Approved ($'000s)

Capital Program	2021	2022	2023	2024	2025	2021-2025
	OEB-Approved					Percentage of Gross
Plant Relocation	$ (7,919)	$ (4,241)	$ (4,274)	$ (3,270)	$ (3,256)	61%
System Expansion	$ (13,075)	$ (3,864)	$ (1,740)	$ (1,692)	$ (1,572)	45%
Customer Connections	$ (17,680)	$ (14,886)	$ (13,536)	$ (13,706)	$ (13,780)	67%
Generation Connections	$ (198)	$ (163)	$ (163)	$ (168)	$ (176)	55%
TOTAL OEB- APPROVED CAPITAL CONTRIBUTIONS	**$ (38,872)**	**$ (23,153)**	**$ (19,713)**	**$ (18,836)**	**$ (18,784)**	**59%**
	Historical Years			Bridge Years		
Plant Relocation	$ (5,309)	$ (3,923)	$ (5,213)	$ (4,299)	$ (3,851)	51%
System Expansion	$ (5,724)	$ (7,700)	$ (3,836)	$ (13,017)	$ (16,900)	53%
Customer Connections	$ (14,918)	$ (15,648)	$ (19,364)	$ (18,658)	$ (19,679)	56%
Generation Connections	$ (72)	$ (69)	$ 7	$ (102)	$ (104)	65%
TOTAL HISTORICAL/BRIDGE CAPITAL CONTRIBUTIONS	**$ (26,022)**	**$ (27,340)**	**$ (28,406)**	**$ (36,076)**	**$ (40,533)**	**54%**

Hydro Ottawa primarily reviews and evaluates System Access Capital Programs in terms of net spending as the cost burden of these projects are offset by customer contributions. Table 10 shows net historical spending by Capital Program. Table 10 is divided into three sections with the OEB Approved amounts first, followed by the historical actuals, and then the annual variances.

1 **Table 10 - Net System Access Historical Spending versus OEB Approved (Annual) ($'000s)**

Capital Program	2021	2022	2023	2024	2025
	OEB-Approved (Net of Contribution)				
Plant Relocation	$ 2,216	$ 4,178	$ 4,200	$ 2,180	$ 2,171
System Expansion	$ 7,040	$ 4,821	$ 5,220	$ 5,076	$ 4,717
Customer Connections	$ 7,455	$ 7,799	$ 7,209	$ 7,275	$ 7,265
Generation Connections	$ 162	$ 133	$ 134	$ 138	$ 144
Metering	$ 947	$ 947	$ 958	$ 957	$ 959
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 17,820**	**$ 17,879**	**$ 17,720**	**$ 15,626**	**$ 15,255**
	Historical Years			Bridge Years	
Plant Relocation	$ 4,692	$ 3,681	$ 2,946	$ 5,906	$ 4,765
System Expansion	$ 2,451	$ 2,228	$ 7,446	$ 13,049	$ 16,330
Customer Connections	$ 13,741	$ 13,463	$ 14,426	$ 13,357	$ 13,808
Generation Connections	$ 175	$ (1)	$ 4	$ 3	$ 4
Metering	$ 579	$ 352	$ 165	$ 310	$ 314
TOTAL NET HISTORICAL/BRIDGE CAPITAL EXPENDITURES	**$ 21,638**	**$ 19,723**	**$ 24,987**	**$ 32,625**	**$ 35,220**
	Variance ($)				
Plant Relocation	$ 2,476	$ (497)	$ (1,253)	$ 3,725	$ 2,594
System Expansion	$ (4,590)	$ (2,593)	$ 2,226	$ 7,972	$ 11,613
Customer Connections	$ 6,286	$ 5,663	$ 7,217	$ 6,082	$ 6,543
Generation Connections	$ 13	$ (134)	$ (129)	$ (134)	$ (140)
Metering	$ (368)	$ (595)	$ (793)	$ (647)	$ (645)
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ 3,817**	**$ 1,844**	**$ 7,267**	**$ 16,999**	**$ 19,965**

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5.1.2. Historical Variances

Hydro Ottawa's System Access net capital expenditures for the 2021-2025 period are projected to exceed the OEB-approved 5-year budget by $49.9M (or 59%). On a gross basis the variance is $88.9M (or 44%), and the capital contribution variance is $39.0M (or 33%). These substantial increases are attributed to a confluence of factors that impacted the program's inherent volatility, despite budget planning based on historical trends, planned municipal infrastructure work, and known third-party projects.

The System Access Investments, encompassing Plant Relocation, System Expansion, Customer Connections, Generation Connections, and Metering, experienced varying degrees of growth. While some programs remained relatively stable, others, particularly Customer Connections and System Expansion, saw considerable increases.

Key Contributing Factors:

- **Increased Customer Connections:** A primary factor was the unexpected surge in customer connection requests. The complexity and location of these connections significantly influenced gross expenditure, customer contributions, and ultimately, net expenditure.
- **Inflationary Pressures:** Substantial increases in material and labor costs, driven by inflation, played a crucial role. Specifically, significant price hikes were observed in:
    - Cable (23.7% to 47.3% higher in 2024 than 2020)
    - Transformers (124.0% to 182.4% higher in 2024 than 2020)
    - Switchgear (24.7% to 59.5% higher in 2024 than 2020)
    - Wood poles (53.5% to 120.2% higher in 2024 than 2020)
    - Meters (93.8% higher in 2024 than 2020)
- **Unforeseen System Expansion Requests:** Several large-scale system expansion projects, not anticipated during the 2021-2025 rate application, contributed to the variance.

Detailed explanations of these factors are provided within the specific sections dedicated to each System Access program below, with further information regarding inflationary pressures found in Section 4 of Schedule 1-2-5 - Impact of Inflationary Pressures.

Plant Relocation and Upgrade

Over the 2021-2025 period, the Plant Relocation and Upgrade program experienced significant expenditure variability, primarily due to the timing and scope of major municipal infrastructure initiatives. This resulted in a net overspend of $7M (47%), a gross overspend of $6.7M (18%), and a negligible capital contribution variance based on the OEB-approved budget. This deviation reflects the program's inherent responsiveness to the dynamic nature of Ottawa's municipal infrastructure projects.

Specifically, the LRT Phase II project was budgeted without Plant Relocations in 2021-2025, however due to municipal delays, Plant Relocation projects have persisted during the 2021-2025 period, resulting in a $2.5M increase. The increases related to LRT driven plant relocations were partially offset by underspends in 2022 and 2023 due to MTO driven projects that did not proceed.

A substantial increase in spending occurred in 2024, with expenditures exceeding the budget by $3.7M. This surge was primarily due to the commencement of the City of Ottawa's Bank Street revitalization project, coupled with continued work on the LRT Phase II project and post-LRT Phase I remediation. Similarly, in 2025, continued spending on the Bank Street Revitalization project is expected to result in a $2.6M increase (119%) over the OEB approved budget.

Key factors of these variances include LRT related variances due to post-LRT Phase I rehabilitation work and changes to the LRT Phase II project's timeline and scope, the completion of Montreal Road's revitalization, and the City of Ottawa's Bank Street revitalization project. In summary, the Plant Relocation and Upgrade program's expenditures were significantly influenced by the dynamic nature of Ottawa's municipal infrastructure projects, resulting in a notable deviation from the OEB-approved budget.

System Expansion

The System Expansion program experienced considerable budget variability during the 2021-2025 period, culminating in a net overspend of $14.6M (54%), a gross overspend of $39.9M (82%), and a capital contribution variance of $25.2M (115%) based on the OEB-approved budget. This substantial variance underscores the program's susceptibility to external factors and unforeseen projects. The program's expenditures are inherently non-discretionary and dynamic, driven by variable customer requests, complexity, and the scale and location of required electrical loads. While Hydro Ottawa actively collaborates with stakeholders to align forecasts (refer to Schedule 2-5-2 - Coordinated Planning with Third Parties), the timing and scope of critical projects are ultimately determined by external entities, which can lead to significant budget fluctuations.

The program's financial trajectory highlights the high degree of variability. Initially, in 2021 and 2022, the program saw considerable underspends, $4.6M and $2.6M respectively. However, this trend significantly reversed in 2023, with expenditures exceeding the budget by $2.2M. This upward trajectory is expected to continue with forecasted overspends of $8M in 2024 and $11.6M in 2025. These drastic shifts were primarily driven by three major, externally influenced projects: the LRT Phase II project, the City of Ottawa's Zero Emission Bus project, and the Department of National Defence (DND) Dwyer Hill Road project.

Note that while the 2021-2025 budget included a budget for one large system expansion, it did not anticipate three. The Zero Emission Bus and DND Dwyer Hill Road projects were entirely unanticipated and could not be included in the 2021-2025 rate application process. Consequently, Hydro Ottawa was compelled to absorb significant, unbudgeted expenditures to accommodate these externally mandated system expansions along with the significant inflationary pressures.

External Project Impacts on System Expansion:

- **LRT Phase II Project:** Hydro Ottawa's responsibilities within the LRT Phase II Project included the relocation and protection of conflicting infrastructure, the expansion of the electrical system to accommodate future LRT stations, and the provision of commercial connections. Modifications to the LRT Phase II project resulted in an estimated $5.8M expenditure exceeding the approved budget. Originally scheduled for completion in 2022, the project experienced significant delays. These delays and associated cost increases were attributable to:
    - Unforeseen conflicts between the LRT Phase II construction activities and Hydro Ottawa's existing infrastructure.
    - Repeated infrastructure relocations mandated by design revisions.
    - Significant postponements in the overall LRT project schedule, specifically:
        - The Trillium Line, delayed by two years.
        - The Confederation Line East, delayed to 2025.
        - The Confederation Line West, delayed by 17 months.
    - The inaccuracy of cost estimates that were developed prior to the onset of the COVID-19 pandemic and subsequent inflationary pressures.

While the LRT Phase II Project was identified during the 2021-2025 rate application process, the specific factors contributing to the budget overruns, including the magnitude of infrastructure conflicts, the frequency of design alterations, and the unprecedented impact of the pandemic, were either inherently unpredictable or their financial implications were not accurately quantifiable at that time.

- **City of Ottawa Zero Emission Bus Project:** The Hydro Ottawa scope of work encompasses the provision of the required electrical infrastructure to support the load of an Electric Bus terminal. In February 2021, Hydro Ottawa received a preliminary inquiry regarding a new electrical load to support the proposed OC Transpo electric bus terminal. Subsequently, in April 2024, Hydro Ottawa received a signed Offer to Connect (OTC) and commenced work on the Zero Emissions Bus Project at 1500 St. Laurent. The project's initiation in 2024 resulted in significant deviations from the OEB-approved budget for the 2024 and 2025 fiscal years. This project was not incorporated into the 2021-2025 rate application due to the definition of the load requirements and the executed Offer to Connect (OTC) not being received within the timeframe required for inclusion in the 2021-2025 rate application process.

- **DND Dwyer Hill Road Project:** In September 2020, the Department of National Defence (DND) submitted a request to Hydro Ottawa for an electrical service upgrade at the Dwyer Hill North training campus and a new electrical service to supply the South training campus. Hydro Ottawa's scope of work entails a transformer upgrade at the existing station to support committed large load requests from the DND Dwyer Hill Training Center Upgrade, ensuring both the customer needs are met and system redundancy is maintained. Hydro Ottawa commenced work on the DND Dwyer Hill Road Project in 2024, resulting in $4.9M in unbudgeted System Expansion Expenditure over the 2024 and 2025 fiscal years. This project was not incorporated into the 2021-2025 rate application due to the definition of the load requirements and the executed Offer to Connect (OTC) not being received within the timeframe required for inclusion in the 2021-2025 rate application process.

The System Expansion program's performance highlights the challenges of development and managing budgets in the face of significant external influences. The unpredictable nature of large-scale infrastructure projects and the authority of external parties to dictate project timelines and scope directly translated into substantial budget volatility.

Customer Connections

Over the 2021-2025 period, the Customer Connections program experienced a net overspend of $31.8M (86%), a gross overspend of $46.5M (42%) and a capital contribution variance of $14.7M (20%) based on the OEB-approved budget. The Customer Connections program encompasses the following subprograms: Residential Subdivisions Program, New Commercial Developments Program, and Infill Services Program.

The significant variance was primarily driven by several key factors:

- **City of Ottawa's Intensification Policies & Provincial Housing Mandates:** The City's focus on higher-density housing, coupled with the Province of Ontario's More Homes Built Faster Act[2] significantly increased residential subdivision connections beyond forecasted levels .
- **COVID-19 Pandemic:** The pandemic's impact on housing demand, coupled with historically low interest rates, contributed to a surge in residential connections.
- **LRT Phase II Project Delays:** Delays in the LRT project affected commercial development connections, impacting project timelines and expenditures.
- **Inflationary Pressures:** Increased material and labor costs contributed to higher unit costs for connections across all subprograms.
- **External Project Dependencies:** The program's reliance on external factors, such as municipal planning and project timelines, resulted in forecasting inaccuracies.

The significant expenditure variance within the Customer Connections program underscores the challenges of forecasting and managing expenditures in a dynamic environment influenced by external factors. Hydro Ottawa recognizes the need for enhanced forecasting methodologies and flexible resource allocation to mitigate the impact of unforeseen changes in customer demand and project timelines. The Residential Subdivisions and New Commercial Developments programs were the primary drivers of the overall variance, highlighting the impact of external factors such as municipal policies, economic conditions, and large-scale infrastructure projects. Details regarding the impact of each subprogram are provided below.

[2] Legislative Assembly of Ontario, "Bill 23, More Homes Built Faster Act, 2022," https://www.ola.org/en/legislative-business/bills/parliament-43/session-1/bill-23

Residential Subdivisions:

The Residential Subdivisions program was a primary driver of the overall variance. Actual expenditures are expected to exceed the OEB-approved budget by $24.0M (161%). This significant overspend was primarily due to:

- Connection volume significantly surpassed forecasted levels, increasing from an annual average of 3,835 to 6,067.
- This substantial increase in connection volumes significantly exceeded the budget assumptions, driven by an unforeseen surge in demand resulting from the More Homes Built Faster Act, 2022 and the pandemic-induced housing boom.
- Unit costs per connection increased from $852 to $1,350 due to inflationary pressures and higher-density development complexities.

New Commercial Developments:

The New Commercial Developments program also contributed significantly to the overall variance. Actual expenditures are expected to exceed the OEB-approved budget by $16.9M (176%). This overspend was primarily driven by:

- Delays in the LRT Phase II project, affecting the timing and expenditures of related commercial connections.
- Increased building density and demand, exceeding forecasted levels based on historical averages.
- Inflationary pressures, contributing to higher unit costs for commercial connections.

Infill Services:

The Infill Services program was the sole subprogram within the Customer Connections capital program that did not contribute to the overall overspend during the 2021-2025 period. Actual expenditures are projected to be $9.2M (74%) below the OEB-approved budget. The budget for this program was developed based on historical spending averages available as of 2019.

However, the economic climate during the period significantly impacted customer lead project execution.

It is evident that a noticeable reduction in smaller-scale projects occurred. This could be attributed to the prevailing economic conditions. Starting in early 2022, the Bank of Canada initiated a series of interest rate hikes to combat rising inflation. These hikes substantially increased borrowing costs for both residential and commercial customers. Simultaneously, customers faced significant inflationary pressures, particularly in the cost of materials.

Infill services projects are typically undertaken by smaller developers or individual proprietors, who may lack substantial financial reserves. Consequently, the combined impact of increased borrowing costs and rising material prices led to the postponement or cancellation of numerous projects. This resulted in the observed underspend, as the anticipated volume of infill connection requests did not materialize. Current projections suggest that spending in 2024 and 2025 will remain consistent with recent years, reinforcing the trend of reduced project activity.

Generation Connections

Over the 2021-2025 period, the Generation Connections program experienced an underspend compared to the OEB-approved budget. Actual expenditures were lower than anticipated, resulting in a net underspend of $0.5M (74%), gross underspend of $1.1M (67%) and capital contribution variance of $0.5M (61%) below estimations. This deviation is primarily attributed to lower-than-expected customer-requested generation connections.

The Generation Connections program is inherently driven by customer demand, with expenditures fluctuating based on the volume and type of connection requests. The program's actual expenditures reflect a consistent trend of lower demand than projected during the 2021-2025 rate application. Specifically, in 2021, spending was slightly higher than the approved budget, with a variance of $0.01M (8% overspend). However, from 2022 to 2025, customer demand was significantly lower than the historical projection used to create the budget.

The underspend during the 2022-2025 period showcases a consistent trend of reduced customer demand for generation connections. This reduction can be attributed to the economic climate during this period. Starting in early 2022, the Bank of Canada initiated a series of interest rate hikes to combat rising inflation. These hikes significantly increased borrowing costs for both residential and commercial customers. Simultaneously, customers faced substantial inflationary pressures, leading to increased costs for materials associated with generation connection projects. This combination of higher borrowing costs and increased project expenses likely deterred many potential customers from pursuing generation connection projects, resulting in the observed underspend. Current projections suggest that spending in 2024 and 2025 will remain consistent with recent years, reinforcing this trend.

Metering

Over the 2021-2025 period, the Metering program experienced a significant underspend compared to the OEB-approved budget. Actual expenditures were substantially lower than anticipated, resulting in a total underspend of $3.0M, representing a 64% variance. This deviation is primarily attributed to lower-than-expected customer-requested installations for retrofitted suite metering.

The Metering program, focused on customer-requested suite metering retrofits, is directly tied to the volume and type of these requests. These significant underspends, totaling nearly $3M over the five-year period, indicate a consistent trend of reduced customer demand for suite metering retrofit installations than projected for the creation of the 2021-2025 budget. Annual spending on suite metering has remained consistent in recent years, but at a lower level than budgeted. Current projections indicate that spending in 2024 and 2025 will remain consistent with recent years, reinforcing the trend of lower-than-anticipated demand.

5.1.3. Forecast to Historical Variance by Capital Program

Forecasted investment for 2026 through 2030 is based on historical spending, known large projects (committed customer requests and large load requests) and changes in government policy (City of Ottawa Intensification Policy). Table 11 details the Forecasted Expenditure for

2026-2030 and Table 12 provides the forecasted contributions. Further details can be found in Schedule 2-5-6 - System Access Investments.

Table 11 – System Access Forecast Expenditures Test Year Expenditures by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
Plant Relocation	$ 44,584	$ 34,957	$ (9,627)	$ 8,917	$ 6,991	$ (1,925)
System Expansion	$ 88,680	$ 107,507	$ 18,827	$ 17,736	$ 21,501	$ 3,765
Customer Connections	$ 157,061	$ 221,069	$ 64,009	$ 31,412	$ 44,214	$ 12,802
Generation Connections	$ 525	$ 4,241	$ 3,717	$ 105	$ 848	$ 743
Metering	$ 1,720	$ 1,724	$ 4	$ 344	$ 345	$ 1
GROSS SYSTEM ACCESS	**$ 292,570**	**$ 369,500**	**$ 76,930**	**$ 58,514**	**$ 73,900**	**$ 15,386**
Capital Contribution[3]	$ (158,377)	$ (196,272)	$ (37,895)	$ (31,675)	$ (39,254)	$ (7,579)
NET SYSTEM ACCESS	**$ 134,193**	**$ 173,228**	**$ 39,035**	**$ 26,839**	**$ 34,646**	**$ 7,807**

The annual gross expenditure for System Access is expected to average $73.9M over the 2026-2030 period which is an increase from the $58.5M average annual spend during the 2021-2025 timeframe.

[3] Note that recent updates to Capital Contributions as a result of the OEB's recent policy changes in System Expansion for Housing Developments (EB-2024-0092) have not been incorporated here. For further information on anticipated impacts to Capital Contributions, please refer to Schedules 1-1-4 - Administration and 9-1-1 - Summary of Current Deferral and Variance Accounts.

Table 12 – System Access Test Years Contributions by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
Plant Relocation	$ (22,595)	$ (19,874)	$ 2,721	$ (4,519)	$ (3,975)	$ 544
System Expansion	$ (47,177)	$ (48,279)	$ (1,102)	$ (9,435)	$ (9,656)	$ (220)
Customer Connections	$ (88,267)	$ (123,944)	$ (35,678)	$ (17,653)	$ (24,789)	$ (7,136)
Generation Connections	$ (339)	$ (4,175)	$ (3,836)	$ (68)	$ (835)	$ (767)
TOTAL CAPITAL CONTRIBUTIONS	**$ (158,377)**	**$ (196,272)**	**$ (37,895)**	**$ (31,675)**	**$ (39,254)**	**$ (7,579)**

The average annual capital contributions for System Access is expected to be $39.2M over the 2026-2030 period which is an increase from the $31.7M average annual contributions during the 2021-2025 timeframe, primarily driven by customer connection requests over the 2026-2030 period.

Plant Relocation

The capital investment for this program is detailed in Section 2 of Schedule 2-5-6 - System Access Investments. The Plant Relocation Program is transitioning from a period of high expenditure, characterized by large complex projects, to a historical norm aligned with municipal planned road network expansion initiatives.

During the 2021-2025 period, the program experienced substantial capital expenditures. The average annual net capital expenditure reached $4.4M, while the average annual gross capital expenditure was $8.9M. Additionally, annual capital contributions averaged $4.5M. These elevated figures were primarily driven by the implementation of large-scale municipal infrastructure projects, most notably the Light Rail Transit (LRT) Phase II project. The complexities and dynamic timelines of these projects resulted in significant variances from the originally approved budget.

The 2026-2030 period has a reduction in capital expenditure as the program returns back to a Pre-LRT Phase I & II baseline. The projected average annual net capital expenditure is $3.0M, and the average annual gross capital expenditure is $7.0M. Furthermore, annual capital contributions are expected to average $4.0M. The future investments are budgeted based on the planned road widening projects outlined in the City of Ottawa's Transportation Master Plan[4], specifically along Bank Street, Prince of Wales Drive, and Preston Street.

System Expansion

The capital investment for this program is detailed in Section 4 of Schedule 2-5-6 - System Access Investments. The System Expansion Program is experiencing significant growth, with projected investments for 2026-2030 substantially exceeding historical levels from 2021-2025. This material change is caused by large infrastructure projects and also by electricity demand growth, residential expansion, transportation electrification, and increased adoption of electrified heating.

During the 2021-2025 period, the average annual net capital expenditure reached $8.3M, while the average annual gross capital expenditure was $17.7M. Additionally, annual capital contributions averaged $9.4M. As described in Section 5.1.2 - Historical Variances, Hydro Ottawa was compelled to absorb significant, unbudgeted expenditures to accommodate externally mandated system expansions.

The 2026-2030 forecast anticipates a rise in the average annual net capital expenditure to $11.8M, while the average annual gross capital expenditure is expected to be $21.5M. Additionally, the expected annual capital contributions will average $9.7M. Key drivers include the City of Ottawa’s Zero Emission Bus initiative, the DND Dwyer Hill Training Center Upgrade, and the new Ottawa Hospital, alongside a dramatic surge in large load connection requests (5 MVA and above). The surge in large load connection requests necessitates a shift from a budget based on historical averages to a growth-adjusted budget and underscores a

[4] City of Ottawa, “Transportation Master Plan, Exhibit 7.2: 2031 Affordable Road Network- Project By Phase- https://documents.ottawa.ca/sites/default/files/documents/tmp_en.pdf

commitment to supporting Ottawa's expansion and electrification goals, ensuring reliable and resilient electricity services for the future.

Customer Connections

The capital investment for this program is detailed in Section 3 of Schedule 2-5-6 - System Access Investments. The Customer Connections program capital expenditure is experiencing significant growth in the 2026-2030 period, with projected investments substantially exceeding historical levels from 2021-2025. This increase is driven by robust residential and commercial development, coupled with the ongoing energy transition and city intensification initiatives.

During the 2021-2025 period, the program experienced significant budget variances primarily due to unforeseen residential growth, commercial project delays, and inflationary pressures, as detailed in Section 5.1.2 - Historical Variances. The average annual net capital expenditure reached $13.8M while the average annual gross capital expenditure was $31.4M. Additionally, annual capital contributions averaged $17.6M. The 2021-2025 budget was established using historical averages for residential subdivisions and infill services, and a historical average plus a growth factor for new commercial development.

The 2026-2030 forecast, is projecting the net average annual spending to rise to $19.4M. The expected gross average annual spending to rise to $44.2M, offset by anticipated average annual capital contributions to $24.8M. This growth is attributed to sustained residential subdivision expansion, increased commercial development driven by transit-oriented projects and large load requests, and continued support for infill projects. Key drivers include the City of Ottawa's intensification policies, the energy transition, and large-scale laboratory developments. The 2026-2030 budget was established using a baseline plus a housing growth factor for residential subdivisions and infill services, and a baseline plus an employment growth factor for new commercial development.

Anticipated increases in customer service requests necessitate the infrastructure investments. The substantial overspend observed in the 2021-2025 period has informed a more robust and growth-aligned budget for the upcoming period. This forward-looking approach, incorporating growth factors into the budget calculations, ensures Hydro Ottawa can effectively support the city's development goals and evolving electricity demands, providing reliable connections for a growing customer base.

Generation Connections

The capital investment for this program is detailed in Section 5 of Schedule 2-5-6 - System Access Investments. The Generation Connections program is set to experience a significant increase in investment during the 2026-2030 period, transitioning to a phase of projected growth driven by the rising adoption of distributed energy resources (DERs).

During the 2021-2025 period, the average annual net capital expenditure was $0.04M while the average annual gross capital expenditure was $0.1M. Additionally, annual capital contributions averaged $0.07M. For this period there was a significant underspend, primarily attributed to reduced customer demand due to economic factors, including interest rate hikes and inflationary pressures. The budget for this period was based on historical averages, which did not accurately reflect the market conditions that were experienced.

The proposed budget for the 2026-2030 period reflects a significant increase, with a net average annual investment of $0.01M. Primarily, this growth is observed in gross expenditures, with the projected gross average annual expenditure reaching $0.85M, offset by anticipated average annual capital contributions of $0.84M. This budgetary expansion is predicated on the forecasted accelerated adoption of Distributed Energy Resources (DERs), with a key driver being the connection of large-scale generators (exceeding 500 kW), with an assumption of at least one such connection per year. The IESO's DER Market Vision and Design Project[5] is expected to explore, design and implement foundational participation models for DERs in

[5] DER Market Vision and Design Project, https://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Distributed-Energy-Resources-Market-Vision-and-Design-Project

Ontario's electricity market and other IESO programs, such as the Save On Energy Home Renovation Savings Program[6] and the Save On Energy Retrofit Program[7] now include incentives for DERs. All of these initiatives are expected to contribute to DER growth. The projected trend of accelerated DER adoption is further detailed in Section 9.3.1 of Schedule 2-5-4 - Asset Management Process. The budget methodology incorporates a year-over-year increase of 25%, accounting for the anticipated growth and the assumption of one major transfer trip and reverse power flow project per annum.

The projected growth, particularly in gross expenditures, reflects the evolving energy landscape and the increasing interest in DER integration, with an emphasis on large generation connections . The planned investments ensure Hydro Ottawa can effectively support the growing demand for generation connections, aligning with the broader energy transition.

Metering

The capital investment for this program is detailed in Section 6 of Schedule 2-5-6 - System Access Investments. The Metering program, focused on customer-driven suite metering installations, is characterized by consistent and stable expenditures. Hydro Ottawa does not anticipate any significant changes to recent volumes with regards to customer-requested installations of new and retrofitted suite metering.

As detailed in Section 5.1.2 - Historical Variances, this program had a significant underspend of $3.0M during the 2021-2025 period, primarily due to a shift in customer preferences towards third-party bulk metering services. Consequently, the 2026-2030 forecast anticipates maintaining the current average expenditure level of $0.3M annually, reflecting the sustained lower demand for suite metering installations. This program does not generate capital contributions.

[6] Save On Energy, "Home Renovation Savings Program, "https://www.saveonenergy.ca/For-Your-Home/Home-Renovation-Savings
[7] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

5.2. SYSTEM RENEWAL EXPENDITURES

System Renewal investments include sustainment programs that are focused on managing and mitigating the risk of asset failure within Hydro Ottawa's distribution network by renewing deteriorating asset infrastructure. The System Renewal Investment Category is broken down into five Capital Programs as described in Table 13.

Table 13 – System Renewal Capital Programs

Capital Program	Description
Stations and Buildings Infrastructure Renewal	• Sustainment of discrete stations and station building assets based on condition (Health Index) and prioritization.
Overhead Distribution Assets Renewal	• Sustainment of discrete overhead distribution assets based on assessed condition (Health Index) and prioritization
Underground Distribution Assets Renewal	• Sustainment of discrete underground distribution assets based on assessed condition (Health Index) and prioritization
Corrective Renewal	• Unplanned replacement of failed assets.
Metering Renewal	• Proactive replacement of end-of-life meters to ensure long-term asset performance.

System Renewal capital expenditures are determined through the Asset Investment Strategy presented in Section 5.3.2.2 of Schedule 2-5-4 - Asset Management Process. The Capital Programs under System Renewal are broken down by Budget Program, as shown in Table 14, which includes a description for each Budget Program along with the primary driver. The program drivers are detailed in Section 5.3.1.1 of Schedule 2-5-4 - Asset Management Process.

1 **Table 14 – System Renewal Expenditure Categories**

Capital Program	Budget Program	Primary Driver	Description
Stations and Buildings Infrastructure Renewal	Station Transformer Renewal	Failure Risk	• Station transformer refurbishment (life extension), or replacement as guided by the Asset Management Process.
	Station Switchgear Renewal	Failure Risk	• Stations switchgear and relay refurbishment (life extension), or replacement as guided by the Asset Management Process.
	Station Major Rebuild	Failure Risk	• Station major rebuilds driven by multiple end-of-life assets.
	Station P&C Renewal	Failure Risk	• Station protection and control devices refurbishment (life extension) or replacement guided by the Asset Management Process.
	Station Battery Renewal	Failure Risk	• Station battery and charger refurbishment (life extension) or replacement guided by the Asset Management Process
	Station & Building Minor Asset Renewal	Failure Risk	• Station minor assets (such as insulators, arrestors, structures, etc.) refurbishment (life extension) or replacement • Refurbishment or replacement of existing station building or property assets
	EOL Voltage Conversion	Failure Risk	• Addresses need of major Station Assets replacement through voltage conversion due to inability to support future growth, mainly in 4kV regions
OH Distribution Assets Renewal	Pole Renewal	Failure Risk	• Planned replacement or upgrade of Hydro Ottawa owned poles or cross-arms based on condition assessment; • Pole attachments and conductors are considered in scope for replacement along with the poles/cross-arms where they are of the same vintage as the poles
	OH Switch / Recloser Renewal	Failure Risk	• Installation of new or the rehabilitation of overhead equipment (i.e. switches, reclosers, cutouts, or arrestors) based on condition or functional requirements (i.e. upgrade to gang operable switches or automated devices)
UG	Vault Renewal	Failure Risk	• Vault rehabilitation due to condition of equipment or

Capital Program	Budget Program	Primary Driver	Description
Distribution Assets Renewal			removal for consolidation or system betterment; ● Includes replacement of Jack-Bus arrangements; ● Exclusive of work considered under Plant Relocation & Upgrade
	Civil Renewal	Failure Risk	● Rehabilitation or rebuild of underground cable chambers, collars, ducts, and equipment pads due to condition or failure risk; ● Includes installation of pads and vault space under pads; ● Duct extensions considered under Line Extensions
	Cable Replacement	Failure Risk	● Replacement of underground cable based on condition; ● All cable types considered, i.e. PILC, XLPE, butyl rubber, etc.; ● Can include associated distribution transformer replacements based on condition assessment on a case-by-case basis
	UG Switchgear Renewal	Failure Risk	● Replacement, refurbishment or upgrade of Hydro Ottawa owned switchgear based on condition
	UG Transformer Renewal	Failure Risk	● Replacement of underground distribution transformers due to functional, safety or environmental concern (leaks, PCBs, corrosion, failure risk, etc.), or upgrade, including transformer shop testing and commissioning
Corrective Renewal	Damage to Plant	Failure	● Replacement of damaged assets, resulting in the loss of functional use of the asset caused by a third party
	Emergency Renewal	Failure	● Failed equipment typically resulting in an outage but not necessarily.
	Critical Renewal	Failure	● Failed equipment that may still be providing service, but no longer meet their designed requirements for safety, environmental or reliability reasons.
Metering Renewal	Metering Upgrades	Functional Obsolescence	● Proactive replacement of obsolete meters with advanced technology, upgrading data management systems, and ensuring regulatory compliance to enhance grid management and long-term asset performance.

5.2.1. Historical Expenditures

The following tables present Hydro Ottawa's System Renewal Capital Expenditures from 2021 through 2025 compared to the OEB Approved amounts. Table 15 details this spending on a five-year total basis, while Table 16 provides the annual spending and variances.

Hydro Ottawa uses its Capital Expenditure Process (Section 3.5 of Schedule 2-5-4 - Asset Management Process) and portfolio optimization (Section 5.3 of Schedule 2-5-4 - Asset Management Process) to ensure strategic oversight and efficient capital utilization of the System Renewal capital program.

Table 15 - System Renewal Historical Spending versus OEB Approved ($'000s)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
Stations Asset Renewal	$ 47,206	$ 31,433	$ (15,773)	(33)%
OH Distribution Assets Renewal	$ 43,278	$ 43,141	$ (137)	-
UG Distribution Assets Renewal	$ 55,184	$ 63,286	$ 8,102	15%
Corrective Renewal	$ 51,220	$ 82,625	$ 31,405	61%
Metering Renewal	$ 13,091	$ 11,835	$ (1,255)	(10)%
TOTAL NET CAPITAL EXPENDITURES	**$ 209,978**	**$ 232,321**	**$ 22,343**	**11%**

As noted above, Table 16 below provides the annual variance against the OEB Approved for each of the capital programs under System Renewal, the table is divided into three sections with the OEB Approved amounts first, followed by the historical actuals, and then the annual variances.

1 **Table 16 - Net System Renewal Historical Spending versus OEB Approved (Annual) ($'000s)**

Capital Program	2021	2022	2023	2024	2025
OEB-Approved (Net of Contribution)					
Stations Asset Renewal	$ 9,938	$ 12,071	$ 8,444	$ 7,437	$ 9,316
OH Distribution Assets Renewal	$ 7,999	$ 9,197	$ 9,197	$ 8,841	$ 8,044
UG Distribution Assets Renewal	$ 11,082	$ 10,780	$ 11,164	$ 11,079	$ 11,077
Corrective Renewal	$ 11,947	$ 9,805	$ 9,838	$ 9,812	$ 9,817
Metering Renewal	$ 4,455	$ 2,561	$ 1,950	$ 2,266	$ 1,860
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 45,421**	**$ 44,414**	**$ 40,594**	**$ 39,436**	**$ 40,114**
	Historical Years			Bridge Years	
Stations Asset Renewal	$ 9,071	$ 12,045	$ 5,404	$ 4,238	$ 676
OH Distribution Assets Renewal	$ 9,284	$ 8,758	$ 8,832	$ 7,419	$ 8,848
UG Distribution Assets Renewal	$ 10,159	$ 17,806	$ 11,981	$ 11,175	$ 12,165
Corrective Renewal	$ 13,253	$ 26,537	$ 12,702	$ 14,943	$ 15,190
Metering Renewal	$ 1,482	$ 323	$ 1,348	$ 4,559	$ 4,123
TOTAL HISTORICAL/BRIDGE NET CAPITAL EXPENDITURES	**$ 43,249**	**$ 65,469**	**$ 40,266**	**$ 42,334**	**$ 41,003**
	Variance ($)				
Stations Asset Renewal	$ (867)	$ (27)	$ (3,040)	$ (3,199)	$ (8,640)
OH Distribution Assets Renewal	$ 1,285	$ (439)	$ (365)	$ (1,422)	$ 804
UG Distribution Assets Renewal	$ (923)	$ 7,025	$ 817	$ 95	$ 1,088
Corrective Renewal	$ 1,306	$ 16,732	$ 2,864	$ 5,130	$ 5,373
Metering Renewal	$ (2,973)	$ (2,237)	$ (602)	$ 2,293	$ 2,264
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ (2,172)**	**$ 21,054**	**$ (327)**	**$ 2,899**	**$ 889**

2

5.2.2. Historical Variances

Hydro Ottawa forecasts that, over the 2021-2025 historical period, total System Renewal capital expenditures will exceed the approved 5 year forecast by approximately $22M, or 11%. This overall variance is significantly influenced by a $33M overspend in Emergency Renewal, primarily attributable to the unprecedented 2022 Derecho storm and increasing emergency asset replacements, which necessitated extensive infrastructure repairs and immediate resource reallocation.

To mitigate the financial impact of the emergency renewal work that was experienced over the 2021-2025 period, Hydro Ottawa reprioritized and deferred certain projects as detailed in Section 4.1 - Historical Variance Overview, while adhering to the portfolio optimization process outlined in Section 5.3 and Section 5.3.2.4 of Schedule 2-5-4 - Asset Management Process.

Key contributing factors:

- **Devastating 2022 Derecho Storm**: An unprecedented weather event requiring extensive, unbudgeted emergency repairs. Further details about the Derecho storm can be found in Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report.
- **Recurring Severe Weather Events**: Multiple additional major storms necessitating emergency responses and resource reallocation, further impacting planned project timelines and budgets. Refer to Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement for the list of events
- **Increased Equipment Failure Rates**: A general rise in reactive equipment replacements, due to residual effects from the extreme weather events, driving up emergency renewal costs.
- **Inflationary Pressures:** Significant increases in material and labor costs due to inflation (Section 4 of Schedule 1-2-5 - Impact of Inflationary Pressures).

System Renewal and System Service have a combined cumulative asymmetrical capital variance account but given the total overages in this investment category no amounts were recorded in this account. Refer to Schedule 9-1-3 - Group 2 Accounts for further details.

Detailed explanations of program variances that contributed to the overall System Renewal variances are provided below.

Station Assets Renewal

During the 2021-2025 period, Hydro Ottawa decided to defer projects within the Station Assets Renewal program as well as other capital programs in response to emergency spending required for the storm activity as well as the significant inflationary pressures during this period. These decisions resulted in an underspend of $15.8M, or 33% below the OEB-approved budget.

Initially, in 2021 and 2022, the program adhered closely to budget, with a minor $0.9M underspend in 2021. However, beginning in 2023, Hydro Ottawa decided to adjust projects to manage the overall envelope of System Renewal expenditures. Specifically, the conversion of the Fisher Station Rebuild to a Voltage Conversion project, coupled with the deferral of the Dagmar Voltage Conversion project to 2026, and the subsequent deferrals of the Rideau Heights and Shillington Station Rebuild projects, resulted in a cascading effect of underspending. Consequently, underspends of $3M were realized in 2023, $3.2M in 2024, and $8.7M in 2025, reflecting the impact of these multi-year project deferrals. Station Assets Renewal Program deferrals are detailed in Section 4.1.3 - 2021-2025 Major Deferrals.

The impact of these deferrals is evident in Table 17 below which highlights the 2021-2025 Budget vs. Actual Station Renewal Unit Comparison per Station Asset Class. Specifically, deferrals resulted in variances in the completion of station transformer renewals (budgeted 10, completed 5), and station switchgear renewals (budgeted 68, completed 55). Conversely, Hydro

Ottawa exceeded its planned number of station relay renewals, completing 39 compared to a budget of 28. This increase was a result of unplanned relay replacements associated with emergency work related to catastrophic switchgear failures at Overbrook and Lincoln Heights.

Table 17 - 2021-2025 Budget vs. Actual Station Renewal Unit Comparison per Station Asset Class

Station Asset Class	2021-2025 Budget	2021-2025 Actuals	Variance
Station Transformers	10	5	(5)
Station Switchgear	68	55	(13)
Station Batteries	10	9	(1)
Station Relays	28	39	11
Station RTUs	2	2	-

OH Distribution Assets Renewal Program

Over the 2021-2025 period, the OH Distribution Assets Renewal program only had a minor total overspend of $0.1M from the OEB-approved budget. However, given the significant cost increases, this was only achieved through reduction of assets renewed as reflected in Table 18 below which highlights the 2021-2025 Budget vs. Actual OH Asset Renewal Unit Comparison. Pole renewals were reduced to 1732 units (budgeted 2000), and OH Switch/Recloser renewals were 56 units (budgeted 1150), see commentary below on the change for this program. OH Transformers are replaced as required through the Pole Renewal program and therefore the specific number of units are not explicitly budgeted.

Table 18 - 2021-2025 Budget vs. Actual OH Asset Renewal Unit Comparison

OH Asset Class	2021-2025 Budget	2021-2025 Actuals	Variance
Poles	2,000	1,732	(268)
OH Transformers	N/A	309	N/A
OH Switches / Reclosers	1,150	56	(1,094)

In 2021, the program exceeded its budget by $1.3M, primarily due to a 13% increase in the installed cost per pole. This was driven by significant inflationary increases on materials and the complexity of certain pole renewal projects. However, as noted in Section 3.1 of Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement, Hydro Ottawa implemented significant steps to enhance labor efficiency through process standardization, dedicated construction roles, optimized construction season schedules, and a refined project delivery model. Had these initiatives not been undertaken, the cost per pole would have increased by 22% instead of the actual 13% increase. The underspend in 2022, 2023 and 2024, offset by the overspend in 2025 in this program is achieved through these significant productivity efforts accompanied by adjustments to planned pole renewal projects, effectively managing costs and mitigating asset failure risks. OH Distribution Assets Renewal Program deferrals are detailed in Section 4.1.3 - 2021-2025 Major Deferrals.

The original proposed scope for the 2021-2025 OH switch/recloser program considered the replacement of all porcelain insulated cut-outs, overhead switches, in-line switches and re-fusing of adjacent taps. However, Hydro Ottawa does not consider the cut-outs as a major commodity class within the overhead switch inventory and therefore does not track the number of units that are replaced. This tracking discrepancy is causing the large variance in the planned versus actual units for 2021-2025.

UG Distribution Assets Renewal Program

Over the 2021-2025 period, the UG Distribution Assets Renewal program experienced an overspend of $8.1M, or 15% above the OEB-approved budget. This variance reflects the program's response to fluctuating market conditions and project complexities.

Controlled implementation within the UG Asset Renewal program during the 2021-2025 period led to the variances outlined in the Budget vs. Actual Unit Comparison (Table 19). Specifically, UG Switchgear renewals were completed at 15 units (budgeted 20), UG cable renewals at 74km (budgeted 130km), and vault transformer renewals at 18 units (budgeted 125). UG

Transformers were planned to be replaced as required through the Cable Renewal program and therefore the specific number of units were not explicitly forecasted. Additionally, in the historic period, the activities within the Cable Chambers program included a variety of renewal activities that were selected annually based on asset condition data from inspections and was funded at approximately $1.01M annually. As such the type and volume of units was not forecasted for the 2021-2025 period. These variances represent adjustments made to manage expenditures via deferrals and cost avoidance as described in Section 4.1 - Historical Variance Overview while maintaining essential system functionality.

Table 19 - 2021-2025 Budget vs. Actual UG Asset Renewal Unit Comparison

UG Asset Class	2021-2025 Budget	2021-2025 Actuals	Variance
UG Transformers	N/A	360	N/A
UG Switchgear	20	15	(5)
UG Cables (km)	130	74	(56)
Cable Chambers	N/A	23	N/A
Vault Transformers	125	18	(107)
Vault Switchgear	N/A	-	N/A

In 2021, the program underspent by $0.9M (8% below budget), however, 2022 saw a significant overspend of $7M. This substantial increase was attributed to the resumption of cable replacement projects post-COVID-19, which faced significant increases in material costs and higher civil contractor prices. Notably, the actual cost per kilometer of cable reached $0.7M/km, compared to the budgeted $0.3M/km.

The program returned to a moderate overspend in 2023, exceeding the budget by $0.8M. This was achieved through Hydro Ottawa's implementation of strategic cost-control measures and proactive adjustments to project execution, demonstrating a commitment to mitigating further budgetary deviations. UG Distribution Assets Renewal Program deferrals are detailed in Section 4.1.3 - 2021-2025 Major Deferrals.

Despite fluctuations, the overall program performance demonstrates Hydro Ottawa's commitment to balancing essential asset renewal with prudent cost management. The significant overspend in 2022 highlights the challenges faced by the utility sector in navigating post-pandemic economic conditions, while the subsequent moderation in overspending reflects proactive efforts to manage costs and ensure efficient resource allocation.

Corrective Renewal Program

The Corrective Renewal program is necessarily reactive, responding to immediate system needs and unforeseen events that arise throughout the year. This inherent variability is reflected in the program's expenditures, which exceeded the OEB-approved budget by a total of $31.4M over the 2021-2025 period, representing a 61% overspend.

In 2021, the program overspent by $1.3M, primarily due to increased emergency pole replacements and transformer oil spills. This demonstrates the program's responsiveness to immediate system risks identified through inspections and ongoing maintenance.

2022 saw a substantial $16.7M overspend (171%), largely attributed to the devastating Derecho storm. This unprecedented event required extensive emergency repairs, exceeding the original Emergency Renewal budget within the Corrective Renewal Program by $15.1M. For additional information on this devastating storm, refer to Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report. Hydro Ottawa did not file a Z-factor for this storm.

The program continued to exceed budget in 2023 by $2.9M, driven by another severe April ice storm and a higher-than-anticipated volume of transformer oil spills. This further emphasizes the program's role in the reactive response to both weather-related emergencies and underlying system issues.

In 2024 and 2025, the program is projected to exceed the approved budget by $5.1M and $5.4M, respectively. This sustained overexpenditure is primarily due to: emergency replacement of poles projected to exceed the approved budget by $2.9M, emergency underground transformer replacement projected to exceed the approved budget by $4.1M, and the proactive replacement of leaking transformers from a specific manufacturer as defined in Section 6 of Schedule 2-5-7 - System Renewal Investments. Forecasts for 2024 and 2025 emergency pole replacement costs were developed using actual costs from 2021-2023 and data on known assets requiring replacement. These costs reflect a 50% per-pole increase attributed to inflationary pressures and updated estimating methodologies. Emergency underground transformer replacements in 2024 cost as much as $122,481 when remediation and base replacement were required. This was a sharp contrast to the $25,648 average cost for emergency replacement without remediation or base replacements. Though maximum costs increased, total volumes are projected to remain consistent for 2024 and 2025 when compared with 2021-2023. However, leaking transformers are expected to spike in 2024 and 2025 as a result of known deficiencies with a specific manufacturer.

Overall, the Corrective Renewal program demonstrates a consistent pattern of responding to immediate system needs and unforeseen events. The significant overspending, totaling $31M, reflects the program's crucial role in maintaining system reliability and safety, even in the face of unexpected challenges and rising costs.

However, it's important to recognize that emergency renewals are not a substitute for targeted renewal work. While they address urgent failures and prevent immediate system disruptions, they often occur without a comprehensive condition assessment of the asset. This means that repairs are made to address the symptom (the failure) rather than the underlying cause (asset degradation). Consequently, emergency renewals may lead to temporary fixes or like-for-like replacements of already deteriorating assets, potentially resulting in recurring issues and increased long-term maintenance needs. Furthermore, emergency work can impact assets at relatively good condition, as these assets may be damaged in the same event that damaged the older assets. This is especially true when considering that impacts of storms and other unforeseen events can far exceed the design limits of the asset, leading to damage regardless of its age or condition.

Targeted renewals, on the other hand, are driven by condition assessments and Predictive Analytics, allowing for proactive replacements that address the root causes of asset degradation. This approach optimizes asset lifecycles and minimizes future maintenance requirements. While exceeding the approved budget, the Corrective Renewal expenditures underscore Hydro Ottawa's commitment to ensuring a resilient and dependable electricity distribution system, it's crucial to balance these emergency responses with strategic, condition-based renewals to achieve long-term system reliability and cost-effectiveness.

Metering Renewal Program

The Metering Renewal program encountered notable challenges throughout the 2021-2025 period, primarily stemming from delays in Gatekeeper meter acquisition and the subsequent transition to the AMI 2.0 initiative (detailed in Schedule 2-5-7 - System Renewal Investments). Despite these complexities, the program ultimately achieved a total underspend of $1.3M, representing a 10% variance from the OEB-approved budget.

In 2021 and 2022, the program experienced substantial underspending, with actual expenditures ($3.0M) and ($2.2M) below the approved budget, respectively. These variances were directly attributable to delays in acquiring Gatekeeper meters, which impacted the Self-Contained Meter Phone Line Elimination project and the replacement of REX 1 meters.

The underspending trend persisted in 2023, with a 31% budget shortfall, equivalent to $0.6M, due to ongoing supply chain constraints affecting critical components. However, in 2024, the program shifted to a $2.3M overspend. This variance was primarily due to the resolution of prior supply chain issues. For 2025, the program is projected to overspend by $2.3M. This is attributed to the successful resolution of supply chain constraints, enabling the progression of REX 1 meter replacements.

5.2.3. Forecast to Historical Variance by Capital Program

The net annual spend for System Renewal is expected to average $86.3M over the 2026-2030 period which is an increase from the $46.5M average annual spend during the 2021-2025 timeframe.

Table 20 below provides a comparison of the 2021-2025 historical period and the 2026-2030 forecast period, detailing both the five-year totals and annual averages for each program.

Table 20 – System Renewal Forecast Expenditures Test Year Expenditures by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
Stations & Building Infrastructure Renewal	$ 31,433	$ 107,656	$ 76,222	$ 6,287	$ 21,531	$ 15,244
OH Distribution Assets Renewal	$ 43,149	$ 67,800	$ 24,651	$ 8,630	$ 13,560	$ 4,930
UG Distribution Assets Renewal	$ 63,286	$ 103,034	$ 39,747	$ 12,657	$ 20,607	$ 7,949
Corrective Renewal	$ 82,629	$ 66,851	$ (15,779)	$ 16,526	$ 13,370	$ (3,156)
Metering Renewal	$ 11,835	$ 86,364	$ 74,529	$ 2,367	$ 17,273	$ 14,906
TOTAL SYSTEM RENEWAL	**$ 232,333**	**$ 431,704**	**$ 199,371**	**$ 46,467**	**$ 86,341**	**$ 39,874**
Capital Contributions	$ (12)	-	$ 12	$ (2)	-	$ 2
NET SYSTEM RENEWAL	**$ 232,321**	**$ 431,704**	**$ 199,383**	**$ 46,464**	**$ 86,341**	**$ 39,877**

Details on Hydro Ottawa's System Renewal Capital Programs from 2026 through 2030 are included in Schedule 2-5-7 - System Renewal Investments.

Stations and Buildings Infrastructure Renewal

The capital investment for this program is detailed in Section 2 of Schedule 2-5-7 - System Renewal Investments. The Stations and Buildings Infrastructure Renewal program investments are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

Based on the Copperleaf PA assessment, long-term asset condition trends were considered to develop a balanced asset renewal investment plan for 2026-2030, managing the risk of asset failure, the lead time for equipment and the resource requirements to execute the programs. This strategy led to Hydro Ottawa proposing an increase to the station renewal budget relative to the 2021-2025 period, with the objective of managing asset performance while balancing supply chain considerations and maintaining customer affordability.

The annual spend for Stations Asset Renewal is expected to average $21.5M over the 2026-2030 period which is an increase from the $6.3M average annual spend during the 2021-2025 timeframe. This increase is primarily driven by investments in five voltage conversion projects necessitated by the need to replace station transformer assets that have reached their end of typical useful life, three of which are new projects (Church AA, Henderson UN, Vaughan DS) and two of which were deferred during the 2021-2025 period (Dagmar AC and Fisher AK) as part of cost containment efforts. These projects account for over half of the program's allocated expenditure. The remaining increase is attributed to the replacement of switchgear lineups at four stations with a higher risk of failure based on operational trends and recommendations from Copperleaf PA.

Comparison of historical actuals (2021-2025) vs. planned (2026-2030) station asset replacement and removal units under Station and Building infrastructure Renewal Program is provided in Table 21. The five year budget reflects a shift towards targeted, efficient upgrades, particularly in response to increasing obsolescence and technological advancements focusing on:

- **EOL Voltage Conversion Program:** The budget increases by $60.6M and focuses on decommissioning 4kV transformers and switchgear at 5 stations and converting customers to 13kV supply. In the historical period Hydro Ottawa completed a significant portion of the 4kV voltage conversion of Fisher and deferred the Dagmar voltage conversion project. The increased budget reflects the critical need to address the degraded 4kV assets as detailed in Section 2 of Schedule 2-5-7 - System Renewal Investments.
- **Station Transformer Renewal:** The budget reduces by $2.3M and focuses solely on completing the Longfields T2 project. In this rate period, Hydro Ottawa has shifted its station transformer renewal focus to the 4kV transformers under the EOL Voltage Conversion program.
- **Station Switchgear Renewal:** The budget substantially increases by $16.1M and is allocated to replace 45 breakers across four stations, addressing aging infrastructure and incorporating inflation-adjusted material costs. The unit increase is driven by a series of catastrophic failures of metal-clad switchgear in the historical period. A program has been developed to target the replacement of EOL and Air-type switchgear at designated critical stations, based on asset condition information.
- **Station Battery Renewal:** The budget increased by $0.5M to facilitate the replacement of 11 battery banks and the removal of 3 battery banks, reflecting a proactive response to observed trends in emergency replacements and condition assessments.
- **Station P&C Renewal:** The budget significantly increased by $6.4M and prioritizes dedicated P&C renewal projects, addressing critical obsolescence in RTU equipment and modernizing transfer trip installations. This investment enhances grid resilience and operational efficiency through the integration of advanced technologies.
- **Station & Building Minor Assets Renewal:** The proposed budget reflects an increase of $6.1M, primarily allocated to the renewal of Operations Facilities, the mitigation of aging asset risks, and supporting increased electrical demand. The primary drivers are end-of-life status of station minor assets and buildings, coupled with the imperative to support increased electrical load. Note that the transfer of the Maple Grove and Dibblee facilities has

contributed to this budget augmentation. This is further detailed in Section 2 of Schedule 2-5-7 - System Renewal Investments.

- **Station Major Rebuild:** The proposed budget is nil for the 2026-2030 period, representing a decrease of $11.2M compared to the 2021-2025 periods. Through 2021-2025, stations with transformers and switchgears that needed replacement were typically recommended for full station upgrades. However, for the 2026-2030 rate period, all stations requiring major asset replacements are in the 4 kV system, being converted to 13 kV under the EOL Voltage Conversion program.

Table 21 - Station Renewal Unit Comparison per Station Asset Class

Station Asset Class	Historical Actuals	Planned
	2021-2025	2026-2030
Station Transformers	5	11
Station Switchgear	55	83
Station Batteries	9	14
Station Relays	39	252
Station RTUs	2	6

Overhead Distribution Assets Renewal

The capital investment for this program is detailed in Section 3 of Schedule 2-5-7 - System Renewal Investments. The investments in the Overhead Distribution Assets Renewal program are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

Comparison of historical actuals (2021-2025) vs. planned (2026-2030) overhead (OH) unit asset renewals encompassed within the Overhead Distribution Asset Renewal Program is provided in Table 22. The annual spend for Overhead Distribution Asset Renewal is expected to average

$13.6M over the 2026-2030 period which is an increase from the $8.6M average annual spend during the 2021-2025 timeframe. The major drivers of the increase are related to:

- **Pole Renewal:** The budget increases by $17M and supports the replacement of 395 poles annually, which is in line with the proposed replacement rate of 400 poles in the historical period. $8M of the budget increase is associated with the increased cost per pole experienced in the historical period. The remaining $9M of the budget increase is attributed to incremental budget allocation to allow for resilience improvements to be incorporated into the renewed design. Productivity improvements have maintained cost efficiency, even with increased volume and inflation. Overhead transformer replacement costs are integrated within this program.
- **OH Switch/Recloser Renewal:** The budget increases by $7.7M is in response to the deteriorating infrastructure, which has resulted in increased outages and corrective maintenance costs in the 2021-2025 period as shown in Schedule 2-5-7 - System Renewal Investments. The plan includes the proactive replacement of 340 manual switches and considers an additional budget to upgrade 40 to remote controllable switches, improving operational efficiency and reliability.

Table 22 - OH Unit Asset Renewal Comparison per OH Asset Class

OH Asset Class	Historical Actuals	Planned
	2021-2025	2026-2030
Poles	1,732	1,975
OH Transformers	309	400
OH Switches / Reclosers	56	340

Underground Distribution Assets Renewal

The capital investment for this program, detailed in Section 4 of Schedule 2-5-7 - System Renewal Investments, is driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

Comparison of historical actuals (2021-2025) vs. planned (2026-2030) underground unit asset renewals encompassed within the Underground Distribution Asset Renewal Program is provided in Table 23. The budget reflects a substantial increase in investment for underground distribution asset renewal, driven by the need to address deteriorating infrastructure, mitigate reliability risks, and manage escalating costs. The annual spend for Underground Distribution Asset Renewal is expected to average $20.6M over the 2026-2030 period which is an increase from the $12.7M average annual spend during the 2021-2025 timeframe. The major drivers of the five year total increase are related to:

- **Cable Renewal:** The budget increases by $33.9M and considers the replacement of 61km down from 74km replaced in 2021-2025. The cost increase is attributable to the increase in the unit rate compared to the historical period. The 2021-2025 unit rate for Hydro Ottawa's cable renewal program was developed using a limited project subset, which proved inadequate to capture the technical complexity of the Ottawa region. This led to a cost discrepancy: 2021-2023 average costs were $0.71M/km (influenced by underground construction unknowns and inflationary pressures), but individual projects reached $1M/km. This was substantially higher than the $0.3M/km rate that was used in developing the 2021-2025 OEB-Approved budget. As a result of varying project complexity, the 2026-2030 budget reflects the higher end of the range, adjusted for inflation, at $1.4M/km to address increased material and contractor costs. Underground transformer replacements are included in this budget.
- **UG Switchgear Renewal:** The budget increases by $3.4M in response to the increased failure rates of UG Switchgear experienced in the historical period, as described in Section 4.3.3 of Schedule 2-5-7 - System Renewal Investments. The program aims to address the

replacement of 30 UG Switchgear which is an increase from the 15 switchgear replaced in the historical period.

- **Vault Renewal:** The budget increases by $2M in response to the growing risk associated with customer-owned vault equipment, as described in Section 4.3.5 of Schedule 2-5-7 - System Renewal Investments. The program aims to address 90 vault transformers in the 2026-2030 period.
- **Civil Renewal:** The budget increases by $1M. The increase is predominately related to cost increases in the program and also considers a slight increase in the number of cable chambers to be addressed (23 to 30).

Table 23 - UG Unit Asset Renewal Comparison per UG Asset Class

Station Asset Class	Historical Actuals	Planned
	2021-2025	2026-2030
UG Transformers	360	400
UG Switchgear	15	30
UG Cables (km)	74	61
Cable Chambers	23	30
Vault Transformers	18	90
Vault Switchgear	-	30

Corrective Renewal

The capital investment for this program is detailed in Section 6 of Schedule 2-5-7 - System Renewal Investments.

The annual spend for Corrective Renewal is expected to average $13.4M over the 2026-2030 period which is a decrease from the $16.5M average annual spend during the 2021-2025 timeframe. The lower forecasted spending in the 2026-2030 period compared to 2021-2025 expenditure is a result of the substantial variance in expenditure over the 2021-2025 period compared to the OEB-approved budget due to an increased number and severity of Major Event Days (MEDs) during this period. With the assumption that the number and severity of

MEDs experienced in this period were an anomaly, the forecasted expenditure for 2026-2030 is better compared with the OEB-approved budget for the 2021-2025 ($51.2M). Factoring in cost increases and acknowledging the realities of climate change and the associated impacts to the electrical distribution system, a total variance of $15.6M compared to the 2021-2025 OEB-approved budget is observed. While the occurrence of a discrete event of the severity of the 2022 Derecho is not explicitly forecast, the increasing frequency and intensity of severe weather events necessitate sustained and strategic investment in infrastructure resilience which is accounted for in the forecasted expenditure for 2026-2030.

Metering Renewal

The capital investment for this program is detailed in Section 5 of Schedule 2-5-7 - System Renewal Investments.

The annual spend for Metering Renewal is expected to average $17.3M over the 2026-2030 period which is an increase from the $2.4M average annual spend during the 2021-2025 timeframe. The increase is attributed to investments in Hydro Ottawa's Advanced Metering Infrastructure 2.0 (AMI 2.0) initiative. This upgrade is required to address the functional obsolescence of the metering fleet to avoid failure, enhance system capabilities, and support grid modernization efforts. The proposed metering renewal plans to replace 161,000 meters (approximately 43% of the total fleet) over the 2026-2030 period with the remainder of the fleet being replaced in the 2031-2035 period. The functional obsolescence of Hydro Ottawa's fleet of meters all at the same time is due to a previous effort to replace all meters over a 4 year period to remain compliant to regulations stemming from Ontario Bill 21 - Energy Conservation Responsibility Act in 2006.

The renewal of metering assets is crucial to ensure sustained levels of customer service, accurate billing, and regulatory compliance.

Comparison of historical actuals (2021-2025) vs. planned (2026-2030) metering asset unit renewals encompassed within the Metering Renewal Program is provided in Table 24.

Table 24 - Metering Unit Renewal Comparison

	2021-2025 Historical Actuals	2026-2030 Planned
Metering Replacements	8,811	161,000

5.3. SYSTEM SERVICE EXPENDITURES

System Service investments are "modifications to a distributor's distribution system to ensure the distribution system continues to meet distributor operational objectives while addressing anticipated future electricity service requirements" as per Section 5.1.2 of the OEB's Chapter 5 Filing Requirements.

Hydro Ottawa's System Service Investments are broken out into six capital programs as described in Table 25 below.

Table 25 – System Service Capital Programs

Capital Program	Description
Capacity Upgrades	• For relieving system capacity constraints resulting from load growth.
Distribution Enhancements	• A modification to the distribution system to improve system operating characteristics.
Station Enhancements	• A modification to a station to improve system operating characteristics.
Grid Technologies	• Enhancements to the Advanced Distribution Management System and data archival system to improve monitoring and control of the distribution network in real-time.
Control and Optimization	• Enhancements to grid management by integrating advanced systems like DERMS to monitor and adjust electricity flow in real-time, improving efficiency, stability, and responsiveness to changing conditions like outages and fluctuating renewable energy sources.
Field Area Network	• Extend connectivity and add resilience to grid-edge device communications.

Capital Programs under System Service are also broken down by Budget Program. Table 26 provides a description of each Budget Program along with the primary driver. The program drivers are detailed in Section 5.3.1.1 of Schedule 2-5-4 - Asset Management Process.

1 **Table 26 – System Service Expenditure Categories**

Capital Program	Budget Program	Primary Driver	Description
Capacity Upgrades	Stations Capacity Upgrades	Capacity Constraints	• New stations or increased station transformation capacity through transformer upgrades or additions at existing stations as identified through the System Capacity Assessment.
	Distribution Capacity Upgrades	Capacity Constraints	• New distribution capacity projects identified through the System Capacity Assessment including conductor upgrades, and line extensions (Not deemed "System Expansion").
	Non-Wire Upgrades	Capacity Constraints	• New support during peak demand in capacity constrained areas until capacity upgrades are completed to alleviate constraints while also benefiting those customers who are open to adopting distributed energy resources
Distribution Enhancements	Distribution System Reliability	Reliability	• Specific enhancements to particular areas identified as having poor system reliability; typically more complex projects, including line extensions and addition of remote operable switches.
	Capacity Voltage Conversion	Capacity Constraints	• Distribution voltage conversion to increase capacity in areas seeing significant growth; • Typically coincides with the retirement of existing stations or distribution assets due to condition or failure risk
	Distribution Enhancements	Reliability	• Modifications to the existing distribution system made to improve system operating characteristics or operability (e.g. circuit reconfiguration) • Installation of automated equipment for the purposes of improving operability
	Distribution System Observability	Observability	• This initiative will improve system visibility by adding automated devices in strategic locations
	Distribution System Resiliency	Resilience	• This initiative will reduce outage times and improve system reliability using new assets that provide real-time condition data, loading data, and fault-finding capabilities
Station	Stations	Reliability	• Modifications to an existing station that is made to

Capital Program	Budget Program	Primary Driver	Description
Enhancements	Enhancements		improve system operating characteristics.
Grid Technologies	SCADA Upgrades	System Efficiency	● Upgrades to the ADMS platform; both hardware and software upgrades are considered.
	RTU Upgrades	N/A	● A historical Budget Program whereby the scope has been redistributed into the Grid Technologies, as well as Control and Optimization Capital Programs
	Communication Infrastructure	N/A	● A historical budget program which has been redistributed into the Field Area Network budget program.
Control and Optimization	Control and Optimization	Observability & Resilience	● Enhancements to grid management by integrating advanced systems like DERMS to monitor and adjust electricity flow in real-time, improving efficiency, stability, and responsiveness to changing conditions like outages and fluctuating renewable energy sources.
Field Area Network	Physical Fiber Extension	System Efficiency	● Installation of new fiber segments to improve network diversity and resilience.
	Wireless Communication	System Efficiency	● Deployment of infrastructure for testing wireless communication for Grid DA devices.
	Management of Grid-Edge Device	System Efficiency	● Deployment of an Intelligent Electric Device Management system to centrally monitor, configure, troubleshoot and access Intelligent Electronic Devices.
	SCADA Network Cyber Security	System Efficiency	● Installation of threat detection, capabilities to increase cyber security in the SCADA network.

5.3.1. Historical Expenditures

The following Tables present Hydro Ottawa’s System Service Capital Expenditures from 2021 through 2025 compared to the OEB Approved amounts. Table 27 details this spending on a five-year total basis, while Table 28 provides the annual spending and variances.

Hydro Ottawa uses its Capital Expenditure Process (Section 3.5 of Schedule 2-5-4 - Asset Management Process) and portfolio optimization (Section 5.3 of Schedule 2-5-4 - Asset Management Process) to ensure strategic oversight and efficient capital utilization of the System Service capital program.

Table 27 - Net System Service Historical Spending versus OEB Approved - 5yr ($'000s)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
Capacity Upgrades	$ 75,849	$ 108,196	$ 32,347	43%
Stations Enhancements	$ 2,739	$ 2,576	$ (163)	(6)%
Distribution Enhancements	$ 29,573	$ 27,515	$ (2,058)	(7)%
Grid Technology	$ 8,859	$ 20,813	$ 11,953	135%
Field Area Network	$ 6,069	$ 1,947	$ (4,122)	(68)%
TOTAL CAPITAL EXPENDITURES	**$ 123,089**	**$ 161,047**	**$ 37,959**	**31%**

As noted above, Table 28 below provides the annual variance against the OEB Approved for each of the capital programs under System Service, the table is divided into three sections with the OEB Approved amounts first, followed by the historical actuals, and then the annual variances.

1 **Table 28 - Net System Service Historical Spending versus OEB Approved - Annual ($'000s)**

Capital Program	2021	2022	2023	2024	2025
	OEB-Approved (Net of Contribution)				
Capacity Upgrades	$ 19,791	$ 9,717	$ 14,577	$ 17,799	$ 13,964
Stations Enhancements	$ 905	$ 459	$ 459	$ 459	$ 459
Distribution Enhancements	$ 2,614	$ 11,987	$ 5,579	$ 4,597	$ 4,796
Grid Technology	$ 1,224	$ 2,961	$ 1,775	$ 755	$ 2,145
Field Area Network	$ 902	$ 1,044	$ 1,044	$ 1,044	$ 2,035
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 25,436**	**$ 26,168**	**$ 23,434**	**$ 24,654**	**$ 23,398**
	Historical Years			Bridge Years	
Capacity Upgrades	$ 20,669	$ 6,775	$ 7,941	$ 29,757	$ 43,054
Stations Enhancements	$ 99	$ 1,238	$ 215	$ 661	$ 363
Distribution Enhancements	$ 2,428	$ 3,254	$ 2,816	$ 10,727	$ 8,291
Grid Technology	$ 151	$ 2,604	$ 5,591	$ 5,712	$ 6,756
Field Area Network	$ 591	$ (46)	$ 24	$ 300	$ 1,079
TOTAL HISTORICAL/BRIDGE NET CAPITAL EXPENDITURES	**$ 23,937**	**$ 13,825**	**$ 16,585**	**$ 47,157**	**$ 59,543**
	Variance ($)				
Capacity Upgrades	$ 877	$ (2,942)	$ (6,637)	$ 11,958	$ 29,090
Stations Enhancements	$ (805)	$ 779	$ (244)	$ 202	$ (95)
Distribution Enhancements	$ (187)	$ (8,733)	$ (2,763)	$ 6,130	$ 3,495
Grid Technology	$ (1,073)	$ (358)	$ 3,816	$ 4,957	$ 4,611
Field Area Network	$ (311)	$ (1,090)	$ (1,021)	$ (744)	$ (956)
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ (1,499)**	**$ (12,343)**	**$ (6,849)**	**$ 22,503**	**$ 36,145**

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5.3.2. Historical Variances

Hydro Ottawa's System Service capital expenditures for the 2021-2025 period are projected to exceed the OEB-approved budget by approximately $38M, a 31% variance. This significant deviation is primarily attributed to a combination of factors: initial underspending due to COVID-19 related project delays in 2021-2022, followed by escalating costs driven by unforeseen capacity requirements, including the Mer Bleue substation, identified through regional planning, and substantial scope adjustments to the Advanced Distribution Management System (ADMS) initiative. These increases were further compounded by external factors, including inflationary pressures and industry-wide supply chain disruptions, further contributing to cost increases. Details on coordinated planning with external stakeholders can be found in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties, and the impact of inflationary pressures in Section 4 of Schedule 1-2-5 - Impacts of Inflationary Pressures.

Key contributing factors:

- **COVID-19 Pandemic Impact:** Supply chain and resource availability disruptions
- **Evolving Capacity Needs:** Project scope changes identified through regional planning with external stakeholders
- **Inflationary Pressures:** Increased material and labor costs
- **Reprioritization:** Prioritization of critical projects
- **ADMS Scope Adjustments:** Significant modifications to the ADMS initiative

As noted above, System Renewal and System Service have a combined cumulative asymmetrical capital variance account, therefore given the total overage in this investment category and on an annual basis when combined with System Renewal, no amounts were recorded in this account. Refer to Schedule 9-1-3 - Group 2 Accounts for further details.

Detailed explanations of program variances that contributed to the overall System Service variances are provided below.

Capacity Upgrades

Over the 2021-2025 period, the Capacity Upgrades program experienced significant budget increases, culminating in a total overspend of $32.3M or a 43% variance from the OEB-approved budget. This variance was primarily driven by:

- **Material Cost Escalations:** Significant price increases in core commodities and electrical components.
- **Supply Chain Disruptions:** Delays and shortages in critical materials and equipment.
- **Land Acquisition Challenges:** Rising real estate values and environmental assessment delays.
- **Unforeseen Capacity Needs:** The Mer-Bleue station was identified through a collaborative regional planning initiative with external stakeholders.
- **Project Delays and Scope Adjustments:** Leading to schedule adjustments and cost increases.

Initially, the program experienced underspending in 2022 and 2023, with actual expenditures below budget, primarily due to delays in key projects. Notably, the New East Station Capacity Upgrade and the Riverdale Switchgear Upgrade faced setbacks. The New East Station project was delayed due to complexities associated with land acquisition. The Riverdale Switchgear Upgrade was delayed due to necessary scope adjustments required to adhere to capacity planning requirements identified through area planning.

However, 2024 and 2025 saw a shift to significant, unavoidable overspending. The New East Station project faced substantial cost escalations, now projected to be $23.3M (or 163%) over budget. This significant increase is largely due to transformer and high-voltage breaker costs, which more than doubled due to industry-wide material shortages and inflationary pressures. General construction costs also increased in line with industry-average inflation, as generally described in Schedule 1-2-5 - Impact of Inflationary Pressures. Additionally, the collaborative regional planning with external stakeholders identified the need for the Mer-Bleue station capacity upgrade, adding $13.8M in unbudgeted expenditures to the program. Through regional planning, construction of Mer Bleue MTS was determined as the optimal solution to decommission the aging Bilberry TS and transfer loads to a 230 kV supply, relieving pressure on the constrained 115 kV system project, as described in Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments. Despite facing unprecedented external challenges, Hydro Ottawa effectively adapted its Capacity Upgrades program to meet evolving capacity requirements.

Station Enhancement

There were no material variances in the Station Enhancements program, annually or on a total basis. The 5 yr total variance was $0.2M or 6% below the 2021-2025 OEB-approved budget.

Distribution Enhancement

Over the 2021-2025 period, Hydro Ottawa's Distribution Enhancements program experienced budgetary fluctuations, resulting in a $2.0M underspend, a 7% variance from the OEB-approved budget. This variance was primarily driven by strategic investment prioritization and unforeseen external events.

In 2022, Hydro Ottawa underspent by $8.7M due to the strategic deferral of large line extension projects and scope adjustments following the Derecho storm, which facilitated a reassessment and prioritization of distribution enhancements. This trend continued in 2023, with a $2.8M underspend attributed to strategic reprioritization necessitated by the lingering effects of the 2022 Derecho storm, additional 2023 storm activity, and the labor strike. Distribution Enhancement Program deferrals are detailed in Section 4.1.3 - 2021-2025 Major Deferrals.

Conversely, 2024 and 2025 saw substantial overspending: $6.1M in 2024 and $3.5M in 2025. This overspending was primarily due to the execution of four large line extension projects, implemented to address the previously deferred projects from 2022 and 2023.

Hydro Ottawa's strategic reprioritization demonstrates a commitment to maintaining and enhancing distribution network reliability. By leveraging the portfolio optimization process, as detailed in Sections 5.3 and 5.3.2.4 of Schedule 2-5-4 - Asset Management Process, Hydro Ottawa effectively manages investment priorities. The program's adaptability, evidenced by the response to the Derecho storm and project reprioritization, reflects a dynamic and responsive approach to budget management. Hydro Ottawa aligned expenditures with evolving operational needs, ensuring resources were directed to critical priorities. The strategic deferral and subsequent execution of large line extension projects highlight Hydro Ottawa's commitment to responsible financial stewardship and its ability to navigate changing circumstances while maintaining core operational objectives.

Grid Technology

Over the 2021-2025 period, Hydro Ottawa's Grid Technology program experienced significant budgetary fluctuations, resulting in a substantial overspend of $12M (135% variance) from the OEB-approved budget. However, with the reallocation of funds from the underspent Field Area Network program, as noted below, the net variance in this program is $7.8M. This variance was primarily driven by evolving project scope, unforeseen external events, adjustments to project implementation, and inflationary increases impacting professional service fees.

Initially, a $1.1M underspend in 2021 resulted from deferring the Advanced Distribution Management System (ADMS) initiative, which includes SCADA Upgrade, Outage Management System Replacement, Distribution Management System enhancement, and planned integrations. This deferral was due to COVID-19-related disruptions.

In 2022, a further $0.4M underspend occurred as internal resources were redirected to operational tasks following the Derecho storm. When the ADMS initiative resumed, planning revealed significant budget gaps and a lack of internal resources, necessitating a dedicated project resource model, expanded professional services, and schematics map conversion, resource details in Section 3.1 of Attachment 4-1-3(C) - Workforce Growth.

The 2023 labor disruption compounded ADMS initiative delays, requiring additional professional services. These cumulative delays, along with the decision to prioritize ADMS, led to a $3.8M overspend (215% variance).

Hydro Ottawa notes that the ADMS program is currently undergoing a comprehensive review, and therefore, specific details of the Grid Technology budget program, including the capital budget, are subject to significant change. Updated information and supporting documentation related to the program will be filed with the responses to interrogatories. This approach ensures transparency and allows stakeholders to fully assess the program's potential impact and provide informed feedback within the rate application process.

The $12M overspend (or $7.8M after considering the Field Area Network budget reallocation) is a culmination of the initial underspends due to delays, the subsequent increased costs for resources and professional services, and the overall initial budget gaps and scope changes, such as the crucial addition of the schematics map conversion and cyber security requirements.

Field Area Network

Over the 2021-2025 period, Hydro Ottawa's Field Area Network program was underspent by $4.1M, or 68%, from the OEB-approved budget. This variance was driven by regulatory delays, evolving technological challenges, and the decision to prioritize the Grid Technology program.

In 2021, the program underspent by $0.3M due to delays awaiting critical regulatory changes from the CRTC, a prerequisite for deploying and operating wireless communication services. Although the CRTC's regulatory changes were implemented in 2022, the program continued to experience underspending throughout the rate period due to ongoing challenges in obtaining necessary spectrum licenses and the lack of common industry standards for device manufacturers. These issues hindered the procurement and installation of essential equipment, including base stations and cellular-enabled field devices, preventing the program from advancing as planned. Consequently, funds were redistributed to Grid Technology to offset the

ADMS overspend, resulting in underspending of $1.1M in 2022, $1.0M in 2023, $0.7M in 2024 and $1.0M in 2025 from the OEB-approved budget.

5.3.3. Forecast to Historical Variance by Capital Program

The net annual spend for System Service is expected to average $93.8M over the 2026-2030 period which is an increase from the $32.2M average annual spend during the 2021-2025 timeframe.

Table 29 below provides a comparison of the 2021-2025 historical period and the 2026-2030 forecast period, detailing both the five-year totals and annual averages for each program.

Table 29 – System Service Forecast Expenditures by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
Capacity Upgrades	$ 108,244	$ 346,890	$ 238,646	$ 21,649	$ 69,378	$ 47,729
Stations Enhancements	$ 2,576	$ 3,050	$ 474	$ 515	$ 610	$ 95
Distribution Enhancements	$ 27,523	$ 92,786	$ 65,263	$ 5,505	$ 18,557	$ 13,053
Grid Technology	$ 20,813	$ 6,408	$ (14,404)	$ 4,163	$ 1,282	$ (2,881)
Control and Optimization	-	$ 3,586	$ 3,586	-	$ 717	$ 717
Field Area Network	$ 1,947	$ 20,750	$ 18,804	$ 389	$ 4,150	$ 3,761
TOTAL SYSTEM SERVICE	**$ 161,103**	**$ 473,472**	**$ 312,369**	**$ 32,221**	**$ 94,694**	**$ 62,474**
Capital Contributions	$ (56)	$ (4,333)	$ (4,277)	$ (11)	$ (867)	$ (855)
NET SYSTEM SERVICE	**$ 161,047**	**$ 469,139**	**$ 308,092**	**$ 32,209**	**$ 93,828**	**$ 61,618**

Details on Hydro Ottawa's System Service Capital Programs from 2026 through 2030 are included in Schedule 2-5-8 - System Service Investments but a brief overview of the changes in spend between the historical period and the forecast period is provided below.

Capacity Upgrades

The capital investment for this program is detailed in Section 2 of Schedule 2-5-8 - System Service Investments. System capacity needs and required upgrades are determined through the System Capacity Assessment (outlined in Section 9 of Schedule 2-5-4 - Asset Management Process) and Integrated Regional Resource Planning (detailed in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties).

The gross annual spend for Capacity Upgrades is expected to average $69.4M[8] over the 2026-2030 period, which is an increase from the $21.6M average annual spend during the 2021-2025 timeframe. Over the 2026-2030 period, there will be 753MVA[9] of new capacity in construction versus 180MVA during the 2021-2025 timeframe. As a result, 75% of the budget growth is related to capacity investments required to support the committed connection requests driving this new capacity. More specifically, 56% is related to station capacity investments to support forecasted load and 26% is distribution capacity upgrades, enabling full utilization of the station capacity through feeder construction. The remaining 18% of the growth has been allocated to the new Non-Wires Capacity Upgrades program, which involves implementing alternative solutions to traditional infrastructure upgrades to increase capacity and improve grid reliability. This program encompasses investments in utility-owned Battery Energy Storage Systems (BESS) and Non-Wires Customer Solutions. Specifically, Hydro Ottawa plans on deploying approximately 27.5MW of utility-owned BESS at 4 substations over the 2026-2030 period. Further, Hydro Ottawa will offer a portfolio of energy efficiency, generation, and demand response programs that can also leverage customer DERs, to help address system needs, through the Non-Wires Customer Solutions Program. The planned investments, including both

[8] Net of Capital Contributions this program is expected to average $68.5M over the 2026-2030 period.
[9] Station projects- Piperville, Mer Bleue, Kanata North, Greenbank, Upgrades to Bronson DS and Cyrville MTS

BESS and customer solutions, are critical to support growth and electrification in the community by providing additional flexibility and capacity to the distribution system.

Stations Enhancements

The capital investment for this program is detailed in Section 4 of Schedule 2-5-8 - System Service Investments.

The annual spend for Stations Enhancements is expected to average $0.6M over the 2026-2030 period, aligning with the $0.5M average annual spend during the 2021-2025 timeframe. This program covers continued investments in cyber security to safeguard critical infrastructure as well as installation of monitoring equipment at station transformers to improve system reliability, enable proactive maintenance, and facilitate data-driven decision-making. These improvements also support grid modernization, creating improved observability at stations and building the foundation for future grid modernization initiatives.

Distribution Enhancements

The capital investment for this program is detailed in Section 3 of Schedule 2-5-8 - System Service Investments.

The annual spend for Distribution Enhancements is expected to average $18.6M over the 2026-2030 period which is an increase from the $5.5M average annual spend during the 2021-2025 timeframe. This increase is primarily driven by significant investments in two new programs, which account for over 70% of the program's allocated budget:

- **Distribution System Resiliency:** This program focuses on mitigating the impact of adverse weather events through strategic undergrounding of lines, reinforcement of existing infrastructure, reconfiguration of feeders, and relocation of lines to less vulnerable areas.
- **Distribution System Observability:** This program aims to enhance system reliability and reduce outage times by investing in new assets that provide real-time data on system

conditions, loading, and fault locations, enabling proactive maintenance and faster response to issues.

The remaining 30% of the budget is made up of the following programs:

- **Reliability:** Improves efficiency and reliability through feeder reconfiguration and phase balancing.
- **Enhancements:** Supports DER integration through infrastructure upgrades and pilot projects, leveraging federal funding for innovation.

These programs are critical to improve grid resilience to severe weather events, shorten outage times, improve reliability, increase grid flexibility, enhance DER integration, and advance Hydro Ottawa's grid modernization road map.

Grid Technology

The capital investment for this program is detailed in Section 5 of Schedule 2-5-8 - System Service Investments.

The annual spend for Grid Technology is expected to average $1.3M over the 2026-2030 period which is a decrease from the $4.2M average annual spend during the 2021-2025 timeframe. The 2021-2025 spend included a material investment in a new Advanced Distribution Management System, whereas the 2026-2030 period will see minor enhancements and upgrades.

Control and Optimization

As this Control and Optimization Capital Program is new, forecast-to-historical variance analysis is not applicable. Capital investment details are available in Section 7 of Schedule 2-5-8 - System Service Investments.

The annual spend for Control and Optimization is expected to average $0.7M over the 2026-2030 period. This captures a new program under System Service supporting grid modernization efforts by enhancing the Advanced Distribution Management System (ADMS) with new modules like the Distributed Energy Resource Management System (DERMS). These upgrades enable several grid modernization functionality in tandem with observability and controllability devices facilitating the improvement of grid stability, efficiency, and resilience, enabling better grid management and real-time outage restoration.

Field Area Network

The capital investment for this program is detailed in Section 6 of Schedule 2-5-8 - System Service Investments.

The annual spend for Field Area Network is expected to average $4.2M over the 2026-2030 period which is a $3.8M increase compared to the $0.4M average annual spend between 2021-2025. The incremental annual spend is predominantly related to increased reliability and resilience of the communication network, aimed at modernizing and future-proofing Hydro Ottawa's communication infrastructure. The $20.8M investment activity related to this program over the 2026-2030 period will fund four strategic projects that enhance communication reliability, address deteriorating infrastructure, and meet evolving technology requirements. Furthermore, grid modernization is reliant on the deployment of observation devices targeted at collecting real time data of asset use and performance, these devices in turn are extremely reliant on a reliable and expansive communications network.

5.4. GENERAL PLANT EXPENDITURES

General Plant investments are "modifications, replacements or additions to a distributor's assets that are not part of its distribution system; including land and buildings; tools and equipment; rolling stock, electronic devices and software used to support day to day business and operations activities and capital contributions to other utilities" as per Section 5.1.2 of OEB's Chapter 5 Filing Requirements.

Projects and programs in this category are driven by the requirements for capital expenditures to support day-to-day business and operations activities. There are ten capital programs under General Plant which are described in Table 30.

1 **Table 30 – General Plant Capital Programs**

Capital Program	Program Description
CCRA	Connection Cost Recovery Agreements are capital contributions to intangible assets purchased from other utilities such as Hydro One in conjunction with Hydro Ottawa's major station projects.
Fleet Replacement	Acquisition of vehicles to replace end of life vehicles. The program objective is to provide safe, reliable and efficient vehicles to meet the operational requirements.
Tools Replacement	Tools are needed to carry out the distribution maintenance and capital program efficiently and effectively, this program covers replacement of aged tool equipment.
Buildings - Facilities	The program addresses the necessary building improvements for the administrative buildings [10], storage and fleet garage space to ensure employees have a safe and efficient environment to operate within.
Grid Technology	This program addresses the maintenance and upgrade of tools and software that supports modernization of grid operations, integrates new technologies like DERs and supports grid planning. The program focuses on network visualization and management, data collection and archiving, and network modelling and simulation.
Meter to Cash	This program supports critical business functions such as billing, meter reading, collections, and financial reporting. Upcoming upgrades to systems like Oracle's Customer Care & Billing (CC&B) and Advanced Metering Infrastructure (AMI) aim to ensure compliance, improve customer self-service options, and address end of life infrastructure.
Customer Engagement Platform	This program encompasses tools such as MyAccount, outage communication systems, and energy management platforms. It prioritizes enabling intuitive self-service, delivering detailed energy insights, and enhancing customer satisfaction through seamless digital experiences.
Enterprise Solutions	This program focuses on maintaining and upgrading applications such as ERP and IT Service Management systems. These enhancements ensure business continuity, streamline workflows, and reduce cyber security risks.
Infrastructure & Cyber Security	This program invests in strengthening IT systems to protect against cyber threats, maintain data integrity, and support business continuity. The program aims to ensure systems are secure, scalable, and aligned with industry best practices to safeguard critical infrastructure.
Data and System Integrations	This program consolidates fragmented data systems to create an integrated, reliable, and efficient framework. It aims to reduce manual interventions, enable real-time decision-making, and ensure compatibility across platforms to support both operational and strategic initiatives.

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[10] As of January 1, 2026, Dibblee and Maple Grove Operations Centres are reclassified under System Renewal - Stations and Operations to better align with USofA definitions

The Capital Programs under General Plant are categorized by Budget Program, as shown in Table 31, which also identifies the corresponding primary driver. For General Plant, the Capital Program and Budget Program classifications are equivalent. Please refer to Section 5.3.1.1 of Schedule 2-5-4 - Asset Management Process for the driver definitions.

Table 31 – General Plant Expenditure Categories

Capital Program	Budget Program	Primary Driver
CCRA	CCRA	System Investment Support
Fleet Replacement	Fleet Replacement	System Investment Support
Tools Replacement	Tools Replacement	System Investment Support
Buildings - Facilities	Buildings -Facilities	System Investment Support
Grid Technology	Grid Technology	Business Operations Support
Meter to Cash	Meter to Cash	Business Operations Support
Customer Engagement Platform	Customer Engagement Platform	Business Operations Support
Enterprise Solutions	Enterprise Solutions	Business Operations Support
Infrastructure and Cyber security	Infrastructure and Cyber security	Business Operations Support
Data and System Integrations	Data and System Integrations	Business Operations Support

5.4.1. Historical Expenditures

The following tables present Hydro Ottawa's General Plant Capital Expenditures from 2021 through 2025 compared to the OEB Approved amounts. Table 32 details this spending on a five-year total basis, while Table 33 provides the annual spending and variances.

Table 32 - Net General Plant Historical & Bridge Spending versus OEB Approved ($'000)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
CCRA	$ 26,658	$ 16,964	$ (9,695)	(36)%
Fleet Replacement	$ 16,681	$ 17,598	$ 917	5%
Tools Replacement	$ 2,343	$ 3,161	$ 818	35%
Buildings - Facilities	$ 2,066	$ 6,970	$ 4,904	237%
Grid Technology	$ 1,760	$ 1,952	$ 192	11%
Meter to Cash	$ 6,983	$ 3,582	$ (3,401)	(49)%
Customer Engagement Platform	$ 1,990	$ 7,497	$ 5,507	277%
Enterprise Solutions	$ 12,630	$ 5,706	$ (6,924)	(55)%
Infrastructure and Cyber security	$ 7,474	$ 7,845	$ 371	5%
Data and System Integrations	$ 1,608	$ 1,553	$ (55)	(3)%
TOTAL CAPITAL EXPENDITURES	**$ 80,193**	**$ 72,827**	**$ (7,367)**	**(9)%**

As noted above, Table 33 below provides the annual variance against the OEB Approved for each of the ten capital programs under General Plant, the table is divided into three sections with the OEB Approved amounts first, followed by the historical actuals, and then the annual variances.

1 Table 33 - Net General Plant Historical Spending versus OEB Approved - Annual ($'000)

Capital Program	2021	2022	2023	2024	2025
	OEB-Approved (Net of Contribution)				
CCRA	$ 16,918	$ 210	$ 200	$ 5,130	$ 4,200
Fleet Replacement	$ 6,247	$ 4,526	$ 2,220	$ 1,681	$ 2,008
Tools Replacement	$ 474	$ 474	$ 462	$ 465	$ 469
Buildings - Facilities	$ 428	$ 428	$ 403	$ 403	$ 403
Grid Technology	$ 261	$ 427	$ 271	$ 424	$ 376
Meter to Cash	$ 2,529	$ 2,238	$ 605	$ 605	$ 1,008
Customer Engagement Platform	$ 924	$ 423	$ 241	$ 221	$ 181
Enterprise Solutions	$ 1,138	$ 744	$ 302	$ 4,932	$ 5,513
Infrastructure and Cyber security	$ 2,151	$ 1,132	$ 1,176	$ 1,260	$ 1,755
Data and System Integrations	$ 470	$ 272	$ 328	$ 222	$ 316
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 31,540**	**$ 10,874**	**$ 6,208**	**$ 15,343**	**$ 16,228**
	Historical Years			Bridge Years	
CCRA	$ 16,903	$ (2,318)	$ (3,752)	$ 1,730	$ 4,400
Fleet Replacement	$ 1,258	$ 4,654	$ 5,440	$ 3,245	$ 3,002
Tools Replacement	$ 704	$ 564	$ 393	$ 927	$ 574
Buildings - Facilities	$ 555	$ 2,085	$ 2,208	$ 1,599	$ 523
Grid Technology	$ 514	$ 192	$ 443	$ 425	$ 377
Meter to Cash	$ 510	$ 1,383	$ 1,083	$ 252	$ 353
Customer Engagement Platform	$ 551	$ 1,189	$ 2,168	$ 2,589	$ 1,000
Enterprise Solutions	$ 968	$ 1,250	$ 1,795	$ 1,023	$ 670
Infrastructure and Cyber security	$ 1,261	$ 1,934	$ 1,922	$ 1,815	$ 911
Data and System Integrations	$ 49	$ 329	$ 446	$ 361	$ 368
TOTAL HISTORICAL/BRIDGE NET CAPITAL EXPENDITURES	**$ 23,273**	**$ 11,262**	**$ 12,146**	**$ 13,967**	**$ 12,179**
	Variance ($)				
CCRA	$ (15)	$ (2,528)	$ (3,952)	$ (3,400)	$ 200
Fleet Replacement	$ (4,989)	$ 128	$ 3,220	$ 1,564	$ 994
Tools Replacement	$ 230	$ 89	$ (69)	$ 462	$ 105
Buildings - Facilities	$ 127	$ 1,657	$ 1,805	$ 1,196	$ 120

Capital Program	2021	2022	2023	2024	2025
Grid Technology	$ 253	$ (235)	$ 172	-	$ 1
Meter to Cash	$ (2,019)	$ (855)	$ 479	$ (352)	$ (654)
Customer Engagement Platform	$ (374)	$ 766	$ 1,927	$ 2,368	$ 819
Enterprise Solutions	$ (170)	$ 506	$ 1,492	$ (3,909)	$ (4,843)
Infrastructure and Cyber security	$ (890)	$ 802	$ 747	$ 555	$ (844)
Data and System Integrations	$ (421)	$ 57	$ 117	$ 139	$ 52
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ (8,267)**	**$ 388**	**$ 5,938**	**$ (1,376)**	**$ (4,049)**

5.4.2. Historical Variances

Over the five-year period, General Plant Net Capital Expenditures were $7.4M, or 9%, below the OEB Approved amount.

It is important to note that the CCRA capital program has a symmetrical Group 2 account[11] due to the sometimes unpredictable nature of costs and timing. Excluding the CCRA Program, the overall General Plant program is projected to exceed the OEB Approved budget by $2.3M, or 4%. This is attributed to several new required initiatives and inflationary pressures, partially offset by deliberate deferrals, such as the ERP Project, to mitigate the overall budget overrun.

General Plant also has an asymmetrical capital variance account, requiring any cumulative underspending to be returned to ratepayers. However, overspending does not result in amounts being recorded in this account. The variances discussed below are based on the total five-year variance by program (Table 32), while Table 33 shows annual variances. These annual variances are largely due to circumstances beyond Hydro Ottawa's control, including the pandemic, significant supply chain disruptions, severe weather events in 2022 and 2023, and an 84-day strike in 2023. These disruptions during 2021-2023 resulted in underspending recorded

[11] Note: The Group 2 accounts reflect capital additions, while this schedule reflects capital expenditures. For capital additions information, refer to Schedule 2-1-1 Rate Base Overview

in the asymmetrical capital variance account, as noted in Schedule 9-1-3 - Group 2 Accounts. However, it is expected that the cumulative position at the end of 2025 will be a total overspend.

Key contributing factors:

- **Unforeseen Events:** COVID-19 pandemic, severe weather and the strike caused delays in some programs while other programs severe weather required additional spending in Grid Technology and influencing the deferral of the ERP project.
- **Changes in Project Scope or Requirements:** Evolving needs to meet new regulatory obligations and customer requirements.
- **Inflationary Pressures:** Significant increases in materials, outside services, vehicle costs and technology costs due to inflation were observed, for additional details refer to Section 4 of Schedule 1-2-5 - Impact of Inflationary Pressures).

CCRA

The CCRA Program is expected to be $9.7M below the total OEB Approved amount for 2021-2025. The largest contributors to this underage were the Hydro One payments associated with transmission upgrades for Cambrian MTS (the project was $5.6M under budget), and the A6R true-up, which was $2M under budget. As noted above please refer to Sections 2.3 and 2.4 of Schedule 9-1-3 - Group 2 Accounts, for further details on the CCRA deferral and variance accounts. The specific projects in this program during 2021-2025 are shown in Table 34.

Table 34 - 2021 - 2025 CCRA Payments ($'000s)

CCRA Payments	Historical Years			Bridge Years		Total
	2021	2022	2023	2024	2025	2021-2025
Richmond South DS	$ 33	-	-	-	-	$ 33
Cambrian MTS	$ 16,056	$ 113	$ (5,704)	-	-	$ 10,465
A6R Upgrade	-	$ (2,019)	-	$ 730	-	$ (1,289)
Merivale MTS Rebuild	$ (151)	-	-	-	-	$ (151)
Slater T1 Emergency	-	-	$ 504	-	-	$ 504
Limebank MS T4	$ 29	-	-	-	-	$ 29
Overbooke TO Switchgear Upgrade	$ 251	$ 339	$ 6	-	-	$ 595
Riverdale TR	-	-	-	-	$ 400	$ 400
Piperville MTS	-	-	$ 685	$ 1,000	$ 3,000	$ 4,685
Uplands MTS Rebuild	$ 2	$ 58	-	-	-	$ 60
Hawthorne 115 kV	$ 680	$ (891)	-	-	-	$ (211)
Lincoln Heights B2 Bus	$ 4	$ 82	$ 8	-	-	$ 95
Woodroffe TW Metering	-	-	$ 33	-	-	$ 33
Brian Colburn Station	-	-	-	-	$ 1,000	$ 1,000
Terry Fox MTS	-	-	$ 715	-	-	$ 715
TOTAL	**$ 16,903**	**$ (2,318)**	**$ (3,752)**	**$ 1,730**	**$ 4,400**	**$ 16,964**

Fleet Replacement

The Fleet Replacement Program is expected to be $0.9M or 5% above the 2021-2025 OEB Approved level. The cost overage is primarily a result of increased vehicle unit cost due to inflation and also the decision to replace some vehicles with electric or hybrid which typically carry a price premium. Hydro Ottawa received $0.1M in EV rebates on the purchase of E-Transit vans which is included under Capital Contributions. To offset some of the cost, nine vehicles slated for replacement during this period were deferred to a future period.

Tools Replacement

The Tools Program is expected to be $0.8M or 35% above the 2021-2025 OEB Approved level.

This overage is primarily driven by a higher than usual amount of tools with long lifespans reaching the end of their useful lives and requiring replacement. The original estimate was based on historical cost per employee and therefore did not capture the anomalous increase required in this period. The variance is further explained by the purchase of new defibrillators for fleet vehicles and a Customer Battery Pilot program, initiated during the COVID-19 pandemic to ease the burden of customers working from home during planned power outages. This program also experienced a number of general inflationary pressures.

Buildings - Facilities

The Buildings - Facilities Program is expected to be $4.9M or 237% above the 2021-2025 OEB Approved level. Capital expenditures were higher than planned due to the following projects that were not envisioned when the capital plan was developed for the 2021-2025 Custom IR Application:

- Construction of a shared access roadway at the East entrance to the Hunt Club Road facility - this was an externally driven project which was foreseen during the construction of the new facility, but was originally planned for construction after 2025. The third party developer subsequently advanced the construction schedule to 2022. Although ahead of schedule, this new roadway provides a secondary access point to the facility and operations center, which enhances site access and contributes to a safer and more efficient operational environment. The cost of this project was shared with the third party.
- To support the growth of Hydro Ottawa's electric vehicle fleet, charging stations were installed at all Operations Facilities. The decision to accelerate its electric vehicle purchases was driven by advancements in technology, availability, and more attractive pricing. The 2021-2025 application was prepared when suitable electric work vehicles were scarce and largely untested. The installation of charging stations was therefore a prerequisite for transitioning to electric vehicles. Hydro Ottawa received $0.3M in government funding for the charging stations, which is included under Capital Contributions.
- Lastly, two unforeseen health and safety hazards were reported that were required to be addressed in this period. One was a new HVAC/ventilation unit that was installed at the

Bank Street garage to address health and safety concerns and comply with Ministry of Labour standards for garage ventilation. The second was the creation of additional storage space to reduce trip hazards and congestion in the fleet garage, while also providing improved conditions for vehicle servicing and training.

Grid Technology

The Grid Technology - Operations Initiatives is projected to exceed the 2021-2025 OEB Approved level by an amount of $0.2M largely due to inflationary pressures.

Meter to Cash

The Meter to Cash Program is projected to be $3.4M, or 49%, below the 2021-2025 OEB Approved amount, primarily due to underspending on the AMI Analytics & Integration Enablement project.

The AMI Analytics & Integration Enablement project, as detailed in the 2021-2025 rate application, did not reach its planned expenditure due to unforeseen challenges and changing priorities. Significant delays, caused by external factors like the COVID-19 pandemic, the 2022 Derecho, and the 2023 strike, necessitated project scope and timeline adjustments. Concurrently, the evolving AMI landscape and the need for enhanced grid modernization capabilities prompted a reevaluation of the project's objectives.

In 2022, Hydro Ottawa successfully upgraded its critical smart meter data infrastructure from Elster MAS to Honeywell Connexo version 12.2. Originally estimated at $1.2M, the upgrade cost was reduced to $420,000 due to a negotiated discount. While initially planned for early 2021, the upgrade was delayed until March 2022 due to prolonged software product delays. A minor upgrade, typically scheduled every five years to mitigate technology obsolescence, cyber security risks, and escalating support costs, was planned for 2025. However, due to the Honeywell 12.2 product delay, this upgrade has been deferred to 2027 and aligned with the AMI 2.0 program.

Ultimately, Hydro Ottawa prioritized the development of a comprehensive AMI 2.0 Metering Renewal Program, ensuring investments were directed towards a future-proofed solution for long-term grid modernization and customer needs. For more information on the Metering Renewal Program, please refer to Section 5 of Schedule 2-5-7 - System Renewal Investments.

Customer Engagement Platforms

The $5.5M, or 277%, overage is primarily due to professional service fees for developing and enhancing Hydro Ottawa's customer portal, "MyAccount," for web and mobile applications. MyAccount is a key engagement channel, providing all customer classes with self-service tools for managing electricity usage, billing, payments, service requests, outage information, preference management, and moves. The portal had evolved organically over two decades, resulting in an interconnected system of multiple web and mobile technologies, services, and solutions. While this solution served the company well, rapid technological change, increasing customer experience demands, a dynamic energy industry, and Hydro Ottawa's continued growth rendered it unable to scale or adapt, making it inadequate for future needs.

Consequently, Hydro Ottawa opted to redesign its aging customer portal on a unified platform with a refreshed user interface, a new foundational architecture, a modernized technology stack, and a focus on enhanced customer experience. This new architecture will enable seamless integration of future enhancements and adaptation to evolving customer needs. The redesign also included a new administrator portal, improving agent experience and streamlining customer service. A proven implementation partner was selected to assist in the redesign, with scope and priorities overseen by the Customer Experience (CX) Steering Committee. This initiative, identified as a significant need after the 2021-2025 rate application filing, was not budgeted. The original budget only covered minor enhancements and support for the legacy platform and did not account for the redesign.

The stated scope was further expanded due to emerging regulatory obligations and necessary customer self-service enhancements. Examples include the implementation of Ultra-Low Overnight (ULO) rate options, Net Metering, Green Button, Equal Monthly Payment Plan

(EMPP) automation, Autopay registration, and Move In Move Out (MIMO) automation. This investment has positioned Hydro Ottawa to better meet customer needs, adapt to unforeseen disruptions, and demonstrates the company's commitment to continuous customer experience and engagement enhancement

Enterprise Solutions

Enterprise solutions are expected to be $6.9M or 55% below the OEB approved level primarily due to the deferral of the new Enterprise Resource Planning (ERP) system.

After careful consideration, Hydro Ottawa decided to defer its ERP program as initially planned over the 2021-2025 term. The original plan called for selection of new ERP software in 2023, design and execution in 2024 with a go-live launch at the end of 2025. Like many organizations, the global pandemic shifted priorities, caused supply chain challenges, cost constraints and more. Further, Hydro Ottawa experienced an unusual number of climate events including the May 2022 Derecho that had devastating impacts across the community necessitating a whole-of-company response shifting priorities once again. Additionally, in March 2023, collective bargaining talks broke down resulting in approximately 390 unionized staff commencing legal strike action a few months later, which lasted 84 days and shifted priorities once again. This, coupled with the findings on the asset management side that necessitated an Enterprise Asset Management (EAM) system which was not originally scoped in during the preliminary planning in 2018, alongside significant inflationary pressures in the technology space since COVID, would have resulted in a significant overrun on this project. Finally, Oracle announced that JD Edwards EnterpriseOne ERP (version 9.2) support would be extended to at least December 2035 (note that Oracle has been extending the support announcements since April 2017 when support was to be terminated in October 2028). Based upon all of these factors, coupled with the overspends in the other investment categories, management decided to defer the project.

Initially the ERP project was proposed for the 2026-2030 timeframe; however, given competing priorities it was decided Hydro Ottawa would continue to leverage its current JD Edwards ERP version for the 2026-2030 period but will focus on improving Enterprise Asset Management processes and technology (refer to Attachment 4-1-1(A) - Transition to Cloud Computing for additional details on the EAM system).

Offsetting this is a $2.7M investment in IT Service Management (Service Now) which includes subscription and professional services fees for three modules: ITSM, ITOM, and SPM. IT Service Management (ITSM) aimed to improve IT Helpdesk productivity and employee experience through a unified cloud and mobile solution. IT Operations Management (ITOM) focused on reducing cyber risk via centralized asset and configuration management. Strategic Portfolio Management (SPM) aimed to streamline IT business demand management and enhance project portfolio visibility. This investment modernized IT service management capabilities by replacing an aging on-premise ticketing system with the ServiceNow cloud platform, a need identified after the 2021-2025 rate application filing.

Infrastructure & Cyber Security

The Infrastructure & Cyber Security program is expected to be $0.4M or 5% above the OEB Approved amount for 2021-2025. The main drivers for the variance are due to inflationary costs of software licenses, computer equipment (laptops and mobile devices), network appliances including firewalls, switches, wireless access points and data center. License true-up costs related to Microsoft and other software also contributed to the increase.

Data and System Integrations

Data and System Integrations spending is not expected to have a material variance from the OEB Approved level.

5.4.3. Forecast to Historical Variance by Capital Program

The annual spend for General Plant is expected to average $26.8M (gross) over the 2026-2030 period, which is an increase from the $15.3M average annual spend during the 2021-2025 timeframe.

Table 35 below provides a comparison of the 2021-2025 historical period and the 2026-2030 forecast period, detailing both the five-year totals and annual averages for each program.

Table 35 – General Plant Forecast Expenditures Test Years Expenditures by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
CCRA	$ 16,964	$ 45,859	$ 28,895	$ 3,393	$ 9,172	$ 5,779
Fleet Replacement	$ 17,698	$ 40,593	$ 22,894	$ 3,540	$ 8,119	$ 4,579
Tools Replacement	$ 3,161	$ 4,878	$ 1,717	$ 632	$ 976	$ 343
Buildings - Facilities	$ 7,295	$ 6,551	$ (744)	$ 1,459	$ 1,310	$ (149)
Grid Technology	$ 1,952	$ 4,296	$ 2,345	$ 390	$ 859	$ 469
Meter to Cash	$ 3,582	$ 8,850	$ 5,268	$ 716	$ 1,770	$ 1,054
Customer Engagement Platform	$ 7,497	$ 2,522	$ (4,975)	$ 1,499	$ 504	$ (995)
Enterprise Solutions	$ 5,706	$ 1,429	$ (4,277)	$ 1,141	$ 286	$ (855)
Infrastructure and Cyber security	$ 10,999	$ 15,370	$ 4,371	$ 2,200	$ 3,074	$ 874
Data and System Integrations	$ 1,553	$ 3,482	$ 1,929	$ 311	$ 696	$ 386
TOTAL GENERAL PLANT	**$ 76,405**	**$ 133,830**	**$ 57,425**	**$ 15,281**	**$ 26,766**	**$ 11,485**
Capital Contributions[12]	$ (3,579)	$ (12,629)	$ (9,050)	$ (716)	$ (2,526)	$ (1,810)
NET GENERAL PLANT	**$ 72,827**	**$ 121,201**	**$ 48,375**	**$ 14,565**	**$ 24,240**	**$ 9,675**

Details on Hydro Ottawa's General Plant Capital Programs from 2026 through 2030 are included in Schedule 2-5-9 - General Plant Investments but a brief overview of the changes in spend between the historical period and the forecast period is provided below.

CCRA Payments

The annual spend for CCRA payments is expected to average $9.2M over the 2026-2030 period, which is an increase from the $3.4M average spend during the 2021-2025 timeframe. As

[12] Capital Contributions for Test Years 2026 and 2027 also include additions for PILS Contributions of $5,066 and $4,096 respectively. Please see Schedule 9-1-4 (section 7) and Schedule 6-1-1 (section 4) for further explanation.

with the previous, application, Hydro Ottawa has requested continuance of the deferral and variance account for this program, please refer to Schedule 9-1-3 - Group 2 Accounts.

This increase is primarily driven by the increased number of transmission upgrades required to service new and upgraded stations to support the growing community.

Fleet Replacement

The annual spend for Fleet Replacement is expected to average $8.1M over the 2026-2030 period which is an increase from the $3.5M average annual spend during the 2021-2025 timeframe. This increase is driven by two key factors: First, the need to support additional staff as detailed in Attachment 4-1-3(C) - Workforce Growth, requires additional vehicles. Second, a significant portion of the existing fleet is required to be replaced based on deteriorating condition as detailed in Section 11 of Schedule 2-5-9 - General Plant Investments.

Tools Replacement

The annual spend for Tools Replacement is expected to average $1.0M over the 2026-2030 period which is an increase from the $0.6M average annual spend during the 2021-2025 timeframe. This increase is driven by additional tool requirements to supply additional staff across the organization as indicated in Attachment 4-1-3(C) - Workforce Growth.

Buildings - Facilities

The annual spend for Buildings - Facilities is expected to average $1.3M over the 2026-2030 period which is a slight decrease from the $1.5M average annual spend during the 2021-2025 timeframe. Although on a net basis there is very little change on an annual basis, as the 2021-2025 average annual gross spend excludes $0.3M in government funding received to subsidize the cost of electric vehicle chargers. The Dibblee and Maple Grove Operations Centres were reclassified to the System Renewal Investment Category for better alignment with regulatory reporting requirements. Buildings - Facilities spending for 2026-2030 is driven by: interior improvements for new staff, sewer connection for the Bank St. facility, and electrical service upgrades for decarbonization and energy efficiency.

Grid Technology

The annual spend for Grid Technology is expected to average $0.9M over the 2026-2030 period which is an increase from the $0.4M average annual spend during the 2021-2025 timeframe. This increase is driven by a need to digitize and augment key functions like planning and design through data management, analytics, system integration, and grid simulation capabilities.

Meter to Cash

The annual spend for Meter to Cash is expected to average $1.8M over the 2026-2030 period which is an increase from the $0.7M average annual spend during the 2021-2025 timeframe. This increase is due to planned AMI critical infrastructure upgrades in 2027 and an upgrade to Hydro Ottawa's CC&B CIS system in 2028. For more information on the AMI 2.0 Metering Renewal Project, refer to Section 5 of Schedule 2-5-7 - System Service Investments. For more information on the AMI system and CC&B CIS upgrades, refer to Section 2 of Schedule 2-5-9 - General Plant Investments.

Customer Engagement Platform

The annual spend for Customer Engagement Platform is expected to average $0.5M over the 2026-2030 period which is a decrease from the $1.5M average annual spend during the 2021-2025 timeframe. This decrease is anticipated because the majority of the work required to redesign Hydro Ottawa's Customer Portal "MyAccount" was completed in the 2021-2025 timeframe.

Enterprise Solutions

The annual spend for Enterprise Solutions is expected to average $0.3M over the 2026-2030 period which is a decrease from the $1.1M average annual spend during the 2021-2025 timeframe. This decrease is anticipated because the majority of the work required to implement IT Service Management "ServiceNow" was completed in the 2021-2025 timeframe and as noted above the new ERP project was reprioritized beyond 2030.

Infrastructure and Cyber Security

The annual spend for Infrastructure and Cyber Security is expected to average $2.4M over the 2026-2030 period which is an increase from the $1.6M average annual spend during the 2021-2025 timeframe. These averages are net of the $3.2M and $3.5M Scientific Research and Experimental Development (SRED) tax incentive totals from the 2021-2025 and 2026-2030 periods, respectively. This increase is due to the expanded infrastructure footprint for both IT and Operational Technology (OT) as more technologies are required to support the current and future initiatives. See Section 2.3.4 of Schedule 2-5-1 - Distribution System Plan Overview for references to the National Cyber Threat Assessment 2025-2026 published by the Canadian Centre for Cyber Security and discussion supporting the need to combat increased cyber threats, particularly in areas of critical infrastructure such as the energy sector[13].

Data and System Integrations

The annual spend for Data and System Integrations is expected to average $0.7M over the 2026-2030 period which is an increase from the $0.3M average annual spend during the 2021-2025 timeframe. This increase is predominantly due to escalating requirements to connect IT/OT cloud and on-premise systems, to manage future data needs in support of grid modernization, customer experience initiatives and finally automations which drive productivity and operational efficiencies.

[13] Canadian Centre for Cyber Security, "National Cyber Threat Assessment 2025-2026," https://www.cyber.gc.ca/sites/default/files/national-cyber-threat-assessment-2025-2026-e.pdf

6. IMPACT ON OPERATION AND MAINTENANCE COSTS

6.1. OVERVIEW

System Operations and Maintenance (System O&M) expenditures are crucial for ensuring the reliable and safe operation of the electrical distribution system. The primary factors for these expenditures are asset and system maintenance needs, compliance obligations, and the resource requirements to handle a higher volume and greater complexity of work.

Capital investments, such as those for new equipment and upgrades, have an impact on System O&M costs. Table 36 presents the Total Gross Capital Expenditure and System O&M by Program. This table allows for a broad understanding of how capital spending and System O&M costs are distributed across various utility programs.

The programs encompassing system operations and maintenance costs for the 2021-2026 period are discussed at length in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs and this section should be read in conjunction with that schedule. Table 36 reflects System O&M costs only of these programs while the program costs in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs are total program costs including administrative costs. Note that the total in Table 36 below is also reflected in the Appendix 2-AB as System O&M and also the Operations and Maintenance subtotal in Appendix 2-JA. To provide a high-level overview of the relationship between capital expenditures and System O&M costs, the total gross capital expenditures are also reflected in Table 36 with System O&M shown as a percentage of the total gross capital expenditures. The percentage fluctuates largely due to storm activity and major event days and the reactive unplanned nature of those expenses.

Table 36 – Total Gross Capital Expenditure and System O&M by Program ($'000s)

Program	Historical Years			Bridge Years		Test Year
	2021	2022	2023	2024	2025	2026
Engineering & Design	$ 5,420	$ 5,861	$ 6,456	$ 7,549	$ 7,129	$ 13,232
System Ops & 24/7	$ 4,612	$ 9,323	$ 8,029	$ 5,976	$ 6,640	$ 6,423
Vegetation Management	$ 3,811	$ 6,720	$ 6,257	$ 6,430	$ 5,822	$ 6,149
Facilities	$ 4,946	$ 5,472	$ 4,753	$ 6,039	$ 6,223	$ 6,750
U/G Locates	$ 3,273	$ 3,538	$ 3,389	$ 4,666	$ 5,285	$ 6,027
Distribution Support	$ 251	$ 2,528	$ 3,922	$ 6,420	$ 4,789	$ 4,670
Distribution O/H & U/G Maintenance	$ 2,110	$ 2,591	$ 8,085	$ 3,070	$ 3,016	$ 2,714
Stations Maintenance	$ 2,670	$ 2,710	$ 2,888	$ 3,454	$ 4,167	$ 5,033
Testing, Inspection & Maintenance	$ 1,470	$ 1,433	$ 1,555	$ 2,221	$ 2,820	$ 8,894
Metering	$ 1,594	$ 1,910	$ 1,487	$ 1,876	$ 1,890	$ 1,970
Minor Maintenance	$ 1,297	$ 1,317	$ 1,250	$ 846	$ 990	$ 1,669
Other	$ 342	$ 377	$ 13	$ 72	$ 92	$ 259
Total System O&M	**$ 31,798**	**$ 43,779**	**$ 48,082**	**$ 48,619**	**$ 48,864**	**$ 63,790**
Total Gross Capital Expenditure	**$ 138,635**	**$ 137,808**	**$ 123,132**	**$ 173,403**	**$ 189,435**	**$ 309,118**
Total System O&M as a Percentage of Total Gross Capital Expenditure	22.9%	31.8%	39.0%	28.0%	25.8%	20.6%

The relationship between capital investments and ongoing System O&M is influenced by several key factors:

- **Scheduled Maintenance:** A portion of maintenance activities, as mandated by regulatory requirements such as the Distribution System Code, are performed on a predetermined schedule and are largely unaffected by capital investment decisions.
- **Asset Expansion:** An increase in the asset base typically results in a corresponding increase in System O&M requirements, including but not limited to, testing and inspections.

- **Technological Advancement:** The implementation of modern technologies may initially result in increased System O&M expenditures. However, these advancements can yield long-term System O&M efficiencies through features such as remote monitoring and diagnostic capabilities.

- **Asset Replacement and Lifecycle Management:** While the replacement of deteriorating assets with newer models generally results in reduced maintenance requirements, particularly during the initial phase of their lifecycle, the continuous cycle of asset replacement leads to a consistent influx of assets progressing through their respective lifecycles. Additionally, Hydro Ottawa's proposed asset replacement rate does not maintain pace with the rate at which assets are reaching their typical useful life. Consequently, as assets age and reach conditions of poor or very poor state, the volume of testing and inspection activities may increase to support the growing risk associated with the aging population. This dynamic reflects the ongoing management of an asset portfolio with varying stages of deterioration.

6.2. SYSTEM O&M ANNUAL VARIANCES

System O&M variances are also detailed and included in the overall program variances as detailed in Schedule 4-1-2 - Operating, Maintenance & Administration Program Costs and this section should be read in conjunction with that section.

During the 2021-2025 period, fluctuations in System O&M expenditures were primarily driven by factors such as the impacts of the COVID-19 pandemic, including the highest inflation Canada had seen in 40 years, the May 2022 Derecho storm, a series of other weather events, the 84-day labor strikes, investments in technology and other changes to distribution maintenance programs. For more information on the inflationary pressures over the 2021-2025, refer to Schedule 1-2-5 - Impacts of Inflationary Pressures.

- 2022 Actuals vs. 2021 Actuals
  - System O&M Expenditures were $12.0M higher in 2022 compared to 2021, largely due to the reactive maintenance costs and emergency vegetation following the May Derecho storm, as well as increases in distribution maintenance, and inflationary pressures.
- 2023 Actuals vs. 2022 Actuals
  - Expenditures were $4.3M higher in 2023 compared to 2022. While a portion of the previous year costs were non-recurring (May Derecho), numerous other weather events also occurred again in 2023 (April ice storm, summer lightning storms, tornadoes) increasing unplanned maintenance costs. Several storms, including the tornadoes, occurred during the labour strike, requiring the use of contracted resources and management to complete work.
- 2024 Bridge Year vs. 2023 Actuals
  - Expenditures are expected to be relatively unchanged from 2024 to 2023 on a total basis.
- 2025 Bridge Year vs. 2024 Bridge Year
  - Expenditures are expected to be relatively unchanged from 2025 to 2024 on a total basis.
- 2026 Test Year vs. 2025 Bridge Year
  - Expenditures are expected to increase $14.9M in the 2026 Test Year relative to the 2025 Bridge Year due to increased spend in the Testing, Inspection, & Maintenance program as Hydro Ottawa implements more comprehensive inspections, maintenance of Non-Wires Solutions, and asset refurbishments designed to extend typical useful life. For additional details, refer to Schedule 4-1-2 - Operating, Maintenance & Administration Program Costs. In addition, the development of a cloud-based Enterprise Asset Management solution also increases Engineering &

Design spending in 2026 (Refer to Attachment 4-1-1(A) - Transition to Cloud Computing for more details on this project).

6.3. 2026-2030 CAPITAL PROJECT IMPACTS ON SYSTEM O&M

Capital investment projects have varying impacts on System O&M costs depending on their nature. System Access, System Renewal, System Service and General Plant initiatives each present unique operational demands, sharing some common impacts on maintenance but also diverging in their specific requirements. For instance, while all capital projects might necessitate increased asset maintenance through expansion of the asset base, System Access drives O&M through new customer connections leading to increased service calls and underground locates, whereas System Renewal focuses on managing deteriorating infrastructure, leading to a rise in inspection and testing activities. The following sections provides a high level overview of the System O&M impacts by investment category:

6.3.1. System Access

The significant increase in System Access net capital investments, with an average annual expenditure of $39.2M (up from $31.7M in 2021-2025), is expected to drive increases in System O&M costs. Primarily, the rise in customer connection requests is expected to lead to higher System O&M expenditures through increased meter maintenance, more frequent service calls, and the need for additional locates. The expansion of the system, driven by large infrastructure projects and demand growth, will also necessitate higher System O&M due to the increased number of assets requiring testing, inspection and maintenance. Specifically, new generation connections will require ongoing maintenance of connection equipment, and the growth in metering installations will directly increase meter maintenance and testing costs. Plant relocation projects, while transitioning to a lower expenditure phase, will still contribute to System O&M through the maintenance of newly relocated or upgraded facilities. Overall, the significant growth in customer connections and system expansion will place upward pressure on System O&M costs.

6.3.2. System Renewal

Hydro Ottawa's renewal strategy faces a critical challenge: the rate of asset aging outpaces the pace of replacement, driving a significant increase in System O&M as shown in Table 36 above. Even with substantial renewal investments, the sheer volume of aging infrastructure demands more frequent and thorough inspections. While some aspects of the renewal program, such as station transformer and switchgear replacements, aim to reduce future maintenance needs, the overall portfolio of aging assets continues to expand. This expansion compels Hydro Ottawa to allocate more resources to proactive System O&M.

More specifically, the increasing number of aging poles and underground cables, even with ongoing replacements, significantly increases the need for rigorous inspection and data collection. This data is critical to pinpoint the most critical assets requiring immediate renewal. Without sufficient System O&M investment, the risk of unexpected failures and subsequent outages rises dramatically.

The focus is now on proactive data-driven maintenance. This involves more frequent inspections, advanced diagnostics, and detailed asset condition assessments. The goal is to gather comprehensive data that allows Hydro Ottawa to strategically deploy its limited renewal funds, targeting the assets that pose the greatest risk. This approach allows for intervention before failures occur, minimizing disruptions to customers.

Hydro Ottawa is adapting to a reality where the rate of asset aging outpaces the rate of replacement. This adaptation requires a strategic increase in System O&M funding, enabling more frequent inspections and data collection. This proactive approach ensures the system's reliability and allows for the most efficient use of renewal dollars, ultimately safeguarding the continuity of power for Ottawa's residents and businesses.

6.3.3. System Service

The significant increase in System Service net capital investments, averaging $93.8M annually (up from $32.2M in 2021-2025), is also expected to increase System O&M. Capacity upgrades, driven by demand growth and electrification, will lead to higher costs associated with the increased System O&M requirements of higher-capacity equipment. Distribution and station enhancements, including investments in system resilience and observability, will also increase System O&M through the maintenance of new assets and the implementation of advanced monitoring systems. The addition of Battery Energy Storage Systems (BESS) will increase System O&M costs primarily due to the specialized upkeep related to the systems. The need for regular software updates, robust cyber security monitoring, and specialized IT support for sophisticated control systems further contributes to rising OM&A expenses. Safety and environmental compliance demands dedicated safety systems and adherence to regulations, while continuous monitoring and data analysis for optimal performance require specialized expertise and tools, often involving third-party contracts. The integration of BESS into existing grid operations adds operational complexity, demanding specialized training and adjustments. Furthermore, the necessity of service contracts to monitor and maintain these complex systems must also be accounted for. The expansion of the field area network and the implementation of control and optimization systems will also increase System O&M through the maintenance of communication infrastructure and the operation of advanced grid management tools. Overall, the substantial investments in system service will drive a significant increase in System O&M costs, reflecting the need to support a more complex and technologically advanced electrical grid.

6.3.4. General Plant

The increase in General Plant gross capital investments, averaging $26.8M annually (up from $15.3M annually in 2021-2025), is expected to have a modest impact on System O&M costs. The increased number of fleet vehicles will incur a higher amount of maintenance and fuel costs, although the addition of electric vehicles and the pooling of vehicles (discussed in Schedule 2-5-9 - General Plant Investments) are expected to offset a portion of these costs.

6.4. OTHER SYSTEM O&M FACTORS

Beyond the direct impacts of capital investments, several other factors also influence the overall level of System O&M costs. These include evolving inspection and maintenance practices, vegetation management strategies, and the operational demands of underground locate services. Each of these elements introduces unique cost considerations and operational complexities that contribute to the comprehensive picture of System O&M expenditures. Further details are provided in Schedule 4-1-2 - Operating, Maintenance & Administration Program Costs.

6.4.1. Inspections and Maintenance

Hydro Ottawa is enhancing its Testing, Inspection, and Maintenance (TIM) program to proactively address deteriorating infrastructure and evolving environmental conditions. The program will leverage advanced data collection and analysis techniques, including drone inspections and comprehensive asset health indexing, to transition from time-based to condition-based maintenance. This data-driven approach allows for more accurate condition assessments and targeted interventions, extending the useful life of assets and mitigating reliability risks.

Key initiatives include:

- **Comprehensive Inspection Programs:** Implementing detailed thermographic inspections and advanced techniques for underground cables (Very Low Frequency Tan-Delta, Partial Discharge, and Time Domain Reflectometry) to identify vulnerabilities.
- **Data Collection Enhancements:** Capturing detailed visual and infrared scan information of asset components, including pole-mounted transformers, switches, and vault equipment.
- **Innovation through Technology:** Piloting drone inspections and exploring the use of artificial intelligence for enhanced condition assessment.
- **Asset Intervention/Refurbishment Strategies:** Implementing proactive maintenance for targeted replacement of degrading components, such as bushings, insulators, and splices.

The increased investments in the TIM program will improve asset health data. The transition to a condition-based maintenance program, supported by an Enterprise Asset Management (EAM) solution, will optimize asset lifecycle management and enable data-driven decision-making and further improve the advanced analytics from Copperleaf PA.

6.4.2. Vegetation Management

Hydro Ottawa will leverage Overstory, a software solution that uses AI and remote sensing, to optimize vegetation management practices. This will enhance reliability and cost-effectiveness by enabling data-driven decisions to prioritize routine tree-trimming based on current conditions, mitigating the risks posed by hazardous trees and thereby reducing both reactive maintenance and the number of outages caused by tree contact. System O&M costs for vegetation management are not expected to decrease in the 2026-2030 rate period, as Hydro Ottawa contends with the long-term impacts of the 2022 and 2023 storms. These storms compromised tree health, which contributed to an elevated level of spending to address the damage.

6.4.3. Underground Locates

Bill 93, the Getting Ontario Connected Act, 2022, has increased Hydro Ottawa's operational expenditures to meet legislated timelines. The limited number of qualified service providers in the region creates a less competitive market for underground locate services, impacting pricing. However, using a third-party clearing house to verify underground infrastructure presence has reduced on-site visits and yielded significant cost savings. Despite these savings, System O&M costs are still increasing significantly due to inflation, rising contractor costs driven by mandated timelines, and increased volume.

Attachment 2-5-5 (A) - OEB Appendix 2-AA - Capital Programs Table

(Refer to the attachment in Excel format)

Attachment 2-5-5 (B) - OEB Appendix 2-AB - Capital Expenditure Summary

(Refer to the attachment in Excel format)

SYSTEM ACCESS INVESTMENTS

1. SUMMARY

Hydro Ottawa's planned System Access Capital Investments for 2026-2030 total $173.2M, focusing on five key programs designed to enhance grid reliability, accommodate growth, and support a sustainable energy future. These investments are fundamental to ensuring the safe and reliable delivery of electricity, while delivering tangible benefits to customers, supporting new developments, facilitating renewable energy integration, and enhancing metering accuracy.

System Access Capital Programs:

Section 2. Plant Relocation & Upgrade ($15.1M):
This program funds the relocation or upgrade of Hydro Ottawa-owned or joint-use overhead or underground equipment for third-party infrastructure projects, primarily by the City of Ottawa. This is driven by road widening and other development projects that conflict with existing Hydro Ottawa infrastructure. The program aims to meet regulations, improve system efficiency, and enable economic development.

Section 3. Customer Connections ($97.1M):
This program ensures new and modified customer connections, including residential subdivisions (townhomes, semi-detached, singles, or mixed), commercial developments (underground or vault equipment service), and infill services, are seamlessly integrated into the distribution grid, fulfilling mandated service obligations. The program involves installing transformers, lines, switchgear, and metering infrastructure, and may require roadwork and civil works.

Section 4. System Expansion ($59.2M):
System expansions are initiated when capacity constraints in Hydro Ottawa's infrastructure necessitate upgrades or additions to accommodate new customers or support existing customer service upgrades. Investments may involve upgrading feeders, transformers, or substations to

ensure reliable power supply. Driven by customer service requests, particularly the growing number of large load requests, and Hydro Ottawa's legal obligation to fulfill connection requests, this program aims to ensure timely and efficient customer connections.

Section 5. Generation Connections ($0.1M):

Hydro Ottawa's Generations Connections program facilitates integrating customer owned Distributed Energy Resources (DERs) into the distribution grid, complying with regulations and ensuring system reliability and safety. The program covers infrastructure upgrades and streamlined connection processes.

Section 6. Metering ($1.7M):

Hydro Ottawa's Metering Program invests in metering technology, including Suite Metering for multi-unit buildings.

These investments are fundamental to achieving the following benefits to Hydro Ottawa's customers:

- **Enhanced Reliability:** Investing in grid expansion will result in a more robust and resilient electricity grid.
- **Support for Growth & Development:** Facilitating new customer connections and upgrades ensures that businesses and residents have access to the essential electricity services needed to thrive, contributing to a vibrant and prosperous community.
- **Enabling a Cleaner Energy Future:** By supporting the integration of renewable energy sources, Hydro Ottawa empowers customers to participate in the transition to a more sustainable energy future, reducing greenhouse gas (GHG) emissions and fostering environmental responsibility.
- **Improved Accuracy & Transparency:** The deployment of advanced metering infrastructure will enhance the accuracy and transparency of electricity measurement, providing customers with greater insights into their energy consumption patterns and enabling them to make informed decisions about their energy use.

Hydro Ottawa acknowledges the challenges inherent in implementing these investment programs, including the need to modernize deteriorating infrastructure, manage increasing electricity demand, navigate the complexities of integrating renewable energy sources, and mitigate the impacts of climate change on grid resilience. This document provides a detailed overview of each program and outlines how Hydro Ottawa will proactively address these challenges to deliver safe, reliable, and sustainable electricity service to the residents and businesses of the City of Ottawa and the Municipality of Casselman.

2. PLANT RELOCATION & UPGRADE

2.1. PROGRAM SUMMARY

Investment Category: System Access

Capital Program Costs:

2021-2025: $22.0M

2026-2030: $15.1M

Budget Program: Plant Relocation and Upgrades

Main Driver: Third Party Requirements

Secondary Driver: Capacity Constraints

Outcomes: Public Policy Responsiveness, Operational Effectiveness

Hydro Ottawa's Plant Relocation and Upgrade program includes projects to relocate existing plant equipment to enable infrastructure projects undertaken by third party agencies (e.g. the City of Ottawa and Municipality of Casselman, Ministry of Transportation of Ontario, National Capital Commission). Relocations are required when conflicts exist between existing utility infrastructure and proposed third party capital projects. To maximize construction efficiencies and minimize future service disruptions, utility equipment upgrades are sometimes prioritized over like-for-like relocations.

Third-party requests for relocations are primarily the result of City of Ottawa infrastructure projects. Due to these projects being entirely dependent on third-party plans and schedules, expenditure forecasting is challenging, as Hydro Ottawa does not control the timing and scope. However, Hydro Ottawa collaborates with the City of Ottawa to understand their infrastructure plans and develops a Plant Relocation and Upgrade program forecast that aligns with those plans. For example, Hydro Ottawa reviews development applications (e.g. site plans and zoning amendments) within city rights-of-way and participates in the monthly Utility Coordinating Committee (UCC) to discuss joint planning of development projects. Hydro Ottawa also collaborates with large developers to gain information on development of large commercial, government, or industrial facilities with building footprints which can result in relocations.

Critically, transportation development projects such as the Ottawa Light Rail Transit (LRT) expansion requires significant infrastructure upgrades and relocations of Hydro Ottawa infrastructure, which are factored into the Distribution System Plan (DSP), including load growth projections, infrastructure upgrades, and budget forecasts for this program, see more details in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties. Hydro Ottawa also forecasts for this budget program to align with road widening projects laid out in the City of Ottawa Transportation Master Plan as part of the "Affordable Road Network"[1] initiative. As such, spending in this category is based on historical averages, the scope and timing of larger City of Ottawa projects, and appropriate inflation adjustments.

In total, Hydro Ottawa proposes to invest $15.1M in plant relocation in the 2026-2030 rate period compared to Historical and Bridge Year spending of $22M in the 2021-2025 period. The decline in the required investment in relocation projects is largely driven by the completion of the LRT Phase 2 project.

2.2. PERFORMANCE OUTCOMES

The following outcomes are expected to be achieved through the Plant Relocations and Upgrades program, as outlined in Table 1 below.

Table 1 - Plant Relocations and Upgrades Program Performance Outcomes

OEB Performance Outcomes	Outcome Description
Public Policy Responsiveness	Meet Regulatory Compliance by conforming to Public Service Work on Highways Act[2] (PSWHA) mandates and City of Ottawa regulations
	Identified public safety concerns will be addressed in the scope of work for plant relocation
Operational Effectiveness	Improve system efficiency by upgrading equipment that is being relocated when applicable

[1] City of Ottawa, *Transportation Master Plan*, Exhibit 7.2 2031 Affordable Road Network- Project By Phase (November 2013). Page 70
[2] Public Service Works on Highways Act of Ontario, R.S.O. 1990, c. P.48.

2.3. PROGRAM DRIVERS AND NEED

2.3.1. Drivers

Primary Driver: Third Party Requirements

Under the PSWHA, Hydro Ottawa is mandated to work with public entities requesting infrastructure relocations and respond in a timely manner to facilitate the maintenance and improvement of public infrastructure. Consequently, the primary driver for Hydro Ottawa's relocation work stems from the statutory framework established by this Act.

The 2026-2030 Plant Relocation and Upgrade program is a direct result of the planned road widening projects identified in the City of Ottawa's Transportation Master Plan as part of the "Affordable Road Network" initiative[3]. The following infrastructure projects, forecast by the City of Ottawa for completion during the 2026-2030 rate period, have been identified as impacting Hydro Ottawa's infrastructure:

- **Bank Street -** Planned road widening from two to four lanes between the Earl Armstrong Rd. extension and Rideau Rd.
- **Prince of Wales Drive -** Planned road widening from two to four lanes between Hunt Club Road and Merivale Road
- **Preston Street -** Planned road extension of the existing two-lane urban roadway from Albert Street to Vimy Place (at Kichi Zībī Mīkan)

Secondary Driver: Asset Condition and Lifecycle Optimization

Beyond mandated relocations, Hydro Ottawa proactively addresses asset condition and lifecycle during relocation projects. When a project necessitates a relocation, it presents an opportunity to assess the existing infrastructure's condition and potential for optimization. Each relocation project is evaluated to determine if efficiencies can be achieved by increasing asset capacity, upgrading the infrastructure, or implementing lifecycle improvements, rather than simply replacing assets in kind.

[3] City of Ottawa, *Transportation Master Plan*, Exhibit 7.2 2031 Affordable Road Network- Project By Phase (November 2013). Page 70

For example, several significant projects during the 2026-2030 period anticipated to require plant relocation in conjunction with necessary system expansion include:

- The OC Transpo's Zero Emission Bus Project [4]
- Department of National Defence (DND) Dwyer Hill Training Center Upgrade Project [5]
- The Ottawa Hospital's New Campus Project [6]

Where an upgrade or lifecycle improvement yields a benefit or efficiency, Hydro Ottawa will contribute capital towards the relocation project costs. This approach ensures that relocations serve not only to address immediate needs, but also to enhance the long-term performance and sustainability of Hydro Ottawa's infrastructure.

2.3.2. Current Issues

The City of Ottawa's growth has led to a greater volume of infrastructure relocation requests for Hydro Ottawa. In recent years, Hydro Ottawa has received pole relocation requests for projects such as LRT Phase 2, Montreal Road revitalization, and post-LRT Phase I rehabilitation work on Slater Street and Albert Street. Going forward into the 2026-2030 period, the main sources for relocation work is expected to come from road widening projects as well as large developments in Hydro Ottawa's service territory.

2.4. PROGRAM BENEFITS

2.4.1. System Operation Efficiency and Cost Effectiveness

Integrating capacity upgrades with mandated plant relocations enhances system reliability, improves operational flexibility, and maximizes cost efficiencies. This approach minimizes operational constraints for system operators during planned and emergency switching.

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[4] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/

[5] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/

[6] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/

2.4.2. Customer Benefits

This program will minimize disruption to Hydro Ottawa customers by providing timely and coordinated execution of Hydro Ottawa infrastructure relocations requested by third parties.

2.4.3. Coordination and Interoperability

This program prioritizes coordination and interoperability through proactive stakeholder engagement, data sharing, and adhering to industry standards. This collaborative approach ensures efficient project delivery, minimizes disruptions, and enhances safety for both workers and the public.

2.4.4. Economic Development

This program will enable economic development by addressing infrastructure conflicts that necessitate the relocation of Hydro Ottawa plant for third-party capital projects.

2.5. PROGRAM COSTS

The annual costs for the Plant Relocation and Upgrade program is expected to average $3.0M per year over the 2026-2030 period which is a decrease from the $4.4M average annual costs during the 2021-2025 timeframe. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to be $15.1M compared to $22.0M in the 2021-2025 period. Between 2021 and 2025, program spending was higher than usual due to the utility relocation work associated with the City of Ottawa's LRT Phase 2 project. These relocation costs were significantly above historical averages for Hydro Ottawa. Looking ahead, expenditures are projected to normalize for the 2026-2030 period.

Table 2 presents the Historical, Bridge and Test Year expenditures for the Plant Relocation and Upgrade program.

Table 2 - Historical, Bridge and Test Year Plant Relocation Costs ($’000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Plant Relocation & Upgrades - Gross	$ 10.0	$ 7.6	$ 8.2	$ 10.2	$ 8.6	$ 6.6	$ 6.7	$ 7.1	$ 7.2	$ 7.4
Contributed Capital	$ (5.8)	$ (3.9)	$ (5.2)	$ (4.3)	$ (3.9)	$ (3.8)	$ (3.8)	$ (4.0)	$ (4.1)	$ (4.2)
Contributed Plant	$ 0.5	-	-	-	-	-	-	-	-	-
ANNUAL TOTAL	**$ 4.7**	**$ 3.7**	**$ 2.9**	**$ 5.9**	**$ 4.8**	**$ 2.8**	**$ 2.9**	**$ 3.1**	**$ 3.1**	**$ 3.2**
5-YEAR TOTAL					**$ 22.0**					**$ 15.1**

The Plant Relocations and Upgrade program cost has been forecasted assuming customer contributions (i.e. contributed capital) remain at 66% of gross project cost based on the Historical contribution averages from 2021 to 2023. Likewise, the gross expenditure cost has been calculated based on average project volumes (excluding discrete planned projects) for the 2024 and 2025 years, with addition of discretely planned projects in the 2026-2030 period such as:

- Bank Street - Planned road widening from two to four lanes between the Earl Armstrong Rd. extension and Rideau Rd.
- Prince of Wales Drive - Planned road widening from two to four lanes between Hunt Club Road and Merivale Road
- Preston Street - Planned road extension of the existing two-lane urban roadway from Albert Street to Vimy Place (at Kichi Zībī Mīkan)

While future growth is expected, it is not anticipated to have the same concentrated impact on the Plant Relocations and Upgrade program as LRT Phase 2. The cost factors detailed in Section 2.5.1 below may cause deviations from this forecast. Hydro Ottawa will continue to monitor changes to infrastructure programs to ensure electrical infrastructure development keeps pace with the city's evolving needs.

2.5.1. Cost Factors

- Large unplanned infrastructure projects which require relocation of Hydro Ottawa assets
- Cancellation of discrete planned infrastructure projects driven by third parties
- Project complexity
- Technical challenges
- Skilled labour availability
- Material and equipment costs

2.6. ALTERNATIVES EVALUATION

2.6.1. Alternatives Considered

Alternative One: Do Nothing

The "do nothing" alternative is not viable. Hydro Ottawa is legally obligated under the PSWHA to cooperate with public entities requesting infrastructure relocations. This Act mandates a timely response to facilitate the maintenance and improvement of public infrastructure. Therefore, regardless of other considerations, Hydro Ottawa must relocate infrastructure when required by public projects, making some level of investment unavoidable.

Alternative Two: Project-specific Relocations in Response to Third-Party Requirements

Hydro Ottawa will implement relocations as required by specific third-party projects. This approach ensures that relocations are carried out in direct response to identified needs, aligning with regulatory obligations.

However, recognizing potential opportunities for system improvement, Hydro Ottawa will evaluate each relocation project on a case-by-case basis to determine if targeted upgrades can be efficiently integrated. If an opportunity arises where an upgrade can yield significant benefits, Hydro Ottawa will consider incorporating it into the relocation plan.

2.6.2. Evaluation Criteria

The alternatives were evaluated on the basis of:

- **Regulatory Compliance:** The program must consistently meet all legislative and regulatory requirements. This criterion assesses how well each alternative adheres to all applicable laws, regulations, and industry standards. This includes, but is not limited to, the PSWHA which mandates cooperation with public entities for infrastructure relocations, and any other relevant provincial or federal mandates governing utility operations and infrastructure adjustments. As a regulated utility, Hydro Ottawa must prioritize compliance to ensure legal operation and maintain public trust. Failure to comply with regulations can result in legal challenges, fines, and reputational damage.
- **Economic Development:** The program should contribute to the City of Ottawa's growth and sustainability. This criterion evaluates the program's contribution to the economic growth and sustainability of the City of Ottawa. This includes supporting development projects, enabling business expansion, and fostering stable and reliable electrical infrastructure that attracts investment and supports job creation. A robust and adaptable electrical grid is essential for economic development. Infrastructure relocations and upgrades can facilitate new construction, business operations, and the expansion of services, contributing to the overall economic health and vitality of the city.
- **Environmental Sustainability:** The program should promote environmental sustainability by supporting electrification, renewable energy integration, and energy efficiency. This criterion examines the program's impact on environmental sustainability, including its support for electrification (transitioning to electric vehicles (EV) and electric heating systems), renewable energy integration (connecting solar and wind power to the grid), and energy efficiency initiatives. Hydro Ottawa has a responsibility to contribute to a cleaner environment. By considering these factors in relocation projects, the program can help reduce GHG emissions, promote the use of clean energy sources, and improve overall energy efficiency.
- **Community Benefits:** The program should enhance community well-being through grid resilience and support for sustainable development initiatives. This criterion assesses the program's contribution to community well-being, focusing on grid resilience (ability to withstand and recover from disruptions), reliability of service (minimizing outages), and

support for sustainable development initiatives that enhance quality of life, such as community energy projects or initiatives that promote equitable access to reliable electricity. A reliable and resilient electrical grid is vital for community well-being. It ensures essential services remain operational, supports community initiatives, and enhances the overall quality of life for residents.

Evaluating the alternatives against these criteria will ensure that the program effectively meets its objectives, contributes to the City of Ottawa and Municipality of Casselman's growth and provides reliable and efficient electrical service to customers.

2.6.3. Preferred Alternative

Alternative one fails to meet the Regulatory Compliance criterion. By not participating in relocation projects, Hydro Ottawa would be in violation of the PSWHA and potentially other legal requirements, leading to penalties and reputational damage. It also does not contribute to Economic Development, Environmental Sustainability, or Community Benefits.

Alternative two fully satisfies the Regulatory Compliance criterion by ensuring that Hydro Ottawa fulfills its legal obligations. It supports Economic Development by enabling infrastructure adjustments necessary for construction and expansion projects. While primarily reactive in nature, it allows for potential Environmental Sustainability benefits by considering targeted upgrades that could support electrification or renewable energy integration. Similarly, it contributes to Community Benefits by maintaining reliable service and considering upgrades that enhance grid resilience.

Based on the evaluation criteria, Alternative two: Project-Specific Relocations in Response to Third-Party Requirements is the preferred alternative. It balances the need to meet regulatory requirements with the flexibility to pursue upgrades that enhance the grid's capacity, resilience, and sustainability. This approach allows Hydro Ottawa to respond effectively to relocation requests while also contributing to the economic, environmental, and social well-being of the City of Ottawa.

2.7. PROGRAM EXECUTION AND RISK MITIGATIONS

2.7.1. Implementation Plan

All plant relocation work will adhere to PSWHA-mandated timelines and will be processed sequentially, based on the order in which requests are received.

2.7.2. Risks To Completion and Risk Mitigation Strategies

The Plant Relocation and Upgrade program, being contingent upon third-party projects, presents several potential risks to Hydro Ottawa. Table 3 provides a summary of these key risks and the corresponding mitigation strategies.

1 **Table 3 - Plant Relocation and Upgrade Program Key Risks and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to third party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies, and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

3. CUSTOMER CONNECTIONS

3.1. PROGRAM SUMMARY

Investment Category: System Access

Capital Program Costs:

2021-2025	$68.8M
2026-2030	$97.1M

Budget Program: Residential Subdivisions, Commercial Developments, Infill Services

Main Driver: Customer Service Request

Secondary Driver: Mandated Service Obligations

Outcomes: Customer Focus

The Customer Connection program comprises the following budget programs, designed to address the needs of specific customer load types:

Residential Subdivision Program – This program addresses connections for new residential subdivisions, encompassing a range of housing types, including townhomes, semi-detached units, and single-family homes. These connections are essential for supporting residential growth and development.

Commercial Developments Program – This program addresses connections for commercial developments, which are characterized by their scale and complexity, necessitating substantial electrical infrastructure. Projects under this program are typically served using pad-mounted or vault equipment to accommodate their higher energy demands. The use of this specialized equipment contributes to the higher project costs.

Infill (Residential & Small Commercial) Program – This program encompasses projects to accommodate service connections and service upgrades for residential or small commercial developments located within established urban areas. These projects typically do not necessitate the installation of pad-mounted or vault equipment.

The Customer Connection Program includes investments required by Hydro Ottawa to facilitate customer access to its distribution system in response to the growth projections for the City of Ottawa. This program is required to ensure new and modified load connections are seamlessly integrated into the distribution grid. Hydro Ottawa's program is structured to meet its mandated service obligations as set out in the Distribution System Code (DSC), *Electricity Act, 1998* (Electricity Act), Ontario Energy Board Act 1998 (OEB Act), and Hydro Ottawa's Conditions of Service (COS). These investments enable Hydro Ottawa to meet its commitments for reliable, safe, and efficient access to its distribution system, supporting customer growth and development. The program addresses evolving customer demands and ensures that the necessary infrastructure is in place to support both current and forecast load requirements. Customer Connection projects are customer driven and may include a customer contribution. The determination of these contributions is guided by the OEB's prescribed economic evaluation methodology, which is designed to assess the financial implications and ensure equitable cost-sharing between the utility and the customer.

In total, Hydro Ottawa plans to invest $97.1M in the Customer Connections program in the 2026-2030 period, compared to $68.8M during the 2021-2025 period. The projected increase in investment in the Customer Connections program is primarily attributable to the growing volume and complexity of connection requests, necessitated by continued community growth and development. Growth in residential connections is driven by projected population increases and the associated expansion of housing and employment opportunities. Commercial connection growth is driven by the City of Ottawa's transit-oriented development strategy, including its planned transition to a fully electric bus fleet. This transition involves targeting 354 electric buses by 2027 and achieving complete electrification by 2036. An increase in confirmed customer commitments to large load requests (5 MVA and above) and the broader energy transition, which is increasing demand for EV charging stations and transit infrastructure, such as new warehouses, are also contributing factors. The volume of infill projects is driven by the City of Ottawa's intensification plans, which promote development within existing urban areas. For details refer to Section 6.5 of Schedule 2-5-4 - Asset Management Process.

3.2. PERFORMANCE OUTCOMES

The Customer Connections program expenditures are necessary for Hydro Ottawa to fulfill its mandated service obligations, as defined in Section 7.2 - Customer Connections of the DSC, the Electricity Act, and the OEB Act .

The following outcomes are expected to be achieved through the Customer Connections program, as outlined in Table 4 below:

Table 4 - Customer Connections Program Performance Outcomes

OEB Performance Outcomes	Outcome Description
Customer Focus	This program directly contributes to Hydro Ottawa's customer focus objectives by efficiently fulfilling customer service requests and ensuring compliance with mandated service obligations, as well as Hydro Ottawa’s COS and Electricity Distribution License. Specific mandated service obligations, as tracked by the Utility Scorecard, are detailed in Attachment 1-3-3(C) - Electricity Utility Scorecard Benchmarking Analysis. Successful execution of this program is essential for maintaining high levels of customer satisfaction and meeting regulatory requirements.

3.3. PROGRAM DRIVERS AND NEED

3.3.1. Drivers

Primary Driver: Customer Service Request

Demand requests made by customers constitute the primary reason for new development connections to the distribution grid. Each project, encompassing residential subdivisions, commercial developments, or infill services, presents distinct requirements with respect to electricity load, infrastructure, and connection timelines. These requirements are specified by the customer to ensure alignment with their respective development plans and schedules.

Hydro Ottawa anticipates an increase in customer connection (service) requests, linked to Ottawa's ongoing growth and development initiatives. From 2021 to 2023, Hydro Ottawa experienced annual averages of 6,067 residential customer connections, 143 commercial customer connections, and approximately 3,628 infill related service requests (encompassing new service connections and service upgrades). Notably, a single request can involve multiple services or accounts, particularly for residential subdivisions, multi-unit residential buildings, and commercial developments.

Looking ahead, customer connection requests are projected to increase further in correlation with Ottawa's continued growth, spurred by development initiatives, large load requests, intensification efforts, and electrification trends. As detailed in Section 2.3.1 of Schedule 2-5-1 - Distribution System Plan Overview, since 2018 Hydro Ottawa has observed a significant increase in connection requests and inquiries from large-load customers (5 MVA and above).This upward trend is corroborated by historical data on the conversion rate of initial customer requests and inquiries into confirmed customer commitments (Signed Offers to Connect), as detailed in Section 9.4.1.1 of Schedule 2-5-4 - Asset Management Process.

Key factors contributing to this anticipated increase include:

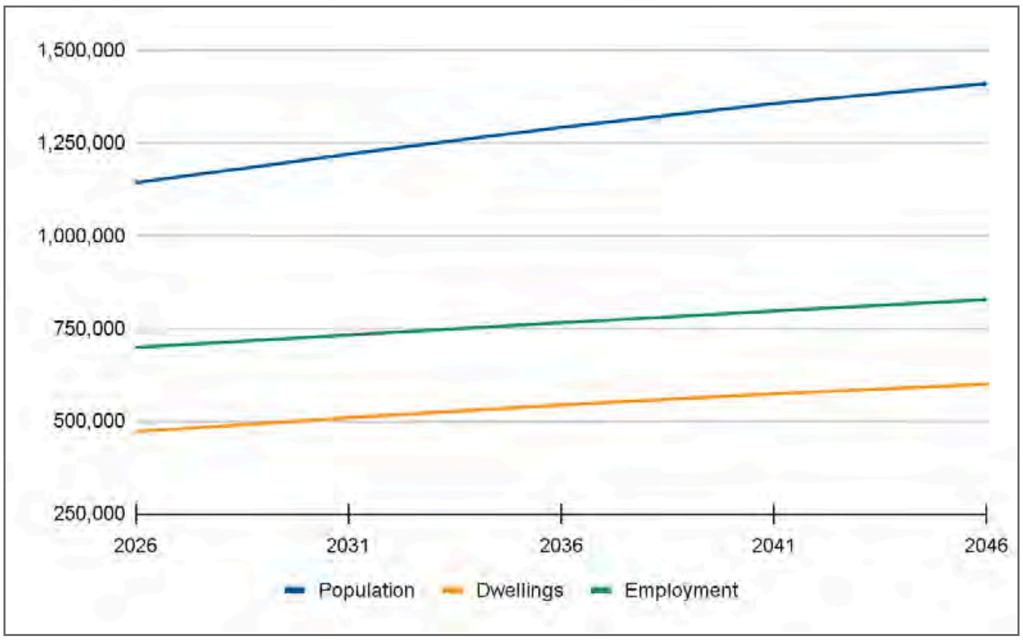
- **Residential Growth:** Driven by forecasted population increases, the resulting expansion of housing and employment opportunities is expected to fuel a rise in residential connection requests. This trend is visually represented in Figure 1, which illustrates the City of Ottawa's population projections[7].
- **Commercial Developments:** The City of Ottawa's transit-oriented development strategy, including its plan to transition to a fully electric bus fleet (354 electric buses by 2027, full electrification by 2036), is a key driver of growth in commercial connections. Further contributing to this growth are the rising number of large load requests (5 MVA and above) and the broader energy transition, which is fueling demand for EV charging stations and transit infrastructure.

[7] City of Ottawa, "Growth projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93

- **Infill Development:** The City of Ottawa's intensification plans, which encourage development within existing urban areas, drive new infill connections. These plans promote higher-density development and the efficient use of existing infrastructure, leading to increased demand for infill service connections and upgrades.

For further details refer to Section 6.5 of Schedule 2-5-4 - Asset Management Process.

Figure 1 - City of Ottawa Growth Projections



Secondary Driver: Mandated Service Obligation

Hydro Ottawa is obligated, under the DSC, the Electricity Act , the OEB Act , and Hydro Ottawa's COS, to fulfill connection requests or provide an offer to connect to any customer within its service territory.

3.3.2. Current Issues

Hydro Ottawa faces several key challenges in managing new and modified customer connections, impacting its ability to efficiently and effectively serve the growing City of Ottawa:

- **Electrification and Emerging Technologies Challenges:** Hydro Ottawa faces significant challenges due to the increasing electrification of Ottawa, driven by national and municipal climate targets, and the emergence of new energy technologies. These trends are significantly increasing electricity demand, particularly in transportation and space heating, straining existing infrastructure and requiring substantial upgrades. The Customer Connection program includes necessary investments to facilitate customer access to the distribution system and seamlessly integrate new and modified load connections, but these upgrades are further complicated by the added demands of electrification. The rise of EV charging infrastructure adds further complexity, demanding strategic planning and load management. Integrating DERs requires advanced grid management capabilities. These converging trends necessitate proactive planning and strategic investment in the grid to ensure continued reliable service. Without a proactive approach, Hydro Ottawa risks falling behind, potentially leading to service disruptions, increased costs, and hindering Ottawa's transition to a sustainable energy future.
- **Responding to Changing Customer Needs:** Responding to changing customer requests presents a significant challenge to Hydro Ottawa's efficient and effective service delivery in a growing city. While the Customer Connection program facilitates customer access to the distribution system and integrates new and modified load connections, modifications to customer load requirements or energization dates necessitate costly redesigns of infrastructure plans, impacting equipment needs, labor, and project schedules. These changes create project management complexities, requiring a highly flexible and responsive planning process within the Customer Connection program framework. The resulting cost increases, due to redesigns, material changes, and potential project acceleration or delays, impact the program costs. Effectively managing these evolving customer needs within the Customer Connection program is crucial to ensure efficient resource allocation, minimize cost impacts, and maintain timely project completion, ultimately supporting the city's continued growth.

3.4. PROGRAM BENEFITS

A robust Customer Connections program ensures that new developments are seamlessly integrated into the grid while promoting operational efficiency, safety, and economic growth. Hydro Ottawa's Customer Connections program is structured to optimize grid performance, meet growing energy demands, and foster long-term community development. The following sections are the key benefits of the Customer Connections Program.

3.4.1. Customer

Reliable and Safe Access: The program ensures reliable and safe access to Hydro Ottawa's distribution system for all customers. This access is fundamental and is maintained through strict adherence to industry regulations and standards, ensuring a dependable connection to the power grid.

Timely Connections: The Customer Connection program leverages the strategic planning and proactive infrastructure upgrades of the System Access program, to provide timely connections for new developments. Timely connections enable customers to begin operations or occupy new homes without delays, helping them avoid potential costs associated with project delays and ensuring their energy needs are met according to their development timelines. The program's focus on preparedness aims to streamline the connection process, meet DSC requirements, and minimize delays.

3.4.2. System Operation Efficiency and Cost Effectiveness

Optimized Infrastructure Utilization: The program's planning process considers both current and forecasted load requirements, ensuring that infrastructure investments are aligned with actual needs. This helps to avoid overbuilding or underutilization of assets, maximizing the return on investment and improving the overall efficiency of the system.

Economies of Scale: The program's integrated planning and bulk purchasing strategies allow Hydro Ottawa to achieve economies of scale. By coordinating projects and procuring materials in bulk, the utility can reduce the per-unit cost of infrastructure development, leading to more cost-effective upgrades and expansions.

3.4.3. Economic Development

Growth and Investment: The program supports the City of Ottawa's economic development strategy, driving growth and attracting investment by providing the essential electrical infrastructure required for residential, commercial, and infill development projects. These new customer connections stimulate local job creation across construction, maintenance, and utility sectors, while simultaneously attracting new businesses seeking to establish operations within a city offering reliable power access. The program's commitment to ensuring reliable and sufficient electrical capacity, including a robust and adaptable grid infrastructure capable of supporting substantial investments and diverse economic activities, positions Ottawa as a prime destination for businesses and developers, thereby fostering economic prosperity and long-term, sustainable growth. Enhancements to infrastructure further contribute to increased property values, incentivizing real estate investment and stimulating additional commercial ventures.

Empowering Business Success: The Customer Connection program empowers businesses of all sizes to thrive in Ottawa. By providing reliable and sufficient power, the program enables commercial operations, supports innovation, and facilitates business expansion, including entrepreneurial activities and new enterprises, contributing to a dynamic and competitive economic environment.

Adapting to Evolving Energy Needs: The program accounts for evolving customer energy needs. By identifying infrastructure investments that support both current and future load requirements, the program ensures the grid can accommodate increasing demands, including the growing adoption of EVs, transition to electric buses, and other electrification initiatives.

Supporting Growth and Development: The program actively supports the growth and development of Ottawa by providing the essential electrical infrastructure needed for new connections and increased electricity demands. This program is a key enabler for residential subdivisions, commercial projects, and infill developments, facilitating the city's expansion and economic progress.

3.4.4. Environment

Enabling a Cleaner Transportation Future: The Customer Connection program supports Ottawa's transition to a cleaner transportation future by providing the essential electrical infrastructure needed for the growing adoption of EV and the electrification of public transit. This program is a key enabler of reduced GHG emissions and improved air quality.

Supporting Sustainable Urban Growth: The program contributes to more sustainable urban development by facilitating infill projects and intensification within established areas. By connecting developments within existing urban boundaries, the program helps to minimize urban sprawl and its associated environmental impacts.

Modernizing the Grid for Energy Efficiency: The program supports the modernization of Ottawa's electrical grid, enabling the implementation of advanced energy management technologies. This includes support for demand response programs and smart meters, which empower customers to optimize their energy usage and contribute to overall energy consumption reduction.

Building a Foundation for a Green Economy: The program's support for electrification, sustainable development, and renewable energy integration creates a foundation for a green economy in Ottawa. By providing the necessary electrical infrastructure, the program attracts businesses focused on clean technologies and supports the development of a sustainable energy sector.

Contributing to a Low-Carbon Ottawa: The program plays a vital role in helping Ottawa achieve its climate change targets and transition to a low-carbon future. By enabling electrification in transportation, supporting sustainable development patterns, and facilitating the integration of renewable energy and smart grid technologies, the program contributes to reducing the city's overall carbon footprint and building a more sustainable future for all.

3.5. PROGRAM COSTS

The annual costs for the Customer Connections program is expected to average $19.4M per year over the 2026-2030 period which is an increase from the $13.8M net average annual costs during the 2021-2025 timeframe. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to reach $97.1M, compared to $68.8M in the 2021-2025 period. This capital program has three major budget programs: Residential Subdivisions, Commercial Development, Infill Services. A minor fourth budget program, ESA Flash Notice, was created for the 2021-2025 rate period, but has been discontinued for the 2026-2030 period due to the completion of all required work.

Table 5 presents the Historical, Bridge and Test Year expenditures by the underlying budget programs, as a part of the Customer Connections program. The program costs for the underlying budget programs are detailed in Sections 3.5.1 to 3.5.3.

Table 5 - Historical, Bridge and Test Year Program Costs - Net of Contributed Capital ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Residential Subdivisions	$ 8.7	$ 8.0	$ 8.0	$ 7.1	$ 7.2	$ 8.4	$ 8.8	$ 9.4	$ 10.0	$ 10.5
Commercial Developments	$ 4.4	$ 5.2	$ 5.5	$ 5.6	$ 5.9	$ 5.8	$ 12.0	$ 9.8	$ 9.0	$ 10.1
Infill Services	$ 0.7	$ 0.3	$ 1.0	$ 0.6	$ 0.7	$ 0.5	$ 0.6	$ 0.7	$ 0.7	$ 0.7
ESA Flash Notice	$ 0.1	$ 0.0	$ 0.0	$ 0.0	$ 0.0	-	-	-	-	-
ANNUAL TOTAL	**$ 13.7**	**$ 13.5**	**$ 14.4**	**$ 13.4**	**$ 13.8**	**$ 14.8**	**$ 21.4**	**$ 19.9**	**$ 19.6**	**$ 21.4**
5-YEAR NET TOTAL					**$ 68.8**					**$ 97.1**

3.5.1. Residential Subdivisions

The annual costs for the Residential Subdivision program, as a part of the Customer Connections Program, is expected to average $9.4M per year over the 2026-2030 period which is an increase from the $7.8M average annual costs during the 2021-2025 timeframe. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to reach $47.2M, compared to $38.9M in the 2021-2025 period.

While the costs associated with the Residential Subdivisions program are primarily driven by customer-initiated requests, a significant portion is offset through customer contributions (i.e. contributed capital and/or contributed plant), determined in accordance with the OEB prescribed economic evaluation methodology. Additionally, in the case of large subdivisions infrastructure is sometimes built by the developer and transferred to Hydro Ottawa offsetting the contributed capital, this is accounted for as contributed plant (in-kind contributions).

Hydro Ottawa evaluates these programs based on net spending, reflecting the balance between project costs and customer contributions. Forecasts for these contributions are derived from historical data, justifying the net investment required from Hydro Ottawa.
Table 6 presents the Historical, Bridge and Test Year costs for the Residential Subdivisions program, as a part of the Customer Connections program, capital contributions include Contributed Plant (non-cash contributions) and Contributed Capital (cash contributions).

Table 6 - Historical, Bridge and Test Year Residential Subdivision Program Costs ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Residential Subdivisions - Gross	$ 12.2	$ 12.5	$ 12.4	$ 11.9	$ 12.3	$ 13.1	$ 13.8	$ 14.7	$ 15.5	$ 16.4
Contributed Plant	$ 21.6	$ 7.4	$ 12.2	$ 12.6	$ 12.6	$ 13.9	$ 14.6	$ 15.6	$ 16.5	$ 17.4
Contributed Capital	$ (25.1)	$ (12.0)	$ (16.6)	$ (17.4)	$ (17.6)	$ (18.6)	$ (19.6)	$ (20.9)	$ (22.1)	$ (23.3)
ANNUAL NET TOTAL	**$ 8.7**	**$ 8.0**	**$ 8.0**	**$ 7.1**	**$ 7.2**	**$ 8.4**	**$ 8.8**	**$ 9.4**	**$ 10.0**	**$ 10.5**
5-YEAR NET TOTAL					**$ 38.9**					**$ 47.2**

Test Year costs for the Residential Subdivisions program were formulated by extrapolating from the 2021-2023 average connection volume, with subsequent adjustments based on the City of Ottawa's projected residential development growth from 2026-2030[8]. Contributed plant values are expected to be 52% of total gross cost, in line with the average contributed plant portion of gross costs over the 2018-2023 period. Contributed capital payments are assumed to remain at 69% of total gross cost in line with the average contribution capital portion of gross costs in the Historical Years.

The Residential Subdivisions program necessitates continued and increased investment during the 2026-2030 period due to a variety of factors including: City of Ottawa intensification plans[9], City of Ottawa growth trajectory[10], and increasing residential electrical demand. Changes in city intensification plans, changes in housing growth, changes in residential electrical demand trends, project complexity, technical challenges, skilled labour availability, and material and equipment costs may cause deviations from this forecast. Hydro Ottawa will continue to monitor housing

[8] City of Ottawa, "Growth Projections for Ottawa: 2018-2046,"
[9] Intensification plans in City of Ottawa's Official Plan
[10] City of Ottawa, "Growth Projections for Ottawa: 2018-2046,"

growth trends and residential electrical demand trends to effectively support the City's development objectives, and ensure the provision of reliable electrical service to all residents.

3.5.2. Commercial Developments

The annual costs for the Commercial Developments program, as a part of the Customer Connections program, is expected to average $9.3M per year over the 2026-2030 period which is an increase from the $5.3M average annual cost per year during the 2021-2025 timeframe. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to reach $46.8M, compared to $26.4M in the 2021-2025 period. During the Historical and Bridge Years, a consistent trend of increasing expenditures in this program was observed, representative of the growth in commercial development.

While costs associated with the Commercial Developments program are primarily driven by customer-initiated requests, a significant portion is offset through contributed capital, determined in accordance with the OEB prescribed economic evaluation methodology.

Hydro Ottawa evaluates these programs based on net capital costs, reflecting the balance between gross project costs and contributed capital. Test Year contributions are derived from Historical data and known planned projects with confirmed customer commitment, further justifying the net investment required from Hydro Ottawa.

Table 7 presents the Historical, Bridge and Test year costs for the Commercial Developments program, as a part of the Customer Connections program.

Table 7 - Historical, Bridge and Test Year Commercial Developments Program Costs ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Commercial Developments - Gross	$ 13.1	$ 13.0	$ 17.9	$ 16.7	$ 17.7	$ 19.0	$ 33.4	$ 25.0	$ 23.8	$ 26.8
Contributed Capital	$ (8.7)	$ (7.8)	$ (12.5)	$ (11.1)	$ (11.9)	$ (13.2)	$ (21.3)	$ (15.2)	$ (14.8)	$ (16.6)
ANNUAL NET TOTAL	**$ 4.4**	**$ 5.2**	**$ 5.4**	**$ 5.6**	**$ 5.9**	**$ 5.8**	**$ 12.0**	**$ 9.8**	**$ 9.0**	**$ 10.1**
5-YEAR NET TOTAL					**$ 26.4**					**$ 46.8**

Test Year costs for the Commercial Developments program were formulated by extrapolating from the 2021-2023 (excluding discrete planned projects) average connection volume, with subsequent adjustments based on the City of Ottawa's predicted employment growth[11] from 2026-2030 and the addition of discrete planned projects such as:

- Canadian Food Inspection Agency (CFIA) Connection
- Public Service and Procurement Canada(PSPC)/National Research Council (NRC) Connection

Annual contributed capital payments are assumed to remain at 64% of gross cost, in line with the average contribution capital proportion of gross costs in the Historical Years.

The Commercial Developments program requires continued increases in investment to sustain commercial development growth in Ottawa over the 2026-2030 timeframe. Changes in commercial development growth trends, increased commercial growth to support housing growth (multi-unit residential buildings), changes to commercial electricity demand, project complexity, technical challenges, skilled labour availability, and material and equipment costs are factors which may drive deviations from this forecast. Hydro Ottawa will continue to monitor commercial growth trends and commercial electrical demand trends to effectively support commercial growth targets and maintain access to stable electricity for commercial customers.

[11] City of Ottawa, "Growth Projections for Ottawa: 2018-2046,"

3.5.3. Infill Services

The annual costs for the Infill Services program, as a part of the Customer Connections program, is expected to average $0.6M per year over the 2026-2030 period, which is generally inline with the $0.6M per year average annual costs during the 2021-2025 timeframe. Hydro Ottawa expects the investment needs in this program to remain the same at $3.2M in both the 2026-2030 and 2021-2025 periods. The Historical and Bridge Years have relatively consistent request volumes for infill services connections due to the City of Ottawa's intensification plans[12], which actively supports urban infill developments.

While the costs associated with the Infill Services program are primarily driven by customer-initiated requests, a significant portion is offset through customer contributions, determined in accordance with the OEB prescribed economic evaluation methodology. The timing of Infill Service projects, and consequently, the actual costs, are influenced by third parties and are not directly controlled by Hydro Ottawa.

Hydro Ottawa evaluates these programs based on net spending, reflecting the balance between gross project costs and contributed capital. Test Year contributions are derived from historical data and known planned projects that have confirmed customer commitment, further justifying the net investment required from Hydro Ottawa.

Infill services customer connections continue to remain consistent, largely due to the City of Ottawa's intensification plans, which actively supports urban infill developments.

Table 8 presents the Historical, Bridge and Test Year costs for the Infill Services program, as a part of the Customer Connections program.

[12] Intensification plans in City of Ottawa's Official Plan - https://engage.ottawa.ca/8204/widgets/36458/documents/62522

Table 8 - Historical, Bridge and Test Year Infill Services Program Costs ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Infill Services - Gross	$ 3.3	$ 3.6	$ 3.5	$ 3.4	$ 3.5	$ 3.6	$ 3.7	$ 3.9	$ 4.1	$ 4.3
Contributed Capital	$ (2.7)	$ (3.3)	$ (2.5)	$ (2.8)	$ (2.8)	$ (3.0)	$ (3.1)	$ (3.3)	$ (3.5)	$ (3.6)
ANNUAL NET TOTAL	**$ 0.7**	**$ 0.3**	**$ 1.0**	**$ 0.6**	**$ 0.7**	**$ 0.5**	**$ 0.6**	**$ 0.7**	**$ 0.7**	**$ 0.7**
5-YEAR NET TOTAL					**$ 3.2**					**$ 3.2**

Test Year costs for the Infill Services program were formulated by extrapolating from the 2021-2023 average connection volume, with subsequent adjustments based on the City of Ottawa's projected residential development growth from 2026-2030[13]. Contributed capital is assumed to remain at 88% of gross cost in line with the average contribution capital portion of gross costs over the 2021 to 2023 period.

The Infill Services program depends on consistent investment in the 2026-2030 period to support ongoing urban infill development within the City of Ottawa. Changes in housing growth trends, changes in City of Ottawa policy direction for intensification, changes in residential electrical demand, project complexity, technical challenges, skilled labour availability, material and equipment costs, or third party build schedules may drive deviations in the Test Year costs. Hydro Ottawa will continue to monitor demand for infill connections to support the City of Ottawa's development objectives, and ensure the provision of reliable electrical service to all residents.

[13] City of Ottawa, "Growth Projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93

3.5.4. Cost Factors

Residential Subdivisions

- City intensification plans
- Changes in housing growth trends
- Changes in residential electrical demand trends
- Project complexity
- Technical challenges
- Skilled labour availability
- Material and equipment costs

Commercial Developments

- Changes in commercial development growth trends
- Changes to working models (work from home and hybrid work)
- Increased commercial growth to support housing growth
- Changes to commercial electricity demand
- Project complexity
- Technical challenges
- Skilled labour availability
- Material and equipment costs

Infill Services

- Changes in housing growth trends
- Changes in City of Ottawa policy direction for intensification
- Changes in residential electricity demand
- Project complexity
- Technical challenges
- Skilled labour availability
- Material and equipment costs
- Third party build schedules

3.6. ALTERNATIVES EVALUATION

3.6.1. Alternatives Considered

Alternative One: Do Nothing

The "do nothing" alternative, characterized by the refusal of new customer connection requests, represents an untenable option for Hydro Ottawa. This approach would constitute a direct violation of fundamental regulatory obligations as stipulated in the DSC, the Electricity Act, the OEB Act, Hydro Ottawa's COS and Electricity Distribution License. Furthermore, it would severely impede economic development within the City of Ottawa and Municipality of Casselman by preventing new residential, commercial, and infill development projects from accessing the electrical grid.

Alternative Two: Enable Customer Connection (Recommended)

Hydro Ottawa must invest in the Customer Connections Program to enable new customer connections and accommodate the communities and Hydro Ottawa Customer's evolving energy needs. This investment is crucial for several key reasons:

- **Ensuring Regulatory Compliance:** The program ensures adherence to regulatory requirements mandated by the DSC and other relevant legislation, enabling Hydro Ottawa to fulfill its obligations.
- **Driving Economic Development:** By providing the necessary electrical infrastructure for new residential, commercial, and infill developments, the program directly fuels economic development and supports the City of Ottawa's ongoing growth and expansion. This attracts businesses requiring reliable connections, enables existing businesses to expand and create jobs, facilitates housing construction, and enhances the city's economic competitiveness, attracting further investment.
- **Adapting to Evolving Energy Needs:** The program enables Hydro Ottawa to adapt to the changing energy landscape, including the increasing demand associated with electrification initiatives. This includes supporting the adoption of EVs, the transition to an electric bus fleet, and other emerging technologies that contribute to a more sustainable energy future.

In essence, the Customer Connections program represents a proactive and necessary investment in Hydro Ottawa's customers' future, enabling the City of Ottawa and Municipality of Casselman to grow and thrive economically while ensuring a robust and reliable electrical grid that can adapt to evolving energy needs and support a sustainable energy transition.

3.6.2. Evaluation Criteria

Given that the Customer Connections Program is essential and has no viable alternatives, the primary evaluation criterion is Regulatory Compliance.

- **Regulatory Compliance:** The program must consistently meet all legislative and regulatory requirements, including those mandated by the DSC, the OEB and Hydro Ottawa's COS. This ensures Hydro Ottawa fulfills its obligations to provide safe and reliable electricity services to its customers

While the necessity of the Customer Connections Program is inherent, its implementation can be assessed for its alignment with broader strategic goals:

- **Economic Development:** To the extent possible within regulatory constraints, the program should contribute to the City of Ottawa's growth and sustainability.
- **Environmental Sustainability:** The program should promote environmental sustainability by facilitating customer connections that enable electrification, renewable energy integration, and energy efficiency upgrades.
- **Community Benefits:** Where possible, the program should enhance community well-being through grid resilience and support for sustainable development initiatives.

Evaluating the program against these criteria, within the constraints of regulatory obligations, will ensure that Hydro Ottawa effectively supports the growing community it serves while adhering to its mandated responsibilities.

3.6.3. Preferred Alternative

Hydro Ottawa's evaluation of alternatives for the Customer Connections program definitively selects Alternative 2: Enable Customer Connections as the only viable and recommended course of action, based on its alignment with the established evaluation criteria.

Regulatory Compliance:

- The "Do Nothing" alternative (Alternative One) is immediately rejected due to its direct violation of the regulatory mandates from the DSC, Electricity Act, OEB Act, and Hydro Ottawa's COS and Electricity Distribution License.
- Alternative 2 ensures Hydro Ottawa fulfills its mandated obligations to provide safe, reliable and efficient access to its distribution system , directly meeting the primary evaluation criterion of Regulatory Compliance.

Economic Development:

- The "Do Nothing" alternative would hinder the City of Ottawa's economic growth by preventing necessary electrical connections for new developments.
- Alternative Two actively supports economic development by providing essential infrastructure for new connections, fostering growth and advancement, aligning with the economic development criterion.

Environmental Sustainability and Community Benefits:

- The "Do Nothing" alternative fails to support evolving energy needs, including electrification and renewable energy integration, hindering environmental sustainability efforts.
- Alternative Two enables Hydro Ottawa to adapt to these needs, supporting sustainable energy transition and facilitating community-driven sustainability and resilience, thus addressing both Environmental Sustainability and Community Benefits criteria.

In conclusion, Alternative Two: Enable Customer Connections is the preferred alternative as it meets regulatory requirements, supports economic growth, and facilitates environmental sustainability and community benefits, ensuring Hydro Ottawa fulfills its obligations and contributes to a sustainable future for the community.

3.7. PROGRAM EXECUTION AND RISK MITIGATIONS

3.7.1. Implementation Plan

Hydro Ottawa's Customer Connections program implementation plan encompasses the management of new and/or modified customer connection requests, ensuring compliance with regulatory requirements, supporting the city's growth, and maintaining system reliability. Additionally each connection request is reviewed and processed in accordance with the DSC and OEB regulations, ensuring fairness and compliance to timelines and requirements. The implementation plan includes:

- **Customer Relationship Management (CRM):** Leveraging the CRM system, streamlining processes, prioritizing requests, and maintaining transparent communication with customers.
- **Project Planning and Design:** Conducting thorough capacity assessments, developing detailed engineering plans, optimizing resource allocation, and managing project risks.
- **Construction and Implementation:** Overseeing construction activities, ensuring safety and quality, and coordinating with stakeholders.
- **Customer Connection and Support:** Completing connections, providing ongoing support, and monitoring customer satisfaction.

3.7.2. Risks To Completion and Risk Mitigation Strategies

Hydro Ottawa encounters several risks in managing its Customer Connections program, particularly as new developments and evolving customer demands place increasing pressure on the electricity distribution grid. Furthermore, the program's reliance on third-party projects introduces additional potential risks. Table 9 provides a summary of these key risks and the corresponding mitigation strategies that Hydro Ottawa will employ as needed.

1 **Table 9 - Customer Connection Key Risks and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to third party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Capacity and Infrastructure	Existing infrastructure may not support increased load, particularly with deteriorating assets or in areas nearing capacity limits. System reconfigurations, upgrades, or expansions may be required, posing a risk to program delivery schedule and cost.	Thoroughly assess infrastructure and implement timely upgrades. Develop long-term infrastructure plans and allocate resources efficiently to manage costs and timing of system modifications, minimizing financial impacts.
Customer & Stakeholder Management	Adjustments in customer requests, failure to meet expectations, or communication issues could pose a risk to program delivery budget and schedule.	Maintain flexibility in project designs and budgets, engage with customers regularly to anticipate changes, and ensure transparent communication and prompt response to concerns.
Regulatory & Financial	Non-compliance with changing regulations could pose a risk to program delivery cost and schedule.	Keep abreast of regulatory requirements and engage with stakeholders early. Develop detailed budgets with contingencies and closely monitor financial performance.
Technology & Process Improvement	Inefficient processes or inadequate technology may hinder program effectiveness and responsiveness.	Implement planned CRM enhancements and process optimization measures, including standardized processes, centralized intake, and proactive customer communication.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework

Category	Risk	Mitigation
		will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

4. SYSTEM EXPANSION

4.1. PROGRAM SUMMARY

Investment Category: System Access
Capital Program Costs:
2021-2025: $41.5M
2026-2030: $59.2M
Budget Program: System Expansion
Main Driver: Customer Service Request
Secondary Driver: Mandated Service Obligation
Outcomes: Customer Focus

Hydro Ottawa's System Expansion program is crucial for accommodating growth and ensuring reliable electricity service to the community and its customers. This program facilitates the connection of new customers and supports service upgrades for existing customers by investing in necessary infrastructure expansion to the electrical distribution system. The program identifies and addresses potential constraints by triggering system expansions projects that may include upgrading feeders, transformers, and substations. These system expansions guarantee sufficient capacity for current and projected load requirements, maintaining system reliability and service quality. By adhering to regulatory requirements and the COS, Hydro Ottawa fulfills its commitment to providing safe and efficient access to its distribution system, supporting community development and meeting evolving customer needs. The program's approach ensures that the electrical grid can seamlessly integrate new loads while upholding Hydro Ottawa's service obligations.

Hydro Ottawa employs the OEB prescribed economic evaluation methodology to assess proposed system expansion projects. This evaluation compares the total cost of a project with the projected future revenue generated by the new customer(s) over a defined period. Projected revenue includes the expected number of new connections and anticipated average electricity consumption/demand. In accordance with DSC Section 3.2.1, if the projected future revenue is sufficient to cover the capital and ongoing maintenance costs of the expansion, no capital contribution is required from the customer. Conversely, if a revenue shortfall is projected, the customer will contribute a portion of the expansion costs. This approach ensures long-term planning, financial sustainability, and the efficient connection of new customers to the distribution grid.

Hydro Ottawa's planned investment in its System Expansion program for the 2026-2030 period is $59.2M, an increase from the $41.5M invested in the 2021-2025 period. This increase is primarily due to the growing volume and complexity of system expansion projects necessitated by continued growth and development of the community that Hydro Ottawa serves. Key factors contributing to the Test Year costs include:

- **Large Load Requests and Energy Transition:** Increased confirmed customer commitments for large load requests (5 MVA and above) and the broader energy transition, with its associated demand for EV charging stations and related infrastructure (e.g., new warehouses), are also contributing factors.
- **Residential Growth:** Projected population increases and the associated expansion of housing and employment opportunities are driving growth in residential connections.
- **Commercial Growth:** The City of Ottawa's transit-oriented development strategy, including its planned transition to a fully electric bus fleet (354 buses by 2027 and complete electrification by 2036), is a major driver of commercial connection growth.

Further details can be found in Sections 6.5 and 9.4.1.1 of Schedule 2-5-4 - Asset Management Process.

While Historical spending (2021-2023) was largely driven by the LRT Phase 2 project, the focus has now shifted to major infrastructure projects that began in 2024 which require station builds or upgrades to support the size of the connection request. These include the construction and electrical infrastructure connections for two stations (one new station and one upgraded station) serving Ottawa's ZEB project and the DND, as well as electrical infrastructure development for the new Ottawa Hospital. These projects underscore the increasing complexity and scale of distribution system expansion necessary to meet the community's growing electricity needs.

Depending on future large load requests, the expenditure can increase but will be determined on an as needed basis.

4.2. PERFORMANCE OUTCOMES

The following outcomes are expected to be achieved through the System Expansion program, as outlined in Table 10 below:

Table 10 - System Expansion Program Performance Outcomes

OEB Performance Outcomes	Outcome Description
Customer Focus	Contributes to Hydro Ottawa's customer focus objectives by fulfilling customer service requests and meet mandated service obligations as laid out in Sections 7.2 (customer connections) of the DSC, Electricity Act, and OEB Act; and Hydro Ottawa's COS and Electricity Distribution License. Specific mandated service obligations, as tracked by the Utility Scorecard, are detailed in Attachment 1-3-3(C) - Electricity Utility Scorecard Benchmarking Analysis. Successful execution of this program is essential for maintaining high levels of customer satisfaction and meeting regulatory requirements.

4.3. PROGRAM DRIVERS AND NEED

4.3.1. Drivers

Primary Driver: Customer Service Request

To ensure the continued delivery of reliable and resilient electricity services to a growing customer base, Hydro Ottawa must strategically expand grid capacity to accommodate unprecedented demand as detailed in Section 6.5 of Schedule 2-5-4 - Asset Management Process. This increased demand is driven by several converging factors, including residential growth, transportation electrification, and the increasing adoption of electrified space heating.

Since 2018, Hydro Ottawa has observed a significant increase in connection requests and inquiries from large-load customers (5 MVA and above), with a further surge in electricity demand beginning in 2023. This upward trend is corroborated by Historical data on the conversion rate of initial customer requests and inquiries into confirmed customer commitments (signed Offer to Connect), as detailed in Section 9.4 of Schedule 2-5-4 - Asset Management Process.

Large customer connections (5 MVA or greater) totaled 110 MVA between 2010 and 2023. By 2030, confirmed customer commitments represent another 113 MVA, with an additional 199 MVA in requests and inquiries. If all requests are realized, large customer connections will increase by 312 MVA by 2030, tripling the capacity added in the previous 14 years.

A few key examples of the projects driving these large load requests are:

- The Ottawa Hospital's New Campus[14]
- OC Transpo's Zero Emission Buses[15]
- Department of National Defence Dwyer Hill Training Center Upgrade[16]
- New laboratory facilities for the Regulatory and Security Science Main Project[17], located at the existing CFIAs Ottawa Laboratory
- TerraCanada National Capital Area project located at the National Research Council of Canada facilities[18]

Details regarding supply plans for these projects can be found in Section 9.1 of Schedule 2-5-4 - Asset Management Process.

Hydro Ottawa continues to collaborate with developers and the City of Ottawa through various working groups including the UCC, Energy Evolution and the Decarbonization Working Group,

[14] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/
[15] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/news/article/oc-explained-zero-emission-bus-project/
[16] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/
[17] Government of Canada, "Government of Canada invests in laboratories to support science in Canada." https://www.canada.ca/en/public-services-procurement/news/2024/03/
[18] Government of Canada,"Government of Canada announces milestones for new science facilities in National Capital Area" https://www.canada.ca/en/public-services-procurement/news/2024/07/government-of-canada-announces-milestones-for-new-science-facilities-in-national-capital-area.html

please refer to Schedule 2-5-2 - Coordinated Planning with Third Parties to develop well-informed grid capacity enhancement plans and to ensure the continued provision of reliable electricity services to a dynamic and expanding community. This strategic approach aims to support ongoing residential and commercial development, facilitate urban intensification initiatives, and enable major infrastructure projects within the community in a cost-effective manner.

Secondary Driver: Mandated Service Obligation

Hydro Ottawa is obligated, under the DSC, the Ontario Electricity Act , the OEB Act, and Hydro Ottawa's COS, to fulfill connection requests or provide an offer to connect to any customer within its service territory.

4.3.2. Current Issues

The key challenges Hydro Ottawa faces in managing the System Expansion program include large load connections, limitations in the 4kV and 8kV systems, and distribution system upgrade challenges further detailed below.

4.3.2.1 *Large Load Connections*

Hydro Ottawa received large electrification load requests in the 2021-2025 period ranging from 5 MVA to 57 MVA. The main driver for the majority of large load requests was electrification of space heating, water heating, and transportation in order to align with municipal and federal decarbonization goals. Refer to Section 9.4 of Schedule 2-5-4 - Asset Management Process for more details. The size of the large load requests has required Hydro Ottawa to invest in station upgrades primarily to support capacity requirements of these large load customers. There are currently two station upgrade projects being executed under the System Access investment category which is primarily driven by customer requests as detailed below.

OC Transpo's Zero Emission Buses[19]

A new 230kV to 44kV substation in the east region is being built to support the power supply requirements of OC Transpo's Zero Emission Bus project (ZEB) and has a planned energization in 2027. Figure 2 shows the three existing 44kV stations in Hydro Ottawa's service territory along with the Hydro Road TS under construction and the large load.

Figure 2 - 44kV Stations

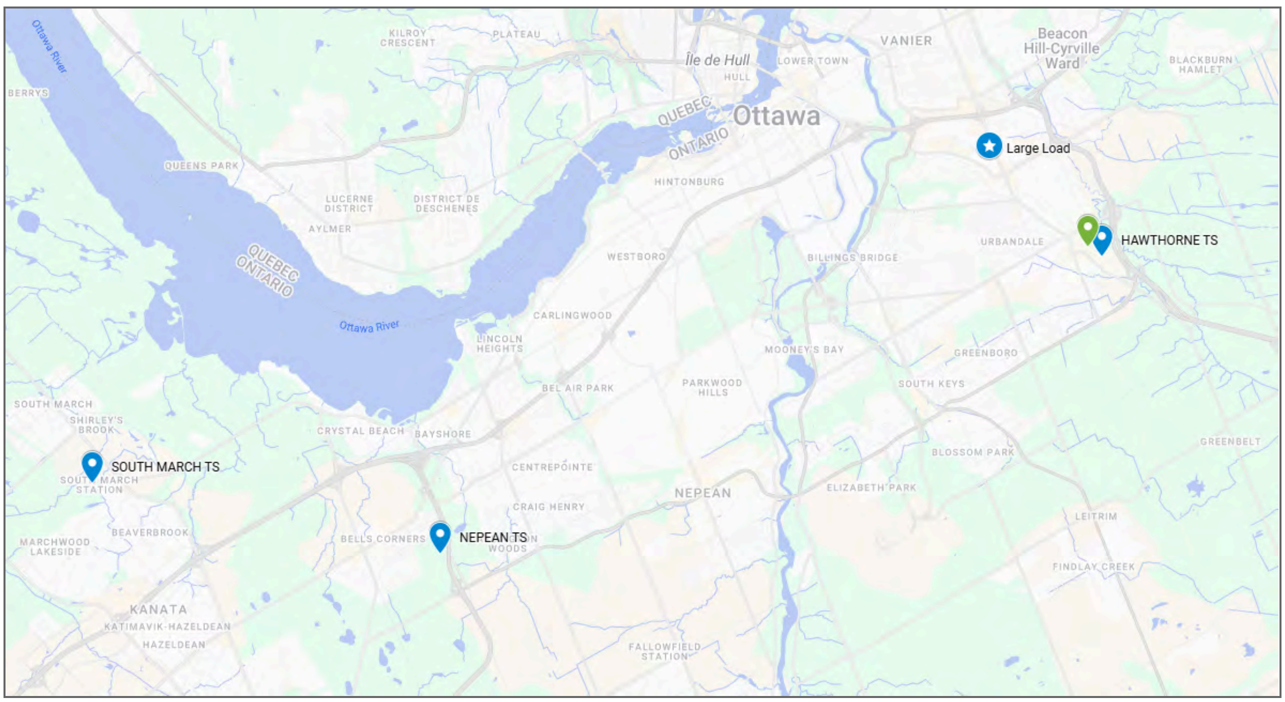
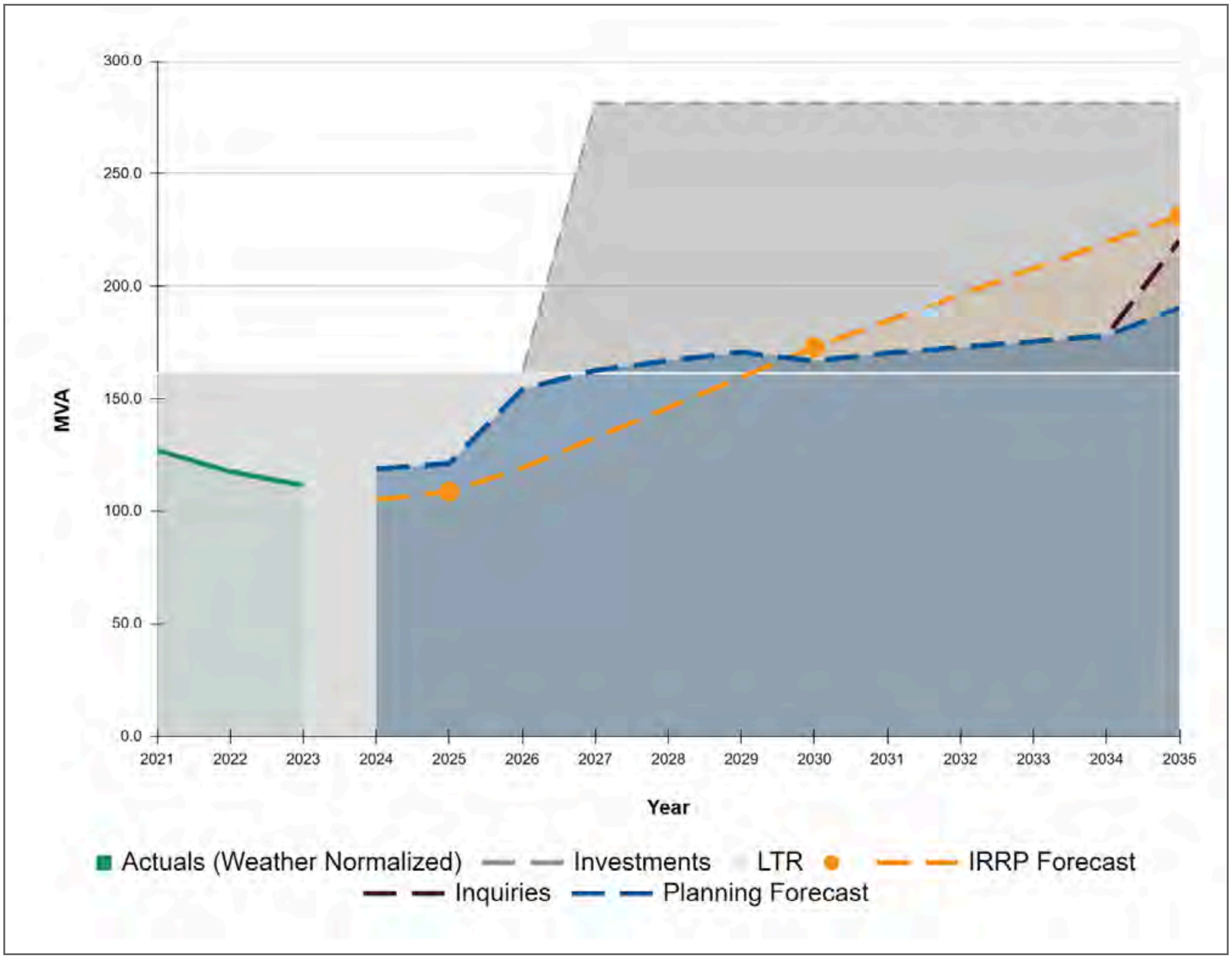


Figure 3 presents the load forecast against planned capacity (LTR), factoring the energization of Hydro Road TS in 2027, which will increase the 44kV Eastern region's capacity to 280 MVA. The figure compares the Integrated Regional Resource Plan IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages.

[19] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/news/article/oc-explained-zero-emission-bus-project/

Figure 3 - 44kV Eastern Region Forecast (Hawthorne TS + Hydro Road TS)



The issues the new Hydro Rd TS helps address are elaborated below.

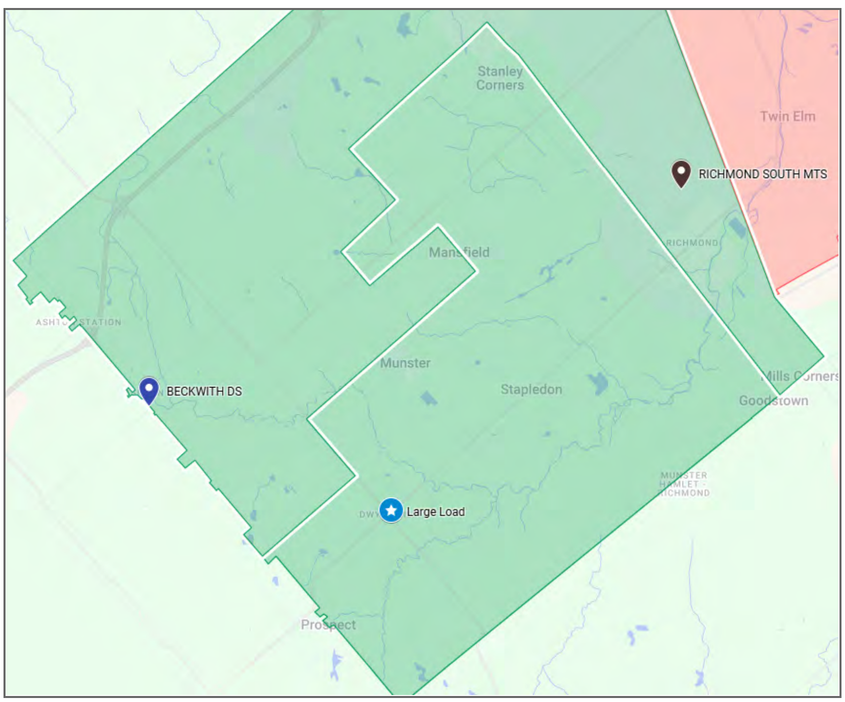
- Due to the size of the ZEB large load request, a 44kV supply option is the only feasible solution in terms of feeder capacity.
- Given the ZEB large load's geographical location, neither Nepean TS nor South March TS are viable connection options. Hawthorne TS, due to its proximity, is the only feasible option. However, it lacks sufficient capacity to meet the load requirements and would exceed its planned capacity by 2027.

- Currently, Hawthorne TS has only one tie to Nepean TS, which is not sufficient to offload the station during contingency scenarios. Building the new 44kV station would improve reliability through inter-station ties between Hawthorne TS and Hydro Road TS.
- Hence building a new 44kV station is the most optimal solution to service this large load.

Department of National Defence- Dwyer Hill Training Centre[20]

Addition of a second transformer at Hydro Ottawa's Richmond South MTS is currently under construction to support the power supply requirements of DND and has a planned energization in 2027. Figure 4 shows the existing Richmond South MTS, Beckwith DS and the large load.

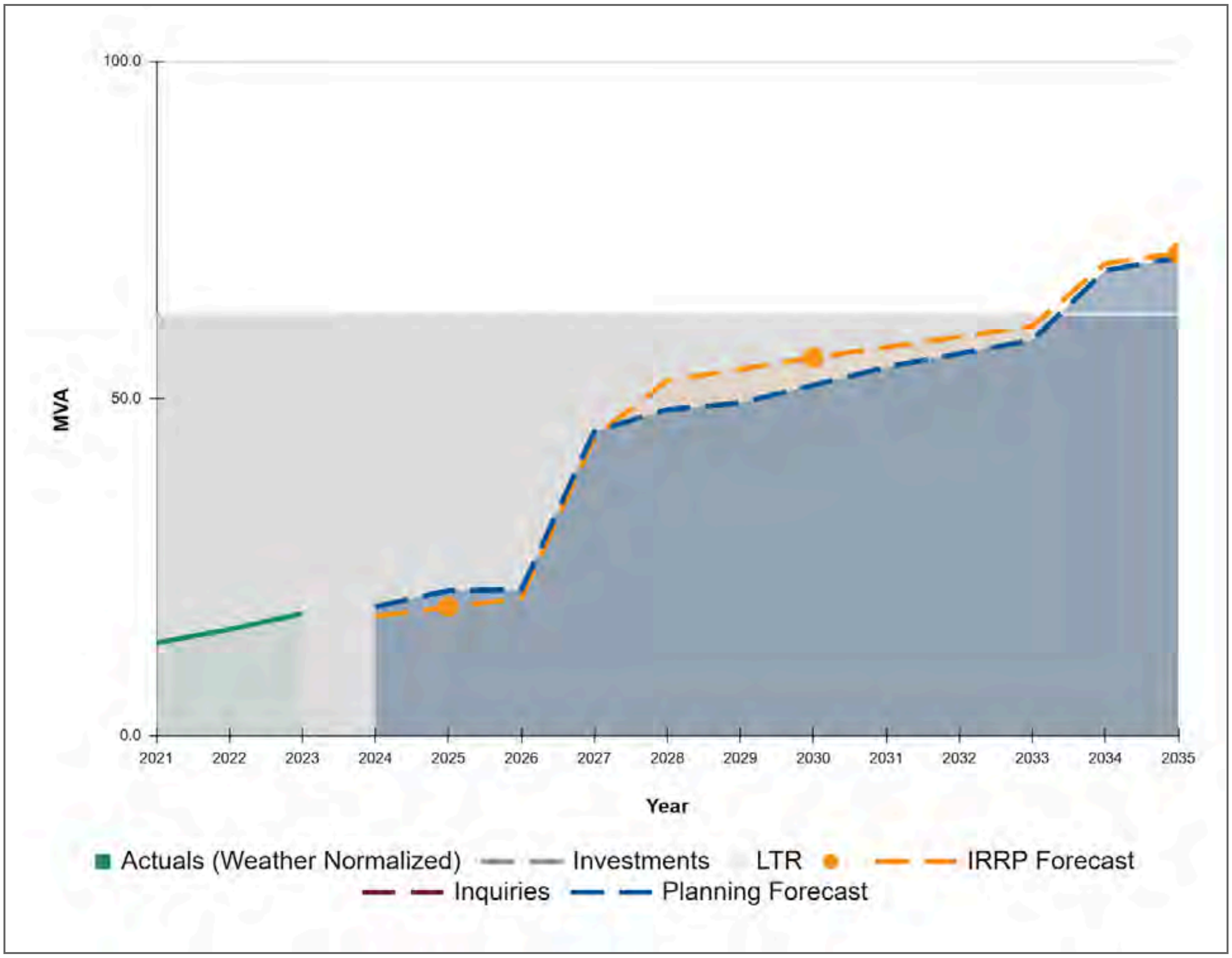
Figure 4 - West 28kV (Southern Region)



[20] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/

Figure 5 presents the load forecast against planned capacity (LTR) of Richmond South MTS. The figure compares the IRRP Forecast, Planning Forecast factoring in the forecasted demand requirements of the large load.

Figure 5 - Richmond South MTS Forecast



The issues the second transformer at Hydro Ottawa's Richmond South MTS helps address are elaborated below.

- Richmond South MTS historically has operated with a single transformer with support from inter-station ties during N-1 contingency scenarios. With the forecasted demand of DND, the inter-station ties will no longer be sufficient to provide support during an N-1 contingency, resulting in stranded load.

- The only other station in close proximity to the large load is Beckwith DS, owned by Hydro One Networks Inc. (Hydro One). Hydro Ottawa owns a single feeder BECK-F2 that supplies this region which is already running above its planning rating. As discussed in Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments, there are limited options to address the loading constraints at BECK-F2 and therefore the addition of incremental load from DND is not an option in the long term. BECK-F2 will support part of the new load until the station upgrade is completed at Richmond South MTS.
- The only viable option to support the large load is to upgrade Richmond South MTS with a second transformer to provide full redundancy during N-1 contingency and extend two new 28kV feeders. Note that the addition of this second transformer is to meet N-1 planning criteria as a result does not show an increase to the planning capacity of the region, further described in Section 5.2.2 of Schedule 2-5-4 - Asset Management Process.

4.3.2.2 Limitations in the 4kV and 8kV systems

Some of the developed areas of Hydro Ottawa's service territory that are seeing growth due to intensification, transit oriented development and electrification are supplied by the 4kV and 8kV system. These systems have limitations compared to the 13kV and 28kV systems as listed below:

- Compared to 28 kV/13kV, the 4kV/8kV systems are less efficient for long-distance power distribution, leading to greater losses and voltage drop issues.
- The maximum capacity that a 4kV/8kV feeder can carry is low compared to higher voltage systems significantly limiting the ability to accommodate the large load requests. The maximum capacity of a 4kV feeder is 2.3MVA and 8kV feeder is 3.6MVA compared to 9.7 MVA on 13kV or 16.4 MVA on 28kV.
- Some of the 4kV and 8kV stations are heavily loaded, hindering new or upgraded customer connections. The increasing number of new load connections or service upgrades require connections/voltage conversions to 13kV and 28kV systems.

4.3.2.3 Distribution System Upgrade Challenges

Expanding the electricity grid to accommodate growth can present significant challenges for Hydro Ottawa. Connecting new customers may require upgrading and reconfiguring the existing system such as long feeder extensions to service new load requests with limited capacity in the lie-along infrastructure.

4.4. PROGRAM BENEFITS

4.4.1. Customer

Reliable and Accessible Electricity Service: The System Expansion program ensures a consistent and reliable supply of electricity, minimizes disruptions, and provides faster, more efficient connections, particularly for new developments. This translates to greater convenience and peace of mind for customers.

Support Economic Growth and Energy Transition: By enabling new customer connections and service upgrades, the program enables new residential, commercial, and industrial developments, supporting economic growth and job creation. It also supports the adoption of EVs and electrified transportation.

Financial Advantages: The System Expansion program's use of economic evaluations can lead to cost offsets for customers, lowering upfront customer costs and promoting affordability. This, coupled with the long-term cost management benefits of proactive upgrades, contributes to greater cost stability and predictability for customers.

4.4.2. Economic Development

Growth and Investment: By extending and upgrading its electrical distribution network, Hydro Ottawa's System Expansion program plays a vital role in promoting regional economic development. It enables residential, commercial, and industrial growth by providing reliable and scalable access to electricity, attracting new businesses and industries to the area. The program supports the City of Ottawa's economic development strategy, driving growth and attracting investment by providing the essential electrical infrastructure required.

Empowering Business Success: The program empowers businesses of all sizes to thrive in Ottawa. By providing reliable and sufficient power, the System Expansion program enables commercial operations, supports innovation, and facilitates business expansion, including entrepreneurial activities and new enterprises, contributing to a dynamic and competitive economic environment.

Adapting to Evolving Energy Needs: The program accounts for evolving energy needs of the customer by identifying infrastructure investments that support both current and future load requirements including growing adoption of EVs and other electrification initiatives.

4.4.3. System Operation Efficiency and Cost Effectiveness

Reduced Energy Losses: Upgrading infrastructure not only increases capacity to serve the customer needs but also improves the efficiency of energy delivery by reducing losses across the network. This contributes to lower operating costs and a more sustainable energy system.

Optimized Resource Allocation: Through economic evaluations, the program ensures optimal financial planning, aligning system investments with future revenue from new customers. This approach minimizes the risk of over-investment, while improving the distribution systems's long-term reliability and efficiency.

Minimized Emergency Repairs and Maintenance Costs: By proactively addressing capacity constraints the program reduces the likelihood of equipment failures due to overloaded equipment and the need for costly emergency repairs. This contributes to lower maintenance costs and improved system reliability.

4.4.4. Coordination and Interoperability

Enhanced Coordination: The program fosters enhanced coordination both internally, between Hydro Ottawa's departments, and externally, with stakeholders such as municipalities, developers, and other utilities. This collaboration ensures that system expansions are efficiently integrated with existing infrastructure and future development plans.

Interoperability with Future Technologies: Collaboration and planning also help ensure that system expansions are compatible with future technological advancements, such as smart grid technologies and DERs. This promotes innovation and allows the grid to adapt to evolving energy needs.

Standardized Equipment and Processes: By standardizing equipment and processes, Hydro Ottawa streamlines long-term system maintenance and operations. This reduces complexity, improves efficiency, and ensures a consistent approach to managing the expanded grid.

4.4.5. Environment

Facilitating Clean Energy Adoption: The program facilitates the adoption of EVs, electric buses, and electrified space heating by ensuring sufficient grid capacity. In turn, the transition away from fossil fuels reduces GHG emissions, improves air quality, and contributes to a cleaner energy mix.

Improving Energy Efficiency: By upgrading infrastructure and implementing smart grid technologies, the System Expansion program improves the overall efficiency of the electricity distribution system, reducing energy waste and minimizing environmental impact. This also supports the development of energy-efficient buildings and sustainable transportation options.

Enabling a Cleaner Transportation Future: The System Expansion program supports Ottawa's transition to a cleaner transportation future by providing the essential electrical infrastructure needed for the growing adoption of EVs and the electrification of public transit, including the city's electric bus fleet. This program is a key enabler of reduced GHG emissions and improved air quality.

4.5. PROGRAM COSTS

The annual costs for the System Expansion program is expected to average $11.8M per year over the 2026-2030 period which is an increase from the $8.3M average costs per year during the 2021-2025 timeframe. In the Test Year period Hydro Ottawa expects the investment needs in this program to reach $59.2M, compared to $41.5M in the Historical and Bridge Year period.

During the 2021-2025 period a consistent trend of increasing expenditure in the System Expansion program was observed, driven by increasing customer demand, as well as the escalating complexity and scale of required infrastructure upgrades. Notably, major investments during the Historical and Bridge Years included infrastructure enhancements to support the LRT Phase 2 expansion and the initial phases of OC Transpo's bus fleet electrification.

While costs associated with the System Expansion are primarily driven by customer-initiated requests, a significant portion is offset through customer contributions (i.e. contributed capital), determined in accordance with the OEB prescribed economic evaluation methodology.

Table 11 presents the Historical, Bridge and Test Year costs for the System Expansion program.

Table 11 - Historical, Bridge and Test Year System Expansion Costs ($’000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
System Expansion - Gross	$ 8.2	$ 9.9	$ 11.3	$ 26.1	$ 33.2	$ 42.9	$ 20.1	$ 14.3	$ 15.0	$ 15.2
Contributed Capital	$ (5.7)	$ (7.7)	$ (3.8)	$ (13.0)	$ (16.9)	$ (18.6)	$ (9.0)	$ (8.7)	$ (2.7)	$ (9.3)
ANNUAL NET TOTAL	**$ 2.5**	**$ 2.2**	**$ 7.4**	**$ 13.0**	**$ 16.3**	**$ 24.3**	**$ 11.0**	**$ 5.6**	**$ 12.4**	**$ 6.0**
5-YEAR NET TOTAL					**$ 41.5**					**$ 59.2**

Test Year costs for the System Expansion program were formulated by extrapolating from the 2021-2023 average volumes (excluding discrete large load requests), with subsequent adjustments based on the observed increase in project complexity and scale, as well as the addition of discrete large load requests. The System Expansion program considers the following discrete projects:

- The construction of the Hydro Road substation to support OC Transpo's transition to a zero-emission bus fleet.
- The upgrade of the Richmond South substation to accommodate the increased load requirements of the DND Dwyer Hill Training Center Upgrade.
- Feeder expansions and other system enhancements required for the new Ottawa Hospital campus.

2026-2030 contributed capital is expected to be 64% of gross cost in line with the average contribution capital proportion for the 2018 to 2022 period.

The System Expansion Program requires continued increases in investment to support the increasing complexity and scale of projects to support the evolving energy needs of the community.

4.5.1. Cost Factors

- Costs of material and equipment
- Skilled labour availability
- Changes in community infrastructure programs
- Project complexity
- Technical challenges of the project
- Location of the project
- Interest rates
- Cancellation or scope changes of infrastructure projects

4.6. ALTERNATIVE EVALUATION

4.6.1. Alternatives Considered

Alternative One: Do Nothing

- The "do nothing" alternative, characterized by the refusal of new customer connection requests due to insufficient capacity, represents an untenable option for Hydro Ottawa.
- This approach would constitute a direct violation of fundamental regulatory obligations as stipulated in the DSC, Ontario Electricity Act, the OEB Act, and Hydro Ottawa's COS and Electricity Distribution License.
- Furthermore, it would severely impede economic development within the City of Ottawa by preventing development projects from accessing the electrical grid due to capacity limitations of the system.

Alternative Two: Enable Customer Connections (Recommended)

- Hydro Ottawa must invest in the System Expansion program to ensure sufficient capacity to accommodate new customer connections and satisfy the evolving electricity demands of the community that Hydro Ottawa serves.
- This investment is required to ensure adherence to regulatory obligations, including those mandated by the DSC and other legislation, enabling Hydro Ottawa to fulfill its statutory duty to provide electricity service to all customers meeting the established connection criteria.

4.6.2. Evaluation Criteria

Given that system expansion is often non-discretionary, driven by the need to meet regulatory obligations for customer connections, the primary evaluation criterion is Regulatory Compliance**.**

- **Regulatory Compliance:** The program must consistently meet all legislative and regulatory requirements, including those mandated by the DSC and the OEB. This ensures Hydro Ottawa fulfills its obligations to provide safe and reliable electricity services to its customers.

While the necessity of system expansion may be driven by regulatory requirements, its implementation can still be assessed for its alignment with broader strategic goals:

- **Economic Development:** To the extent possible within regulatory constraints, the program should contribute to the City of Ottawa's growth and sustainability.
- **Environmental Sustainability:** Where feasible, the program should promote environmental sustainability by supporting electrification, renewable energy integration, and energy efficiency.
- **Community Benefits:** Where possible, the program should enhance community well-being through grid resilience and support for sustainable development initiatives.

Evaluating the program against these criteria, within the constraints of regulatory obligations, will ensure that Hydro Ottawa effectively supports the growing community it serves while adhering to its mandated responsibilities.

4.6.3. Preferred Alternative

Alternative two is the preferred approach for Hydro Ottawa's System Expansion program with the following rational:

- **Regulatory Compliance:** By prioritizing the connection of new customers and investing in necessary capacity upgrades, Alternative 2 ensures adherence to the DSC and other regulatory obligations. This proactive approach avoids potential legal challenges and maintains Hydro Ottawa's compliance with its licensing conditions.
- **Economic Development:** Facilitating the connection of new residential, commercial, and industrial customers is essential for supporting economic growth and development within the City of Ottawa and Municipality of Casselman. Alternative two enables new housing, businesses, and industries to access the electricity grid, fostering economic activity, job creation, and overall prosperity.

  Environmental Sustainability: Alternative two directly supports environmental sustainability by enabling the electrification of transportation, heating, and other sectors. Increased grid capacity allows for the integration of renewable energy sources and facilitates the transition towards a cleaner energy mix. This contributes to reduced GHG emissions and improved air quality.

- **Community Benefits:** Investing in grid capacity enhancements improves the resilience of the electricity distribution system, minimizing the risk of outages and ensuring a reliable power supply for the community. This enhances community well-being and supports sustainable development initiatives by providing the necessary electrical infrastructure for growth and a cleaner energy future.

In contrast, the "Do Nothing" alternative fails to meet these criteria. It would result in regulatory non-compliance, hinder economic development, and limit the community's ability to transition towards a more sustainable energy future.

Therefore, Alternative two is the preferred option as it best fulfills Hydro Ottawa's mandate to provide safe and reliable electricity services while supporting the economic, environmental, and social well-being of the community.

4.7. PROGRAM EXECUTION AND RISK MITIGATIONS

4.7.1. Implementation Plan

Hydro Ottawa's System Expansion program implementation plan encompasses the management of new and modified customer connection requests, ensuring compliance with regulatory requirements, supporting the city's growth, and maintaining system reliability. Additionally each connection request is reviewed and processed in accordance with the DSC and OEB regulations, ensuring fairness and compliance to timelines and requirements. The implementation plan includes:

- **Customer Relationship Management:** Leveraging the CRM system, streamlining processes, prioritizing requests, and maintaining transparent communication with customers.
- **Project Planning and Design:** Conducting thorough capacity assessments, developing detailed engineering plans, optimizing resource allocation, and managing project risks.
- **Construction and Implementation:** Overseeing construction activities, ensuring safety and quality, and coordinating with stakeholders.

- **Customer Connection and Support:** Completing connections, providing ongoing support, and monitoring customer satisfaction.

4.7.2. Risks To Completion and Risk Mitigation Strategies

Hydro Ottawa encounters several risks in managing its System Expansion Program, particularly as new developments and evolving customer demands place increasing pressure on the electricity distribution grid. Furthermore, the program's reliance on third-party projects introduces additional potential risks. Table 12 provides a summary of these key risks and the corresponding mitigation strategies that Hydro Ottawa will employ as needed.

1 **Table 12 - Key Risks of System Expansion Program and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	These scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Technology	Integrating new technologies into existing infrastructure may present challenges related to compatibility, reliability, or cyber security vulnerabilities; this poses a risk to program delivery schedule, cost, and scope.	Conduct thorough technical assessments and pilot testing of new technologies before full-scale deployment to identify and address potential issues. Partner with technology providers and industry experts to ensure seamless integration and mitigate technological risks. Implement robust cyber security measures, including encryption, regular security audits, and continuous monitoring, to protect critical infrastructure and customer data.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

4.8. RENEWABLE ENERGY GENERATION

Under the system expansion program if new station upgrades are deemed necessary to build adequate capacity required to connect new customer demand, Hydro Ottawa ensures that new station transformers shall have reverse power flow capability to enable DERs, with additional functionality enabled by modern microprocessor relays.

5. GENERATION CONNECTIONS

5.1. PROGRAM SUMMARY

Investment Category: System Access
Capital Program Costs:
2021-2025: $0.2M
2026-2030: $0.1M
Budget Program: Generation Connections
Main Driver: Customer Service Request
Secondary Driver: Mandated Service Obligations
Outcomes: Customer Focus

Investments in the Generation Connections program are required to facilitate the integration of generation sources, including renewable DERs and energy storage systems, into the distribution grid. These investments ensure compliance with the Electricity Act[21], OEB regulations[22], and DSC[23] guidelines, which collectively establish the framework and obligations of LDC's to facilitate and manage generation connections while maintaining system reliability and safety. The program encompasses various aspects, such as upgrading infrastructure, improving grid access, and streamlining connection processes to efficiently incorporate diverse energy sources.

Hydro Ottawa's expenditure plans for the Generation Connections program are strategically aligned with the evolving energy landscape for sustainable energy solutions and strengthen the City's transition to a low-carbon future.

Hydro Ottawa plans a net investment of less than $1M through the System Access Capital Investments in the 2026-2030 period compared to a net historical spending of $0.2M in the 2021-2025 period. The increase is driven by anticipated relative accelerated adoption of DERs in 2026-2030 versus 2021-2025 in support of the increasing trend of DER connections, please refer to Section 9 of Schedule 2-5-4 - Asset Management Process, as well as incentive programs such

[21] Electricity Act, 1998, Section 19(1)
[22] OEB Regulations - Chapter 5 - Connection Procedures
[23] Distribution System Code (DSC) - Section 6.1 - Connection of Generation Facilities

as the Save On Energy Home Renovation Savings Program[24] and the Save On Energy Retrofit Program[25] and known projects as committed and/or planned by Hydro Ottawa customers (there is one anticipated large DER connection, above 500 kW, per year between 2026-2030).

There are four types of generation connections within the Generation Connection program:

- Emergency backup generators - used when the local grid electricity supply is temporarily unavailable.
- Net-metering - allows customers to offset their electricity consumption by generating their own renewable energy, with any surplus being fed back into the grid.
- Load displacement generation - for customers who produce electricity solely for self-consumption purposes at all times (no electricity will be exported back to the utility grid)
- Stand-alone generation - for customers with intention of passing all generated electricity into the utility grid with no self-consumption.

Generation categories are defined in accordance with Section 1.2 of the DSC as follows:

- Micro-embedded generation facility: Facilities with a name-plate rated capacity of 10kW or less
- Small embedded generation facility: Facilities with a name-plate rated capacity of 500kW or less in the case of a facility connected to a less than 15kV line or 1 MW or less in the case of a facility connected to a 15kV or greater line
- Medium embedded generation facility: Facilities with a name-plate rated capacity above 500kW but less than 10 MW in the case of a facility connected to a less than 15kV line, or above 1 MW but less than 10 MW in the case of a facility connected to a 15kV or greater line
- Large embedded generation facility: Facilities with a name-plate rated capacity of more than 10 MW

[24] Save On Energy, "Home Renovation Savings Program, "https://www.saveonenergy.ca/For-Your-Home/Home-Renovation-Savings

[25] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

Within Hydro Ottawa's service territory, there is a diverse array of both renewable and non-renewable DERs, including energy-generating and storage facilities. These connections continue to be established under various programs, such as IESO-administered initiatives as well as through Net Metering and Load Displacement programs.

5.2. PERFORMANCE OUTCOMES

The objective of Generation Connections outlined in Table 13 is to ensure the timely, cost-effective, reliable, and safe integration of both renewable and non-renewable DERs into the distribution system for new and existing customers

Table 13 - KPI Metrics Impacted by Generation Connections

OEB Performance Outcomes	Outcome Description
Customer Focus	Contributes to Hydro Ottawa's customer focus objectives by fulfilling generation connection requests and meet mandated service obligations guided by relevant provisions of the DSC, Electricity Act, 1988 (Electricity Act), OEB Act, 1998 (OEB Act), and Hydro Ottawa's COS. Refer to Attachment 1-3-3(C) - Electricity Utility Scorecard Benchmarking Analysis for Mandated Service Obligations in the Utility Scorecard

5.3. PROGRAM DRIVERS AND NEED

5.3.1. Drivers

Primary Driver: Third Party Requirements

The main driver for Generation Connections to the distribution grid is customer driven connection of embedded generation projects. Each request includes specific requirements, including technical specifications for integration, connection impact assessments, and compliance with regulatory standards. Customers initiate these requests to ensure that their installations meet system requirements and are aligned with project timelines and development schedules.

Secondary Driver: Mandated Service Obligations

Hydro Ottawa has a service obligation pursuant to the DSC and governed by the Distributed Energy Resources Connection Procedure (DERCP) to connect generation connections in Hydro Ottawa's service territory

5.3.2. Current Issues

The following factors can limit the distributions systems ability to accommodate generation connections:

- Station Loading – Some station transformers have limited or no capability for reverse power flow. At these stations, the total connected generation cannot exceed either:
  - 60% of the top transformer rating plus the minimum station loading
  - The minimum station loading when the station transformers do not have reverse flow capability. This limit has been adopted from Hydro One's evaluation tool for generation connection assessment.
- Feeder Thermal Rating – Exceeding the feeder ampacity rating will result in overheating the conductors and connected equipment thereby reducing their effective life. For DERs, the available thermal capacity is the full feeder ampacity rating with less contingency loading.
- Short Circuit Rating – Connection of DERs will increase the available current that flows through the system during faults. The total available current during faults cannot exceed the equipment ratings.
- Power Quality – The following power quality concerns arise when connecting distributed generation:
  - harmonics caused by inverter based generation
  - phase imbalance caused by single-phase generators
  - voltage instability caused by generators connected at various points along a feeder, or by induction generators requiring reactive power
  - flicker caused by generators intermittently turning on and off which can affect the voltage on the circuit thus impacting the quality of supply to Hydro Ottawa customers
- Anti-Islanding – DERs may introduce safety and power quality issues in the event of continued un-sanctioned generation after the loss of distribution supply. The installation of transfer trip

functionality and alternate anti-islanding methods may be used to mitigate the potential for the un-sanctioned islanding of a generator. Currently, transfer trip is only required for generation connections equal to or larger than 500kW. The DERs connected to both feeders and station must be managed to prevent adverse impact to existing Hydro Ottawa load and customers.

5.4. PROGRAM BENEFITS

5.4.1. System Operation Efficiency and Cost Effectiveness

Integrating DERs into the distribution grid enhances system operational efficiency by decentralizing power generation, reducing transmission losses, and alleviating strain on central grid infrastructure. This decentralization also drives contributions to cost-effectiveness by minimizing the need for extensive infrastructure upgrades and improving load management. Additionally, DERs offer valuable services such as peak shaving and demand response, further optimizing operational costs and enhancing grid stability.

5.4.2. Customer

For the customer, DER integration can lead to lower energy costs through mechanisms like peak shaving and energy savings, while also offering them the opportunity to generate their own energy and potentially earn bill offsets or credits through programs like Net-Metering.

DERs have the capacity to enhance grid management by supplying/providing localized power that can continue during outages, enhancing/thus improving overall grid resilience. By reducing grid overloads and transmission losses, they lower the risk of equipment failures. DERs also incorporate advanced control features and enable the formation of microgrids, further strengthening grid stability and fault tolerance. They help reduce grid overloads and transmission losses, minimizing the risk of equipment failures. Advanced control features in DERs and the ability to form microgrids further strengthen grid stability and fault tolerance.

5.4.3. Cyber Security and Privacy

DERs can enhance cyber security by decentralizing energy generation, which reduces the risk of a single- point of failures and limiting in the grid and limits the impact of potential cyberattacks. Privacy benefits of DERS include more granular control over energy data, which can be managed and protected at the local level, minimizing exposure to broader data breaches.

5.4.4. Coordination and Interoperability

The distribution grid benefits from improved coordination and interoperability through real-time data exchange and communication between different energy sources. This enhances dynamic resource management and ensures that diverse energy systems operate seamlessly together, resulting in a more flexible and resilient grid.

5.4.5. Economic Development

DERs stimulate economic development by attracting investments in clean energy and creating jobs in the renewable sector. They help reduce energy costs for businesses and households, fostering local economic growth and stability. Additionally, DERs drive innovation and infrastructure enhancement, contributing to long-term economic resilience. Boosting economic development, DERs attract investment in clean energy and create jobs in the renewable sector. They also reduce energy costs for businesses and households, fostering local economic growth and stability. Additionally, DERs drive innovation and enhance infrastructure, contributing to long-term economic resilience.

5.4.6. Environment

Integrating DERs supports environmental sustainability by reducing reliance on fossil fuels and lowering GHG emissions. Utilizing clean energy sources such as solar and wind helps build a greener, more sustainable energy system.

5.5. PROGRAM COSTS

The annual spend for the Generation Connection Program is expected to have limited net cost over the 2026-2030 period, compared to the 2021-2025 period which also reflects this trend.

Hydro Ottawa evaluates these programs based on net spending, reflecting the balance between project costs and customer contributions. Forecasts for these contributions are derived from historical data and committed customer projects. Customer contributions for the Generation Connection Program are expected to match the gross cost of the project.

Table 14 below shows the historical and future spending in the Generation Connection program.

Table 14 - Historical, Bridge and Test Year Generation Connection Expenditures ($'000 000s)[26]

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Generation Connections - Gross	$ 0.2	$ 0.1	-	$ 0.1	$ 0.1	$ 0.7	$ 0.8	$ 0.8	$ 0.9	$ 1.0
Contributed Capital	$ (0.1)	$ (0.1)	-	$ (0.1)	$ (0.1)	$ (0.7)	$ (0.7)	$ (0.8)	$ (0.9)	$ (1.0)
ANNUAL NET TOTAL	**$ 0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
5-YEAR NET TOTAL	**$ 0.2**					**-**				

The increase is driven by anticipated acceleration in adoption of DERs in 2026-2030 versus 2021-2025, this is supported by the increasing trend of DER connections, please refer to Section 9 of Schedule 2-5-4 - Asset Management Process, due to incentive programs such as the Save On Energy Home Renovation Savings Program[27] and the Save On Energy Retrofit Program[28] and known projects as committed and/or planned by Hydro Ottawa customers (there is one anticipated large DER connection, above 500 kW, per year between 2026-2030).

[26] Totals may not sum due to rounding.
[27] Save On Energy, "Home Renovation Savings Program, "https://www.saveonenergy.ca/For-Your-Home/Home-Renovation-Savings
[28] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

5.5.1. Cost Factors

- Infrastructure upgrades or system expansion required to support new generation systems
- Material and equipment costs
- Skilled labour availability
- Regulatory changes

5.6. ALTERNATIVES EVALUATION

5.6.1. Alternatives Considered

Alternative 1: Do Nothing (Refuse Generation Connections)

Refuse customer driven generation connections. This is not an option as by doing this Hydro Ottawa would be violating the DSC as well the COS. Hydro Ottawa must adhere to regulatory requirements that mandate the connection of generation under specific conditions. This compliance necessitates financial investment in infrastructure.

Alternative 2: Enable Generation Connections (Recommended)

Propose investments required to enable generation connections. Hydro Ottawa must invest in the proposed budget to support generation connections. This expenditure is critical for accommodating customer demand and the City of Ottawa's projected growth and addressing its evolving energy needs. Hydro Ottawa is required under the DSC to facilitate these connections, as long as customers fulfill the stipulated conditions, making this investment necessary.

5.6.2. Evaluation Criteria

The alternatives for Generation Connections were evaluated based on the following criteria:

- **Regulatory Compliance:** The program must consistently meet all legislative and regulatory requirements. This criterion assesses how well each alternative adheres to all applicable laws, regulations, and industry standards, including the DSC and Hydro Ottawa COS.
- **Environmental Sustainability:** The program should promote environmental sustainability by supporting renewable energy integration. This criterion examines the program's impact on

environmental sustainability, specifically its support for integrating customer-driven generation, which often involves renewable energy sources. This aligns with Hydro Ottawa's responsibility to contribute to a cleaner energy future.

- **Community Benefits:** The program should enhance community well-being by supporting customer energy choices and energy resilience and independence. This criterion assesses the program's contribution to community well-being, facilitating customer choice by connecting generation sources, allowing them to actively participate in the energy landscape and make decisions that align with their needs and preferences.

5.6.3. Preferred Alternative

Alternative 1: refusing generation connections, fails to meet the Regulatory Compliance criterion. By not facilitating generation connections, Hydro Ottawa would be in violation of the DSC and its COS. It also fails to contribute to Environmental Sustainability or Community Benefits, as it hinders the integration of renewable energy and customer energy choices.

Alternative 2: enabling generation connections, fully satisfies the Regulatory Compliance criterion by ensuring Hydro Ottawa fulfills its legal obligations under the DSC and COS. It supports Environmental Sustainability by facilitating the integration of renewable energy sources, aligning with the company’s commitment to a cleaner energy future. Furthermore, it contributes significantly to Community Benefits by empowering customers with energy independence, enhancing energy resilience, and supporting customer choice in the evolving energy landscape.

Based on the evaluation criteria, Alternative 2: Enable Generation Connections is the preferred alternative. It balances the need to meet regulatory requirements with the opportunity to promote environmental sustainability and enhance community well-being. This approach allows Hydro Ottawa to effectively support generation connections while contributing to a sustainable and resilient energy future for the City of Ottawa.

5.7. PROGRAM EXECUTION AND RISK MITIGATIONS

5.7.1. Implementation Plan

Hydro Ottawa utilizes a CRM system to manage and process connection requests. Generation connection requests are implemented in the order in which they are received. All requests are completed in accordance with mandated timelines.

5.7.2. Risks To Completion and Risk Mitigation Strategies

For Hydro Ottawa's Generation Connection Program, several risks to completion could arise. The potential risks and corresponding mitigation strategies are outlined in Table 15 below:

Table 15 - Key Risks of Generation Connection Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Regulatory and Compliance Risks	Failure to meet existing laws and regulations or changes to those laws and regulations pose a risk to program delivery schedule.	Hydro Ottawa maintains consistent communication with regulatory bodies to stay informed about any changes in regulations. Establishing a robust compliance framework and conducting regular audits ensures adherence to all requirements, minimizing the risk of delays and ensuring smooth project progression.
Infrastructure Capacity Issues	Limited infrastructure capacity such as short circuit constrained feeders or thermal constrained feeders may impede the ability to accommodate new generation connections, posing a risk to program delivery schedule.	Hydro Ottawa conducts thorough assessments of existing infrastructure and prioritizes necessary upgrades or expansions based on capacity needs. Investing in infrastructure improvements and strategic planning helps support the increased load from new connections and ensure efficient integration.

Category	Risk	Mitigation
Technical Challenges	Technical difficulties in integrating new generation systems with existing infrastructure poses a risk to the program delivery schedule.	Hydro Ottawa engages in detailed technical planning and performs rigorous testing before full-scale implementation. Collaborating with technology providers helps identify and resolve potential issues early, ensuring that the integration process is smooth and efficient.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Customer Engagement and Delays	Delays in customer submissions, approvals, or installations can pose a risk to the program delivery schedule.	Hydro Ottawa streamlines the application and approval processes to reduce delays. Providing clear guidelines and support to customers facilitates timely and accurate submissions, thereby minimizing potential disruptions in the project schedule.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Project Management Risks	Poor project management practices can result in missed deadlines and incomplete installations.	Hydro Ottawa implements robust project management practices, including detailed planning, regular progress reviews, and clear accountability structures. Utilizing project management tools to track progress and manage risks helps ensure that projects are completed on time and to specification.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

5.7.3. Timing Factors

Hydro Ottawa is mandated by the DERCP to maintain timelines required in generation connection projects in each stage of the project from connection impact assessments to energization. Hydro Ottawa uses a CRM system to track timelines for each step and monitor performance to avoid non-compliance.

Any delays due to scope change, cost overruns are clearly communicated to the customer to manage customer expectations on project delivery.

5.8. RENEWABLE ENERGY GENERATION

Investments in the Generation Connections program are required to facilitate the integration of generation sources, including renewable DERs and energy storage systems, into the distribution grid.

6. METERING

6.1. PROGRAM SUMMARY

Investment Category: System Access

Capital Program Costs:

2021-2025: $1.7M

2026-2030: $1.7M

Budget Program: Suite Metering

Main Driver: Customer Service Request

Secondary Driver: Mandated Service Obligation

Outcomes: System Accessibility, Customer Engagement, External Governance

The Suite Metering program supports investments in suite metering technology to ensure accurate and compliant measurement of electricity for Hydro Ottawa. Suite Metering initiatives, addresses both new customer connections and planned upgrades for existing customers. Suite Meters are used to individually meter electricity consumption in multi-unit residential buildings, enhancing precision and regulatory compliance.

The scope of the Suite Metering program includes installing smart meters in new or existing residential or commercial buildings, with clear definition of responsibilities for both Hydro Ottawa and the building owner. Hydro Ottawa supplies and installs the metering equipment, ensuring it meets Measurement Canada, building and electrical code standards, while the owner provides access and accurate occupant data.

6.2. PERFORMANCE OBJECTIVES AND TARGETS

The following outcomes are expected to be achieved through the Suite Metering Program, as outlined in Table 16 below.

Table 16 - Suite Metering Program Performance Outcomes

OEB Performance Outcomes	Target
Customer Focus	● Enhance customer engagement with expanded energy management tools by providing access to detailed energy use data. These tools will provide customers personalized insights into energy consumption, opportunities for enhanced energy efficiency and cost savings, greater control over their energy use, ultimately leading to improved customer satisfaction
Operational Effectiveness	● Improve grid planning and grid management by gaining insights from behind the meter customer energy data and consumption patterns at a granular level ● Enhance data-driven decision-making by leveraging meter data using analytics and tools to enhance visibility of behind the meter DERs and their impacts, identify trends, and inform opportunities for Non-Wires Solutions (NWSs) and other demand-side management programs for flexibility and reliability
Public Policy Responsiveness	● Contributes to Hydro Ottawa's grid modernization strategy and the OEBs expectation that utilities incorporate consideration of NWSs into their distribution system planning process by: ○ Utilizing load disaggregation and energy analytics tools for bottom-up behind the meter visibility to DERs and other electricity appliances. Improving visibility will enhance data-driven decision making, inform grid planning, and help uncover opportunities for load reduction and shifting using NWSs

6.3. PROGRAM DRIVERS AND NEEDS

6.3.1. Drivers

Primary Driver: Customer Service Request

The main driver for Hydro Ottawa in the Suite Metering program is to improve billing transparency, accuracy, and provide a single point of contact for customers, addressing potential issues with third-party providers.

Secondary Driver: Mandated Service Obligations

Secondary drivers include enhanced service reliability, consistent regulatory compliance with OEB standards, fair and transparent pricing by eliminating third-party fees, and more efficient maintenance and upgrades. Together, these factors contribute to a better customer experience and greater confidence in the metering and billing processes.

6.3.2. Current Issues

Suite metering presents Hydro Ottawa with several challenges, each requiring specific strategies and investments to overcome.

- **Complex and Costly Installation:** The installation process, whether fitting new buildings or retrofitting older ones, is complex and costly due to varying building layouts and infrastructure constraints. This variability leads to unique engineering requirements and potentially extensive on-site modifications. To address this, Hydro Ottawa uses strategic planning and coordination to optimize timelines and reduce expenses. Investments will support thorough site assessments and customized plans for efficient deployment.
- **Ensuring Reliable Communication with Numerous Meters:** Maintaining consistent and reliable communication with a large number of meters in a suite metering system poses a significant challenge, as building materials and signal interference can disrupt data transmission. This disruption can lead to inaccurate readings and operational inefficiencies, hindering the benefits of real-time monitoring and accurate billing. To address this, Hydro Ottawa will invest in robust communication infrastructure and advanced network technologies. This ensures consistent data transmission and real-time monitoring for accurate metering.

6.4. PROGRAM BENEFITS

6.4.1. System Operation Efficiency and Cost Effectiveness

Suite metering allows for more accurate tracking of individual consumption patterns. This data can be used to implement demand-side management programs in the future, encouraging consumers to shift their usage away from peak hours, thus reducing strain on the grid and the need for infrastructure upgrades.

6.4.2. Customer

By accurately measuring individual consumption in each unit, tenants can ensure fair billing according to their usage.

6.4.3. Environment

Suite metering drives environmental benefits by encouraging energy conservation. It allows for better grid management, lessening the need for infrastructure. By supporting green building practices, suite metering contributes to a more sustainable built environment. Ultimately, it empowers tenants to actively participate in a more environmentally responsible energy system.

6.5. PROGRAM COSTS

The annual spend for the Suite Metering Program is expected to average \$0.3M over the 2026-2030 period which is consistent with the \$0.3M average annual spend during the 2021-2025 timeframe. Hydro Ottawa expects the investment needs in this program to remain the same at \$1.7M in both the 2026-2030 and 2021-2025 periods. Suite metering has remained relatively stable over the 2021-2025 period and this trend is expected to continue.

Table 17 presents the historical and projected future expenditures for the Suite Metering Program between 2021 and 2030.

Table 17 - Historical, Bridge and Test Year Metering Expenditures (\$'000 000s)[29]

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Suite Metering	\$ 0.6	\$ 0.4	\$ 0.2	\$ 0.3	\$ 0.3	\$ 0.3	\$ 0.3	\$ 0.3	\$ 0.4	\$ 0.4
5-YEAR TOTAL					**\$ 1.7**					**\$ 1.7**

Cost projections for the Suite Metering Program were formulated by extrapolating from the 2021-2023 average volume. Continued investment levels in the Suite Metering Program will continue to support customers, providing more visibility of their consumption and facilitating customer conservation efforts. Variability in installation cost, prevalence of third party energy metering, changes in material and equipment, skilled labour availability, changes to regulations, and evolving communication requirements may cause deviations from this forecast. Hydro Ottawa

[29] Totals may not sum due to rounding

will continue to monitor suite metering expenditure trends and continue to support customers, providing more insight into their electrical consumption.

6.5.1. Cost Factors

- Variability of installation cost
- Prevalence of third party energy metering
- Changes in material and equipment, as well as, cost changes
- Skilled labour availability
- Changes to regulations

6.6. ALTERNATIVE EVALUATION

6.6.1. Alternatives Considered

Alternative 1: Bulk Metering: Managing a single meter for the entire building simplifies operations, reduces complexity, and avoids significant infrastructure upgrades. However, tenants lack direct control over their energy use and billing, leading to unfair cost distribution, higher energy consumption, and dissatisfaction with energy transparency.

Alternative 2: Third-Party Metering: Third-party providers handle the metering infrastructure, reducing upfront capital costs for Hydro Ottawa. This arrangement allows Hydro Ottawa to avoid dealing directly with tenants for billing or service issues. However, it loses control over the customer experience, which can lead to lower service standards, delayed issue resolution and inconsistent billing. This situation may result in customer complaints and potential reputational damage to Hydro Ottawa.

Alternative 3: Suite Metering (Hydro Ottawa Managed) - Preferred Alternative: Hydro Ottawa directly manages the suite metering program. This approach allows for increased customer base, enhances energy efficiency and conservation, and improves customer experience and satisfaction. Suite metering enables Hydro Ottawa to expand its customer base by serving individual tenants in a multi-residential unit building instead of only the building owner as a single customer. It encourages responsible energy consumption by providing individual tenants with direct control over their electricity usage and billing, aligning with Hydro Ottawa's energy conservation goals and regulatory mandates. Suite metering also allows for more accurate and personalized billing, leading to higher customer satisfaction. Tenants can monitor their usage and bills directly with Hydro Ottawa.

6.6.2. Evaluation Criteria

The alternatives considered for suite metering were evaluated based on the following key criteria to determine the most beneficial approach for Hydro Ottawa and its customers:

- **Customer Empowerment and Energy Awareness:** The extent to which the alternative provides tenants with direct control over their energy usage and billing, fostering energy awareness and promoting conservation.
- **Operational Efficiency and Complexity:** The impact of the alternative on Hydro Ottawa's operational processes, including billing, customer service, and infrastructure management.
- **Customer Experience and Satisfaction:** The potential of the alternative to enhance customer satisfaction through accurate billing, personalized service, and transparent energy management.
- **Regulatory Alignment and Strategic Goals:** The degree to which the alternative supports Hydro Ottawa's regulatory obligations, energy conservation goals, and strategic objectives, including expanding its customer base.
- **Cost-Effectiveness and Risk Mitigation:** The financial implications of the alternative, including upfront costs, ongoing maintenance, and potential risks associated with customer dissatisfaction or operational inefficiencies.

6.6.3. Preferred Alternative

Based on the evaluation criteria, **Alternative 3**: managing suite metering directly by Hydro Ottawa is the preferred alternative.

Alternative 1: While bulk metering offers operational simplicity, it fails to empower tenants or promote energy conservation, leading to potential customer dissatisfaction.

Alternative 2: Third-party metering, while reducing upfront costs, compromises customer experience and control, posing reputational risks.

Alternative 3: Hydro Ottawa's direct management of suite metering aligns with its strategic goals by expanding its customer base and enhancing energy efficiency. It empowers tenants with direct control over their energy consumption, leading to increased energy awareness and conservation. This approach also ensures a high level of customer satisfaction through accurate and personalized billing, while maintaining control over the customer experience. By directly managing the suite metering program, Hydro Ottawa can effectively balance operational efficiency, customer satisfaction, and regulatory compliance.

6.7. PROGRAM EXECUTION AND RISK MITIGATIONS

6.7.1. Implementation Plan

Hydro Ottawa utilizes a CRM system to manage and process suite metering requests. Suite metering requests are implemented in the order in which they are received. All requests are completed in accordance with mandated timelines.

6.7.2. Risks To Completion and Risk Mitigation Strategies

Resource availability and suite metering panel supply pose the biggest risk to project completion. To meet demand, Hydro Ottawa engaged three suite metering service providers. Clear communication with building owners ensures timely panel delivery and project completion.

6.7.3. Timing Factors

Hydro Ottawa must provide an offer to connect for suite metering requests within 60 calendar days after receiving a complete application. The timeline for an offer to connect is specified in the OEB's DSC, Section 6.2.7. The offer outlines the connection terms, costs, and requirements for connection unit suites.

SYSTEM RENEWAL INVESTMENTS

1. SUMMARY

Hydro Ottawa's System Renewal Capital Investments for 2026-2030 total $431.8M, focusing on five key programs designed to replace deteriorating infrastructure, enhance grid resilience, and ensure the continued delivery of safe and reliable electricity service to the community.

System Renewal Capital Programs:

Section 2. Stations and Buildings Infrastructure Renewal ($107.7M):

Hydro Ottawa's Station and Buildings Infrastructure Renewal Program invests in upgrading and replacing deteriorating assets for stations and station buildings to maintain system reliability and safety. These assets include transformers, switchgear, batteries, protection and control systems, and other minor assets such as reclosers, insulators, arresters, online monitoring equipment and station building roofs. Investment prioritization of condition based assets utilizes Predictive Analytics, the risk assessment model which considers reliability, safety, financial, environment and compliance factors. Non-condition based assets, including RTUs, station minor assets, buildings/facilities and transfer trip installations are prioritized based on age.

Section 3. OH Distribution Asset Renewal ($67.8M):

This program focuses on renewing overhead distribution infrastructure, including poles, transformers, switches and reclosers, with the objective of mitigating long-term risk based on the results from Predictive Analytics.

Recent weather events have highlighted the vulnerability and increased failure rate of overhead equipment. Consequently, the program now includes incremental investment attributed to strategic undergrounding, line relocation, or hardening of critical overhead sections due to added complexity.

Section 4. UG Distribution Asset Renewal ($103M):

This program replaces deteriorating underground distribution assets, including cables, transformers, and switchgear, civil infrastructure and vault equipment, with the objective of mitigating short-term risk based on the results from Predictive Analytics. Investments in this area are essential for maintaining the reliability and resilience of the underground network.

Section 5. Metering Renewal ($86.4M):

This program involves upgrading and replacing functionally obsolete metering infrastructure to support advanced metering functionality and improve system monitoring capabilities. This investment ensures regulatory compliance, improves customer billing, and enables advanced grid management capabilities for improved reliability and customer engagement.

Section 6. Corrective Renewal ($66.9M):

This program addresses the replacement of assets that have degraded to a point of functional failure and pose an imminent failure risk, or have been damaged by third parties. While prioritizing proactive renewal, Hydro Ottawa also recognizes the need for reactive measures to maintain system integrity and address unexpected failures.

These investments address key challenges such as deteriorating infrastructure, the need to adapt to evolving technology (e.g. smart meters), and climate change impacts (including extreme weather events). Hydro Ottawa is committed to providing safe, reliable, and sustainable electricity service to the residents and businesses of Ottawa, and these investments are crucial to fulfilling that commitment.

These investments will deliver tangible benefits to Hydro Ottawa's customers:

- **Enhanced Reliability:** Modernizing and strengthening the grid will reduce the frequency and duration of outages.
- **Enabling a Cleaner Energy Future:** Facilitating the integration of renewable energy sources supports a more sustainable energy future for Ottawa.
- **Improved Accuracy & Transparency:** Advanced metering infrastructure will enhance the accuracy and transparency of electricity measurement and provide customers with greater insights into their energy consumption.

Hydro Ottawa acknowledges the challenges inherent in implementing these investment programs, including the need to replace deteriorating equipment to prevent outages, strengthening the grid to withstand extreme weather and ensure reliable power, and investing in smart meter infrastructure. This document details how these investments will address these challenges to deliver safe, reliable, and sustainable electricity service to the residents and businesses of Ottawa.

2. STATIONS AND BUILDINGS INFRASTRUCTURE RENEWAL

2.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

- 2021-2025: $31.4M
- 2026-2030: $107.7M

Budget Programs: Station Transformer Renewal, Station Switchgear Renewal, Station Battery Renewal, Station P&C Renewal, Station Minor Assets Renewal, Station Major Rebuild, EOL Voltage Conversion.

Main Driver: Failure Risk

Secondary Driver: Reliability, Safety, Environmental, Capacity Constraints

Outcomes: Operational Effectiveness, Customer Focus

Hydro Ottawa's Station and Buildings Infrastructure Renewal Program invests in renewing station assets and station buildings. This program replaces end-of-life station assets in a deteriorated condition, ensuring long-term performance and prioritizing projects based on asset condition and risk, as determined through the distribution asset model in Copperleaf PA (described in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process).

An investment of $107.7M is proposed to this program for this Application. The primary contributor is investments in five voltage conversion projects necessitated by the need to replace end-of-life station transformers. These projects account for over half of the program's expenditure. The majority of the remaining investment is attributed to four station switchgear renewal projects, based on the needs identified through Copperleaf Predictive Analytics (PA). This funding will maintain overall system reliability by optimizing asset replacement strategies and improving the operational asset performance of existing station infrastructure.

The Stations and Buildings Infrastructure Renewal Program encompasses the following Budget Programs for the 2026-2030 period:

Stations Switchgear Renewal: This budget program covers the cost of replacing end-of-life breakers in deteriorated condition at four stations: Rideau Heights DS, Parkwood Hills DS, Hinchey TH, and Russell TB. The program also includes funding to replace relays and RTUs at these stations that have become obsolete or have operational issues.

Station Battery Renewal: This budget program includes the replacement of an average of two battery banks per year over the course of the 2026-2030 rate period. There are 11 stations planned for battery replacement: Augusta UD, Beechwood UB, Bronson SB, Bantree AL, Woodroffe DS, Bayswater UJ, Florence UF, Holland SH, Urbandale AE, Centrepointe DS and Moulton MS stations.

Station Protection & Control (P&C) Renewal: This budget program encompasses the replacement of several critical components within the protection and control system, such as relays and Remote Terminal Units (RTUs). This includes replacing the end-of-life electromechanical relays at both the Carling TM and King Edward TK stations. Additionally, the program targets the replacement of obsolete RTUs at Centrepointe DS, Jockvale DS, and Queensway-Carleton Hospital (QCH) DS. Finally, the program will address the replacement of end-of-life transfer trip installations for the Lemieux Island Filtration Plant and the Britannia Filtration Plant.

Station and Building Minor Asset Renewal: This budget program focuses on replacing non-major station assets, including station outdoor reclosers, lightning arresters/insulators, online dissolved gas analysis (DGA) monitors, and station buildings and operational facilities. The funds will be utilized to replace and upgrade station equipment and buildings, and for specific capital projects at the Dibblee and Maple Grove operational sites. These investments are crucial for maintaining the reliability and efficiency of the electricity distribution system, and for preventing costly equipment failures and service disruptions.

EOL Voltage Conversion: This budget program focuses on decommissioning 4kV stations that have reached end-of-life (EOL). The prioritization of voltage conversion projects is based on station transformer risk assessments conducted within Copperleaf PA. As detailed in Section 9.1.4.6 of Schedule 2-5-4 - Asset Management Process, the 4kV system cannot accommodate anticipated future demands. Consequently, there are plans to decommission 4kV assets. The program's scope encompasses voltage conversion for five stations: Fisher AK, Dagmar AC, Henderson UN, Church AA and Vaughan UG.

2.2. PERFORMANCE OUTCOMES

Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. Investments in stations and buildings infrastructure renewal programs support Hydro Ottawa's performance on the outcomes shown in Table 1.

Table 1 - Station Asset Renewal Program Performance Outcomes

OEB Performance Outcome	Description
Operational Effectiveness	Hydro Ottawa's system reliability objectives are supported by: ● Replacing assets at a pace that allows Hydro Ottawa to achieve 55% of station assets that have reached their end-of-life by 2030. ● Replacing assets at a pace that allows Hydro Ottawa to minimize the percentage of station assets in poor and very poor condition by 2030.
	● Contributes to Hydro Ottawa's Grid Modernization Plan by replacing 145 electromechanical relays with digital relays, thereby improving station-level observability
Customer Focus	Contributes to Customer Satisfaction by maintaining system reliability

2.3. PROGRAM DRIVERS AND NEED

2.3.1. Main and Secondary Drivers

The Station Asset Renewal program's primary and secondary drivers are as follows:

Primary Driver – Failure Risk: The primary driver for station renewal investments is the increasing failure risk due to the number of assets in a deteriorated condition or surpassing their typical useful life (TUL). The proposed investments are supported by the Copperleaf PA distribution asset model which considers asset condition as a part of the risk assessment value framework. Further detail on the distribution asset model is provided in Section 5.1.4.2 of Schedule 2-5-4 - Asset Management Process.

Secondary Drivers – Reliability, Safety, Environmental and Capacity Constraints: Station assets directly affect system reliability, as any failure can lead to power outages for large numbers of connected customers. An increase in station asset failures will negatively impact reliability indices such as System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI), which measure the frequency and duration of customer interruptions.

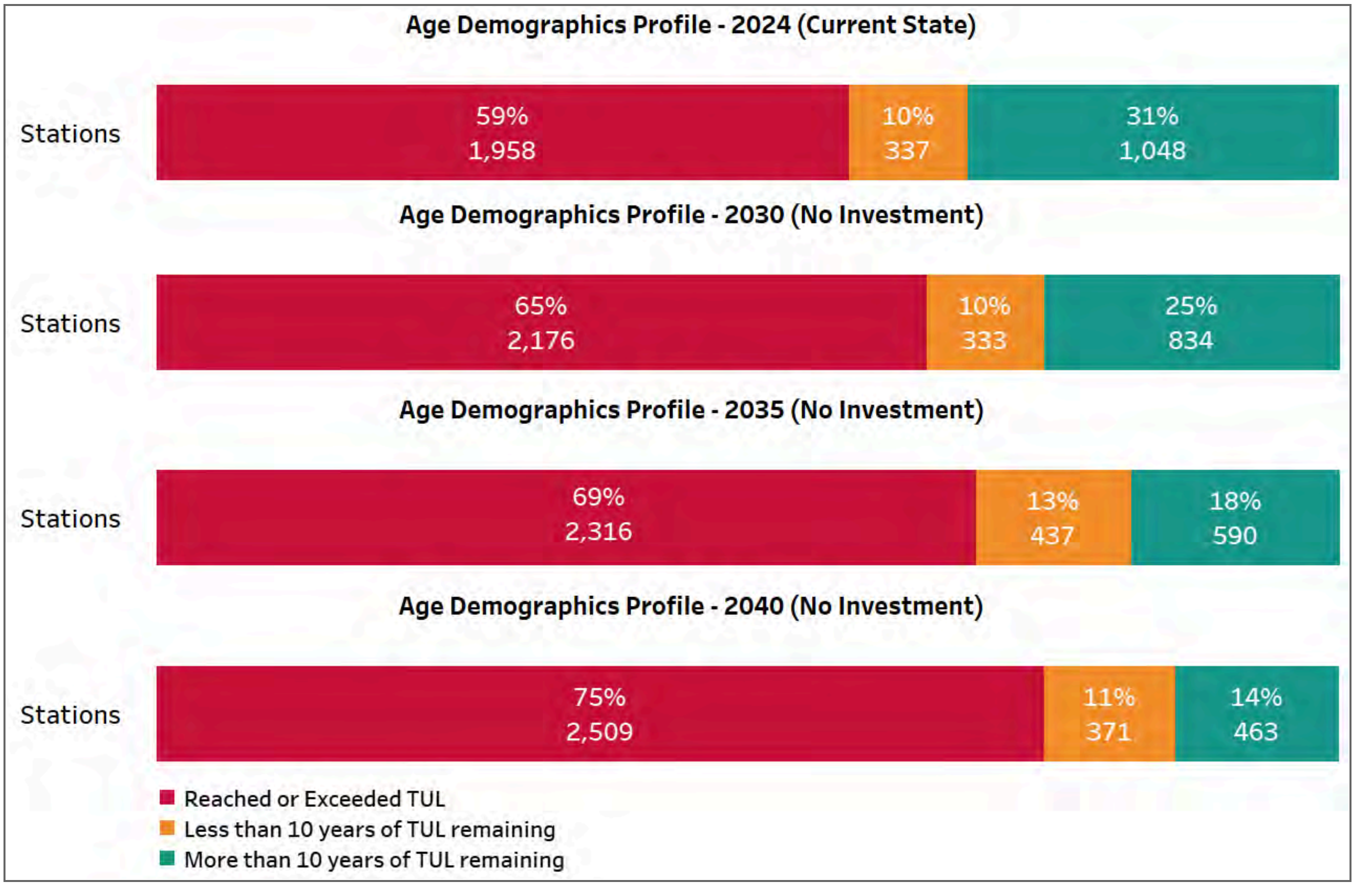
These assets also pose significant safety risks to Hydro Ottawa personnel, contractors, and the public due to the potential for asset failure. Major oil-filled equipment like station transformers can create environmental hazards through oil leaks. Similarly, the failure of Sulfur Hexafluoride (SF_6) switchgear presents environmental risks, as SF_6 is a potent greenhouse gas.

Additionally, increased system capacity needs and the growing demand for electrification make the capacity limitations of 4kV stations a key factor driving station renewal investments, particularly for voltage conversion projects.

2.3.2. Current Issues

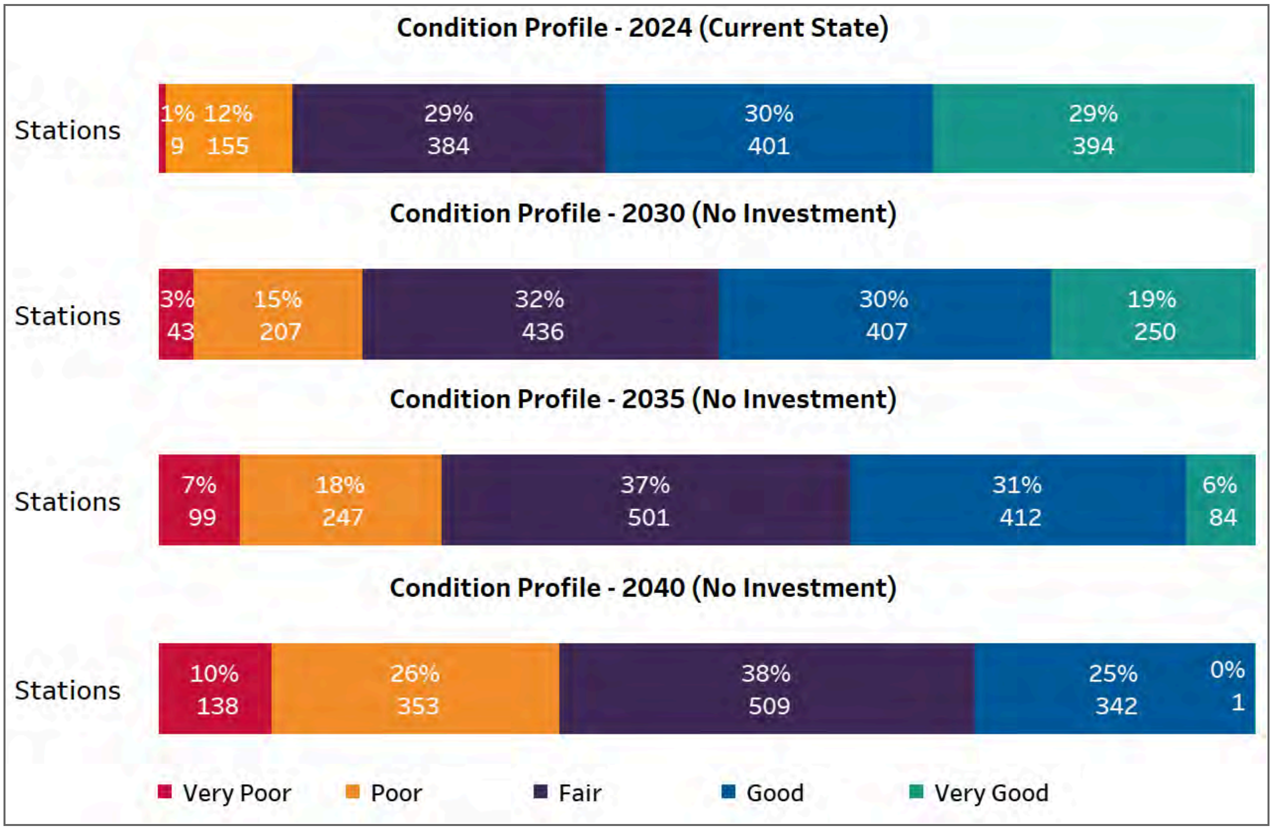
The primary focus of the station renewal program is to mitigate the risks associated with station assets in degraded condition. The age and condition demographics of the major station assets considered within scope of the station asset renewal program are provided in Figures 3 to 14, with the overall summary highlighted in Figure 1 and Figure 2.

1 **Figure 1 - Overall Age Demographics Profile of Station Assets**



2

Figure 2[1] - Overall Condition Profile of Station Assets



For context, TUL refers to the expected duration an asset can reliably operate before it requires replacement or refurbishment. Condition ranges also provide a way to assess the state of an asset and determine the urgency of any necessary interventions. To this end, Hydro Ottawa uses a health index, which is a score from 0% to 100%, to evaluate the condition of an asset from Very Poor to Very Good. More details on Hydro Ottawa's condition assessment framework is presented in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process.

Through Copperleaf PA, Hydro Ottawa established the unique degradation pattern of each individual asset in the system into 2040. Figure 1 shows that, without intervention, Copperleaf PA

[1] Excludes station relays

forecasts Hydro Ottawa's end-of-life station assets to increase by about 5% every five years. Likewise, without intervention, the percentage of assets in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years.

The following sub-sections summarize some of the challenges faced by Hydro Ottawa specific to its existing station assets.

2.3.3. Station Transformers

Figures 3 and 4 demonstrate that Hydro Ottawa’s station transformers are reaching end of life at a rapid pace, with some degree of deterioration. Specifically, Copperleaf PA forecasts that without intervention the percentage of station transformers that have reached their end of life will increase to more than half (51%) in 2030 and continue to grow at a rate of approximately 2.5% every five years, thereafter. Likewise, without intervention, the percentage of station transformers in degraded condition (poor or very poor) will continue to grow at a rate of approximately 7% every 5 years. The risk of failure for station transformers, a major asset class, can significantly disrupt the distribution system. As lead times for new transformers exceed two years and unit replacement costs have significantly increased, the urgency of addressing the risk of failure is amplified. The risk is further compounded by the increased load associated with electrification, as existing transformers are strained to support these additional loads, resulting in accelerated deterioration.

Figure 3 - Age Demographics Profile of Station Transformer

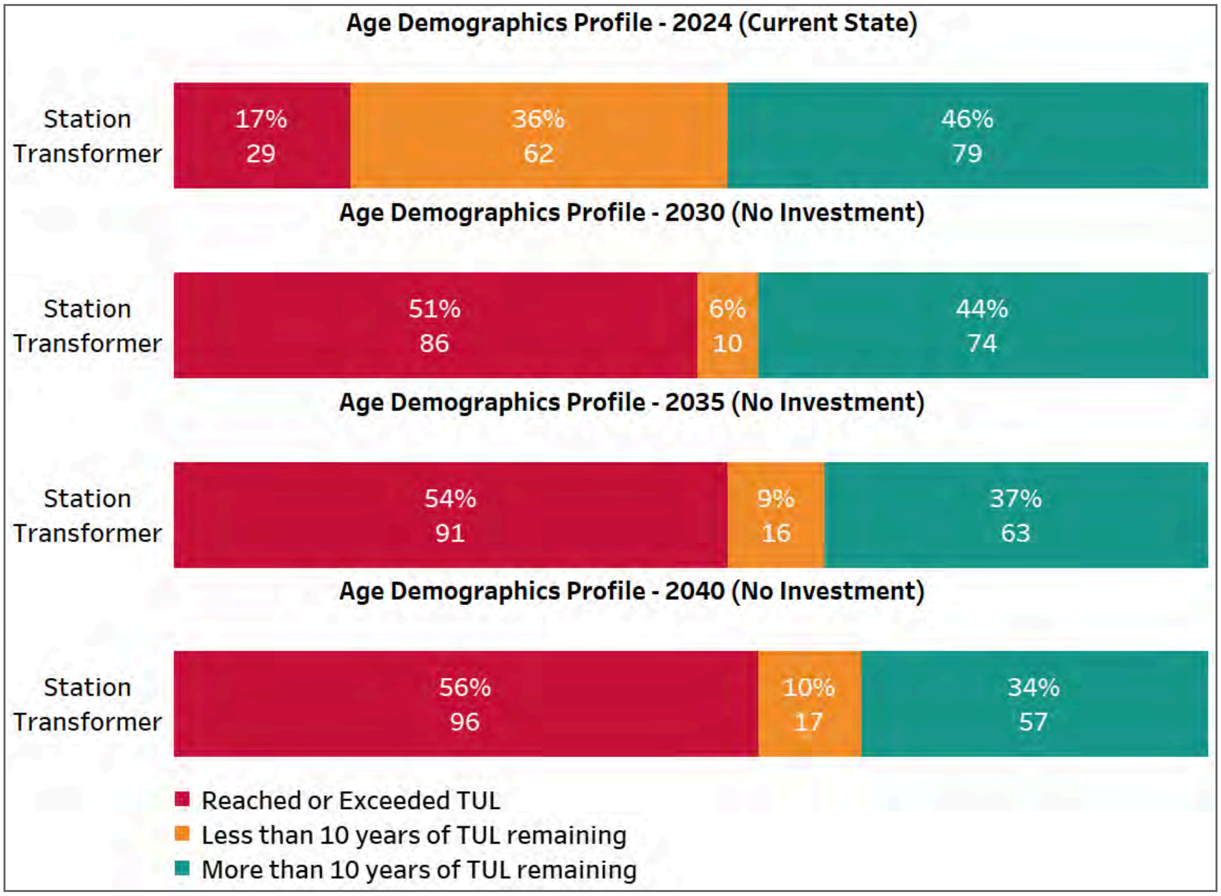
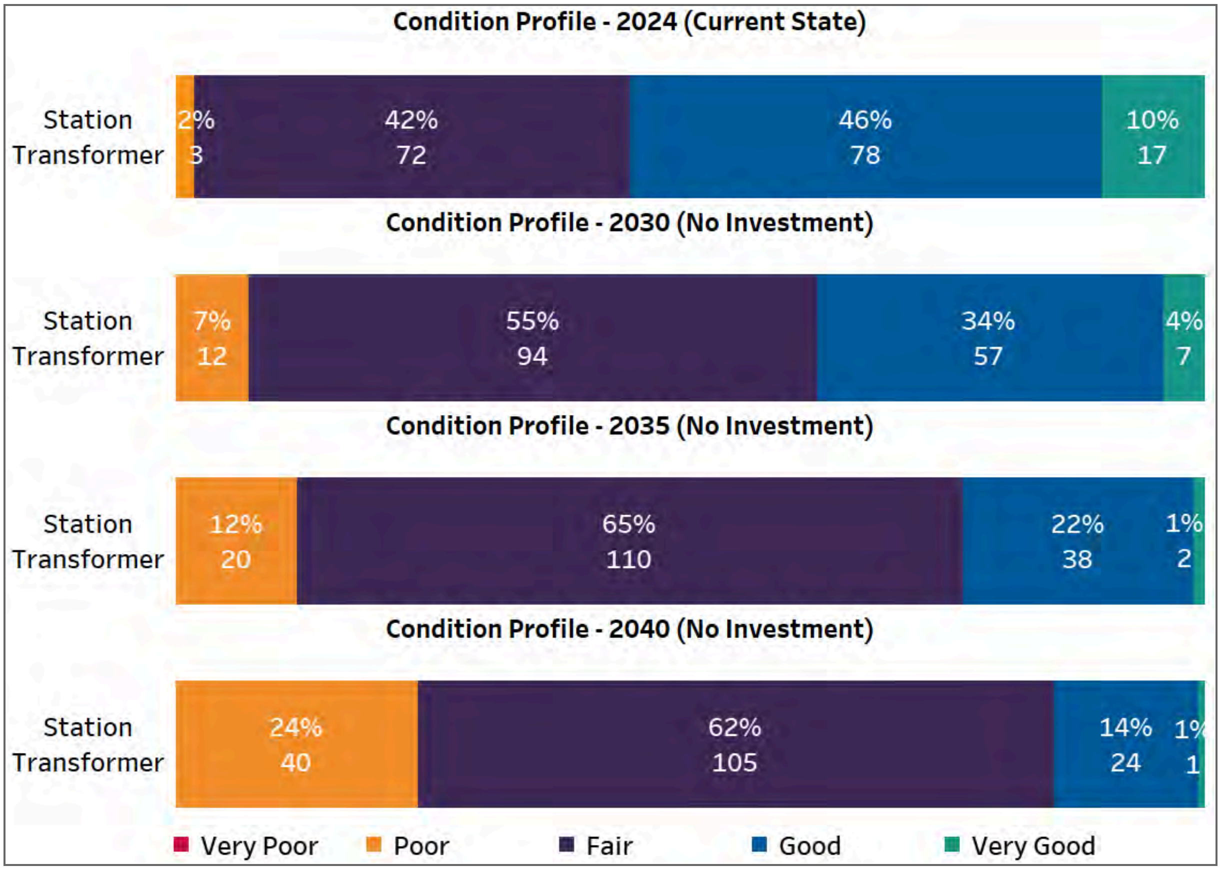


Figure 4 - Condition Profile of Station Transformers



4kV Station Assets: Of Hydro Ottawa's 92 stations, 35 are 4kV stations. These 4kV stations contain 95 station transformers, of which approximately 17% have exceeded their anticipated TUL. By 2030, 7% of these transformers are forecast to be in deteriorated condition. Consequently, Copperleaf PA recommended intervention for station transformers at five stations: Henderson UN, Church AA, Vaughan UG, Carling SM, and Nepean AB.

The 5 aforementioned stations are located in areas of Hydro Ottawa's service territory that are seeing growth due to intensification, transit oriented development and electrification. Hydro

Ottawa's lower voltage systems (4kV/8kV) have limitations compared to the 13kV and 28kV systems as listed below:

- Compared to 28kV/13kV, the 4kV/8kV systems are less efficient for long-distance power distribution, leading to greater losses and voltage drop issues.
- The maximum capacity that a 4kV/8kV feeder can carry is low compared to higher voltage systems significantly limiting the ability to accommodate the large load requests. The maximum capacity of a 4kV feeder is 2.3MVA, 8kV feeder is 3.6MVA compared to 9.7 MVA on 13kV and 16.4 MVA on 28kV.
- Some 4kV and 8kV stations are heavily loaded, hindering new customer connections.

With the anticipated customer demand growth, the 4kV system will be unable to support the forecasted capacity in the future, therefore investments in voltage conversion are essential when replacing the 4kV transformers.

In addition to the station transformers, Hydro Ottawa also reviewed the age/condition of the related station switchgear at the identified stations. Figure 5 and Figure 6 represent the condition and age profiles of these major assets within the aforementioned five 4kV stations. Without intervention, the percentage of 4kV station assets in a degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years. Approximately 86% of the 4kV station assets within these stations have reached the TUL, with all assets forecasted to reach their TUL by 2030.

Figure 5 - Condition Profile of 4kV Assets at Henderson UN, Church AA, Vaughan UG, Carling SM, and Nepean AB

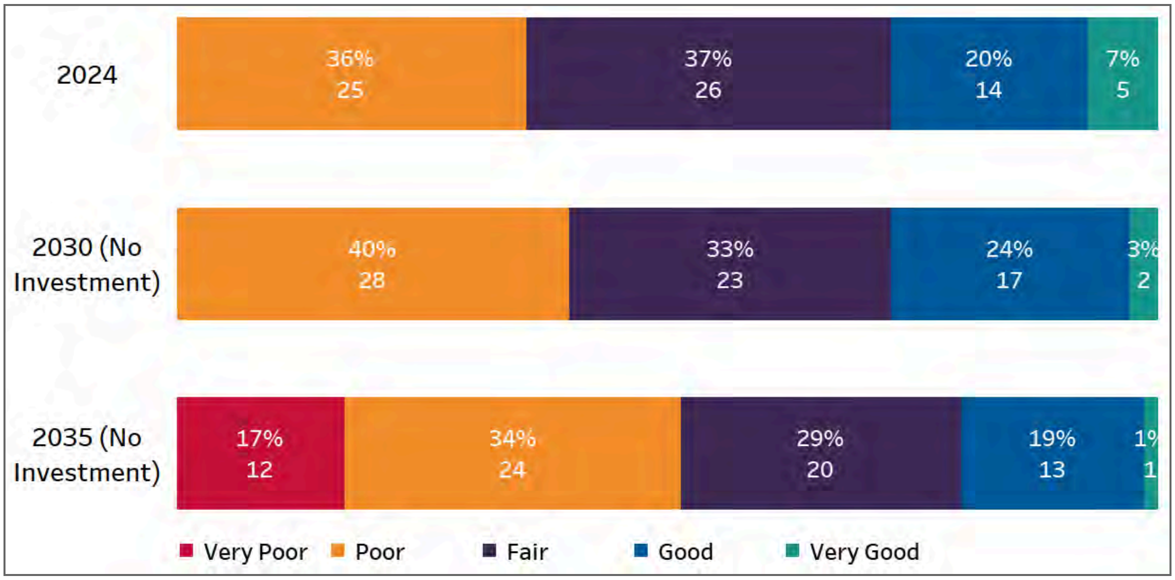
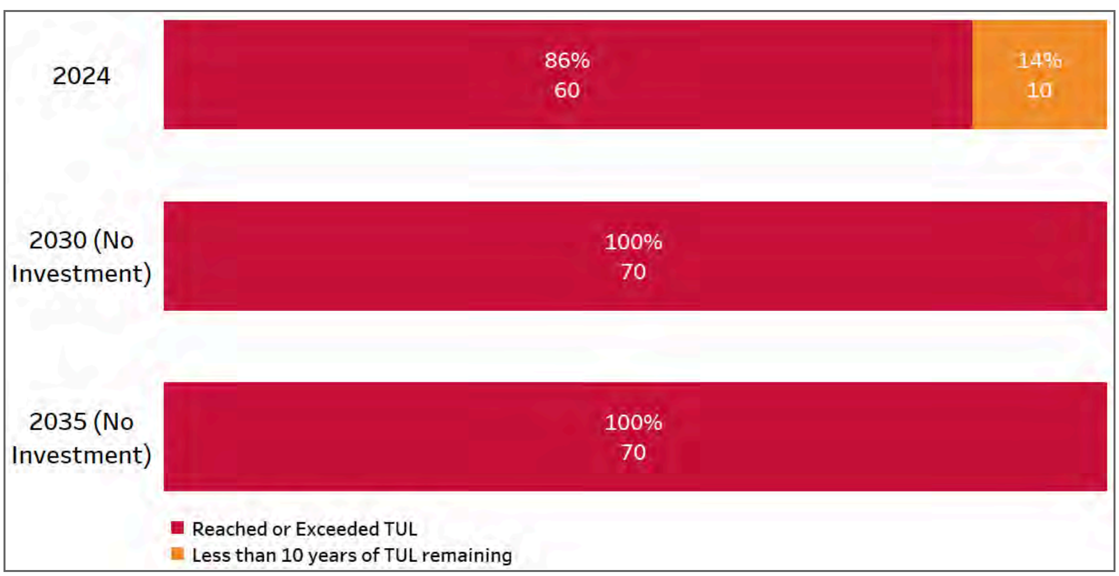


Figure 6 - Age Demographic Profile of Henderson UN, Church AA, Vaughan UG, Carling SM, and Nepean AB



Upon reviewing the 2035 projections of the assets at the aforementioned five stations, Hydro Ottawa has proposed a phased approach to the decommissioning of the 4kV transformers and related station equipment at 3 of the 5 stations (Henderson UN, Church AA, Vaughan UG) through voltage conversions to 13kV. To mitigate the increased risk associated with the two remaining stations (Carling SM, and Nepean AB), Hydro Ottawa will increase monitoring and testing at and will ensure capital spares are available. The high cost and resource intensity of 4kV voltage conversions led Hydro Ottawa to the decision to defer 2 of the 5 stations, leading to an approach that balances long term risk with short term financial and resourcing limitations. In addition to the phased approach of decommissioning station equipment at the aforementioned 3 stations, Hydro Ottawa will prioritize the completion of the EOL voltage conversion initiatives at Fisher AK and Dagmar AC substations. The costs and resources for the planned voltage conversion at these stations is also accounted for, as Hydro Ottawa has a solid plan for execution in 2026-2030, based on the analysis performed to support the re-scoping/deferral strategy.

2.3.4. Station Switchgear

Figure 7 demonstrates that more than half (51%) of Hydro Ottawa's station switchgear have currently reached or exceeded their TUL, with some degree of deterioration. Likewise, without intervention, the percentage of station switchgear in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years.

1 **Figure 7 - Age Demographics Profile of Station Switchgear**

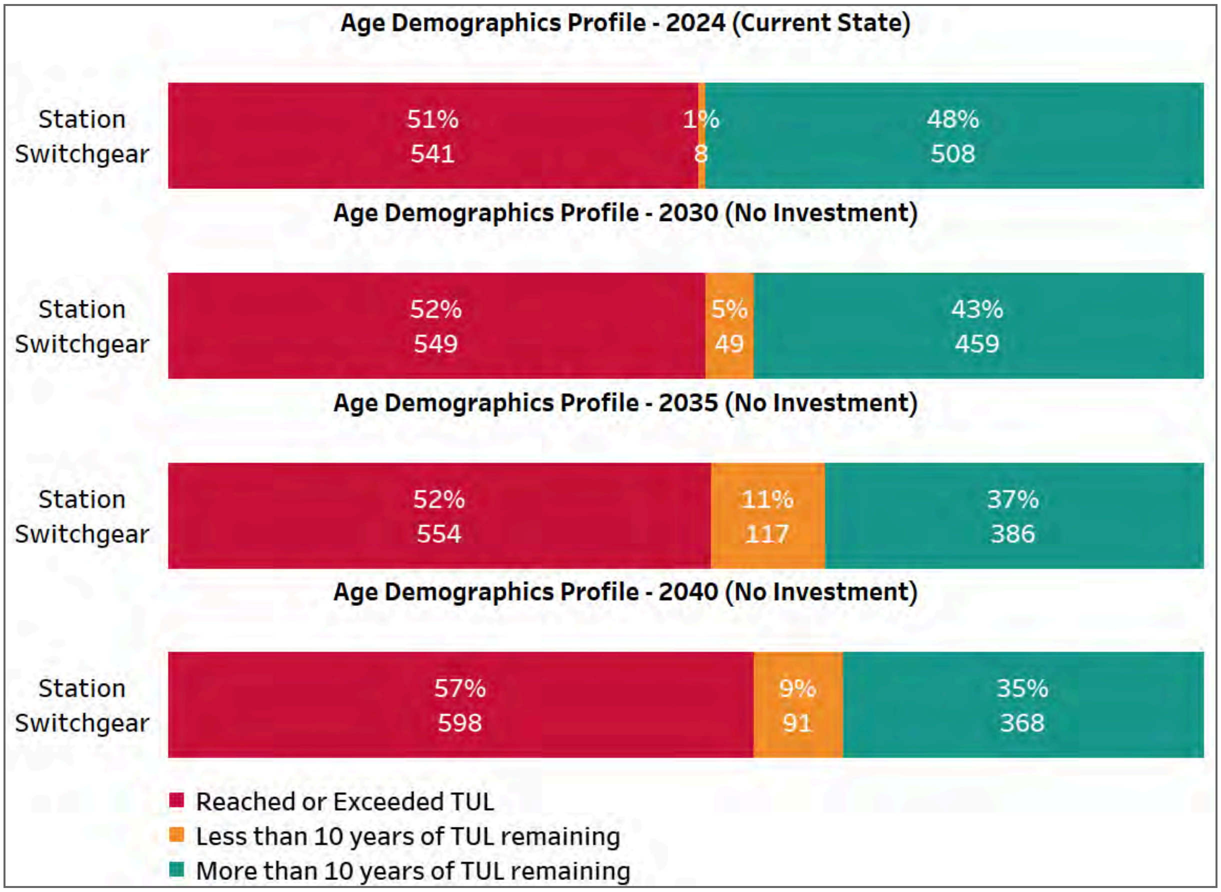
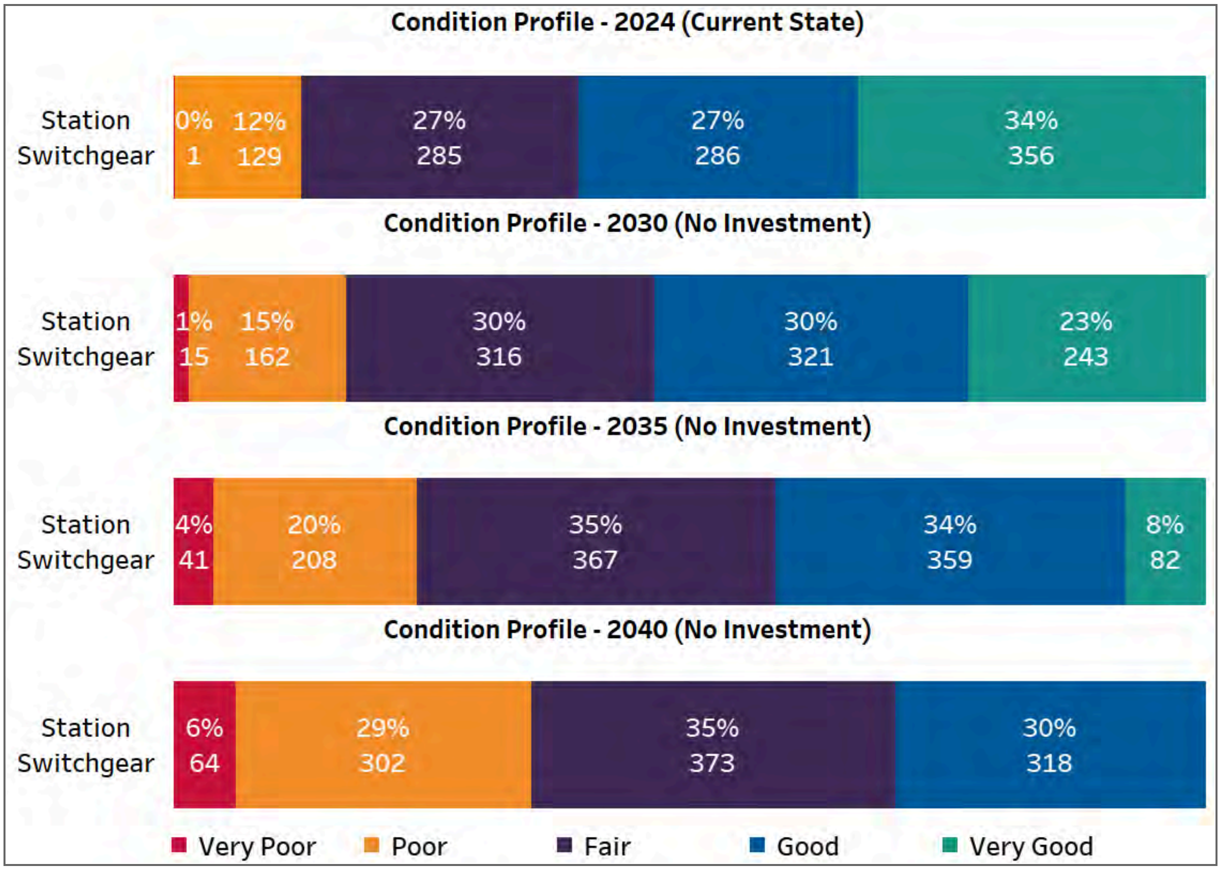
2 

Figure 8 - Condition Profile of Station Switchgear



Furthermore, Hydro Ottawa has experienced metal clad switchgear failures, specifically with the air and SF_6 types, impacting system reliability and resulting in customer interruptions, as shown in Figure 9 and Figure 10. A specific type of air type breaker (FPE DST-2) had reclosed on a fault and failed on two occasions. During both failure events, an arc on one of the phases was not successfully extinguished by the arc chute, leading to the melting of the fixed arcing contact.

Figure 9 - FPE DST-2 Breaker Failure Event

Figure 10 - SF_6 Switchgear Failure Event

Hydro Ottawa has also seen SF_6 switchgear failures with multiple potential failure modes identified, such as overtravel and material damage due to contaminated SF_6. The strain hardening of the copper material due to minor deformation, led to sudden or progressive fracture. Overtravel of the moving contact “hammering” on the fixed arcing contact, or misalignment of the moving contact causing bending of the fixed arcing contact on closing operations had been the underlying contributing failure mechanisms. These failures were addressed under the Emergency Renewal budget program, as outlined in Section 6 - Corrective Renewal.

In light of the aforementioned equipment failures and a comprehensive assessment of the current condition of existing switchgear population, Hydro Ottawa has prioritized the replacement of end-of-life SF_6 and air-type switchgear at 4 critical stations, for the 2026-2030 rate period.

2.3.5. Station Batteries

A substantial proportion of the station battery fleet, approximately 53%, will reach the end of their typical useful life by 2030 (refer to Figure 11). Likewise, without intervention, the percentage of station batteries in degraded condition (poor or very poor) will continue to grow at a rapid rate, reaching 100% by 2040. Batteries play a critical role as a backup power supply for stations and need to be proactively managed to ensure the operation of protection and control devices. As such, Hydro Ottawa is recommending the replacement of 12 battery banks during the 2026-2030 period.

Figure 11 - Age Demographics Profile of Station Batteries

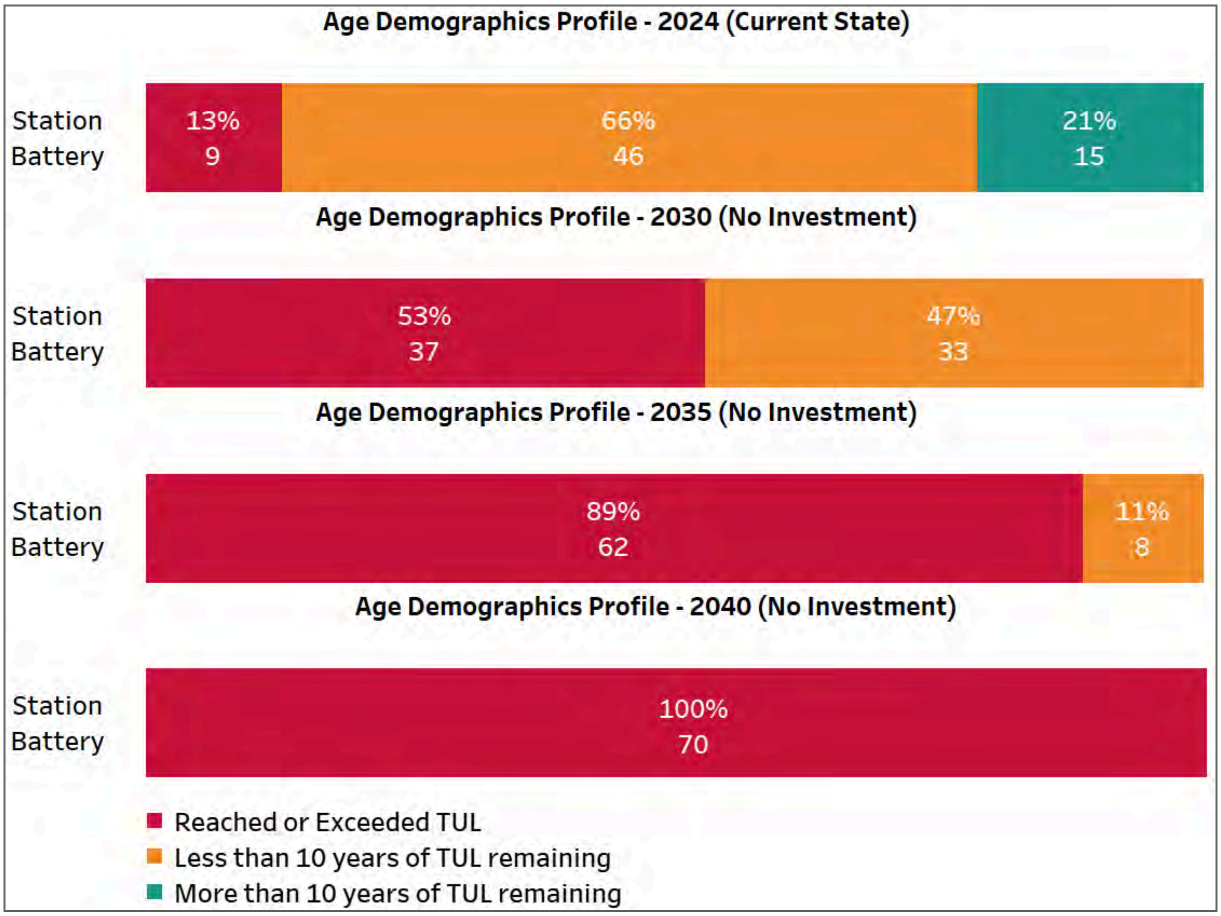
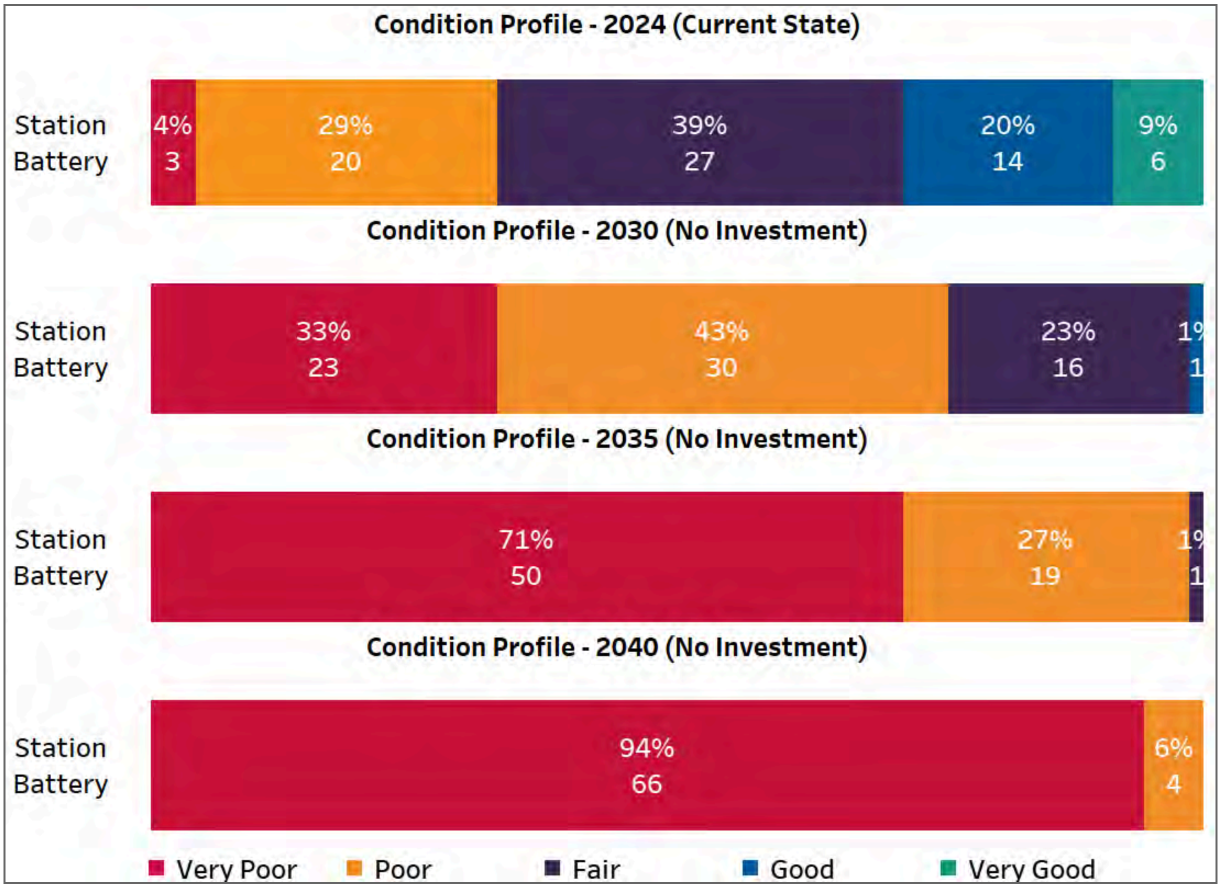


Figure 12 - Condition Profile of Station Batteries

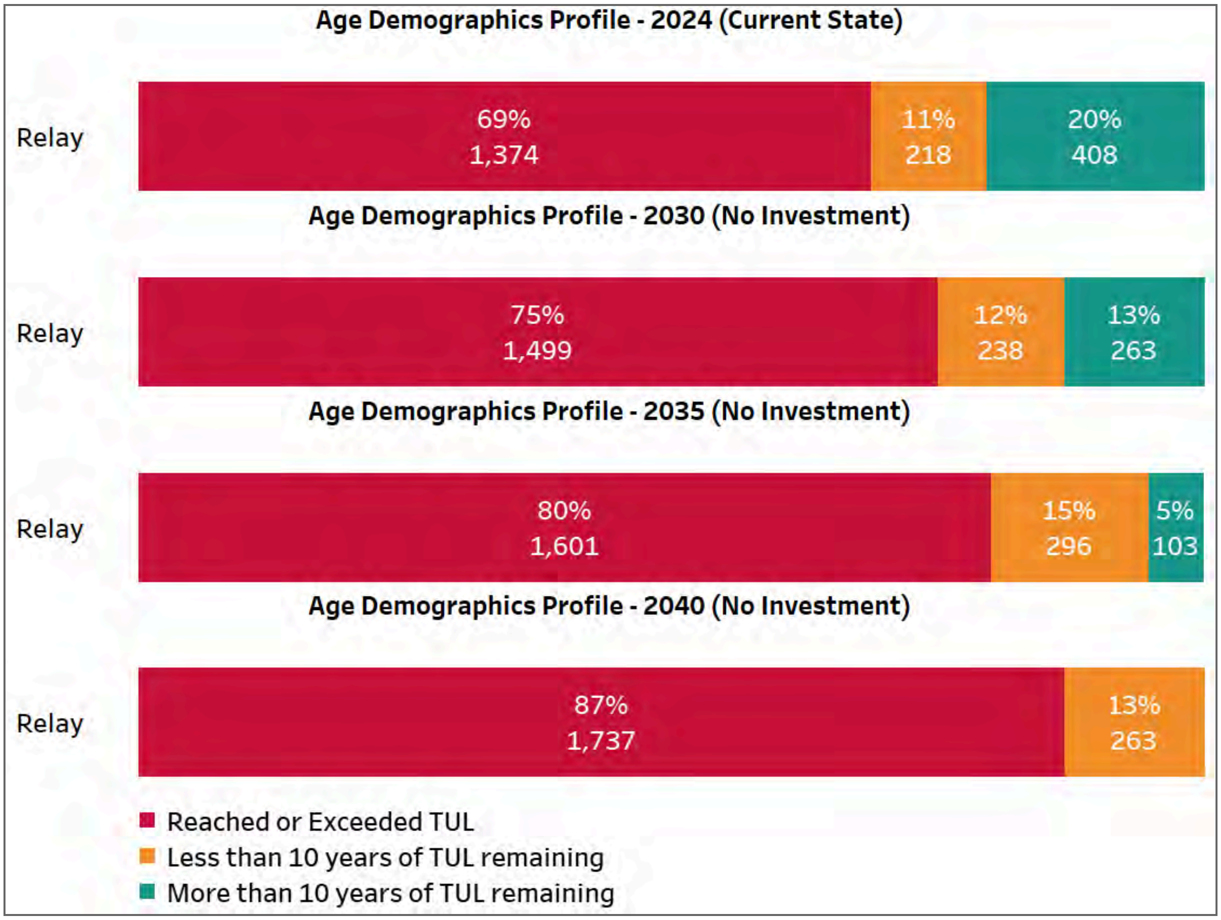


2.3.6. Station P&C

Relays

Approximately 69% of Hydro Ottawa's 2,000 service relays (across all types) have reached the end of their TUL (refer to Figure 13). There is a need to upgrade the obsolete, conventional, electromechanical relays with microprocessor-based ones, to ensure control and protection operation as intended, and eliminate any safety risks around unanticipated failures or miscoordination, alongside minimizing interruption to customers. The planned conversion of the 4kV stations will provide an opportunity to systematically address the obsolescence and failure risk of the electromechanical relays.

Figure 13 - Existing and Forecasted Age Demographics of Station P&C Equipment



Remote Terminal Units (RTUs)

Hydro Ottawa has approximately 340 RTU installations in its substations. The SCOUT, SAGE and RTAC installations represent approximately 30% of the population. Hydro Ottawa has observed the failure of some obsolete SCOUT RTUs which has resulted in them no longer reporting to Supervisory Control and Data Acquisition (SCADA), despite attempts to maintain them. These operational issues affect the substation's ability to communicate with System Office. Hydro Ottawa is proposing investments towards replacing the obsolete SCOUT RTUs at select stations such as Centrepointe DS, Jockvale DS and QCH DS.

Transfer Trip Installations

Hydro Ottawa manages transfer trip installations associated with generation connections. Following consultations with customers regarding their projected operational needs and long-term plans, Hydro Ottawa ensures the ongoing compliance of transfer trip installations with present operational requirements, while also considering anticipated future demands. To this end, Hydro Ottawa has identified two major locations requiring the replacement of transfer trips during the 2026-2030 period: Lemieux Island filtration plant and Britannia filtration plant. The installations at these filtration plants rely on aging telephone line infrastructure for communication, which are susceptible to failure. Strategically targeting the renewal of these P&C assets and their associated communication infrastructure will enable Hydro Ottawa to verify transfer trip functionality and ensure compliance with current standards, to effectively mitigate the risk of disruptions.

2.3.7. Stations and Buildings Minor Assets

Station Minor Assets

Station minor assets, including insulators, lightning arresters, and outdoor reclosers, are crucial for substation operations and reliability. A recent outage at Bells Corner DS substation caused by an insulator-fuse connection failure (Figure 14), necessitated the emergency isolation of a station transformer, highlighting the importance of these assets. Additionally, Hydro Ottawa has experienced operational issues with Kelman online DGA monitors. Managing these units is essential for continuous monitoring of gassing levels, which provides early indication of failures in station transformers, ensuring their safe and reliable operation.

Figure 14 - Station Outdoor Insulator Damage at Bells Corner DS Substation

Hydro Ottawa proactively monitors these assets through annual visual inspections and infrared scans which identifies potential problems, enabling preventative maintenance or replacements to minimize outages and service interruptions. Proactive replacements, determined through these inspections, are implemented to prevent such disruptions. Through these inspections, Hydro Ottawa has identified the need to replace outdoor reclosers, lightning arresters, insulators, and 30% of Kelman online DGA monitors on station transformers, over the 2026-2030 period.

Station Buildings

Hydro Ottawa's service area includes over 70 Hydro Ottawa owned distribution stations, with buildings ranging in age from 2 to 102 years, five of which are designated heritage sites. The City of Ottawa has recognized these five century-old substations (see Table 2) for their architectural significance. Figures 15 and 16 showcase two examples: the Bronson SB and Holland SH stations, respectively. Maintaining these heritage buildings, which house essential equipment, requires significantly greater investments of time, resources and financial expenditure.

Table 2 - List of Hydro Ottawa Heritage Stations

Name	Building Category	In Service Year
Bronson US	Substation	1922
Holland US	Substation	1924
Carling Avenue TS	Substation	1928
King Edward TS	Substation	1931
Riverdale TS	Substation	1933

Figure 15 - Bronson SB Substation

Figure 16 - Holland SH Substation

A primary capital expenditure on station buildings is related to roof replacement. Since the structural integrity of station buildings is critical, Hydro Ottawa utilized a third party to inspect the roof conditions of stations. These inspections have been used to define the capital expenditures for station building infrastructure.

Some examples of deteriorating substation building roof conditions are shown in Figure 17 to Figure 19.

Figure 17 - Substation Roof Bubbling

Figure 18 - Substation Roof Water Pooling

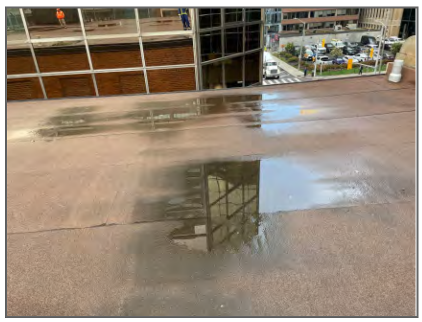
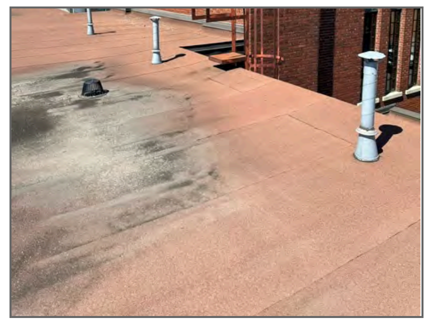


Figure 19 - Substation Roof Damage Caused by Water Pooling



Operations Facilities

In addition to the substations, Hydro Ottawa has two operational facilities: the Dibblee site (98,586 sq ft) and the Maple Grove site (18,300 sq ft). The major planned capital projects for these facilities consist of standard replacements and upgrades typical for maintaining buildings.

2.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the station renewal program are summarized in the section below.

2.4.1. Safety

The replacement of station assets mitigates the risk of catastrophic failure events. Upgraded protection and control systems help rapidly isolate station assets (specifically the station transformer) under fault conditions. Switchgear replacements reduce the risk to employee safety by implementing current standards for arc-resistant switchgear.

2.4.2. System Operation Efficiency and Cost Effectiveness

The renewal of station assets and supporting infrastructure allows for operational advancements, primarily ensuring robust communication between substations and the System Office, with the ability to remotely monitor and control devices through SCADA. Improvements through upgraded protection, monitoring and control systems result in increased system operational efficiencies.

EOL voltage conversion through 4kV station decommissioning increases the availability of distribution feeders and backups, as the dedicated 13kV feeders used to supply 4kV stations can now be re-allocated for other purposes. Investing in voltage conversion when the corresponding station assets reach EOL allows Hydro Ottawa to meet both asset needs as well as growing capacity demands, realizing cost effectiveness in the process. The EOL voltage conversion initiative allows Hydro Ottawa to optimize capital allocation by addressing the risk of station equipment failure and eliminates the need for separate future investments to address capacity issues, ensuring efficient use of resources and improved system performance.

2.4.3. Customer

The stations and buildings infrastructure renewal program focuses on replacing deteriorating and failing station assets to decrease the risk of equipment failures and reduce the risk of outages for customers. The program also includes a significant initiative to convert the older 4kV system thereby increasing the system's capacity to support customers' growing demand for electricity.

2.4.4. Cyber Security and Privacy

The cyber security of digital systems is greatly improved by installation of modern equipment, which addresses the vulnerability of the previous generation of microprocessor equipment around remote access and communication protocols being used.

2.4.5. Coordination and Interoperability

For station transformer renewal projects that involve transmission connection requirements, Hydro Ottawa coordinates with Hydro One Networks Inc. to ensure successful completion of the transmission connection. This coordination is critical for maintaining system reliability and operational efficiency during the replacement process.

The use of modern P&C equipment allows seamless integration of distributed generation resources into the grid, ensuring that new energy sources can be safely and efficiently incorporated into the existing infrastructure.

2.4.6. Economic Development

Hydro Ottawa's Station and Buildings Infrastructure Renewal Program is a key driver of regional economic development. By strategically replacing deteriorating station assets, the program ensures sustained system reliability, a critical factor for attracting and retaining businesses, particularly commercial and industrial customers vital to job creation and economic stability within the service territory. The work under this program directly minimizes costly downtime, safeguarding productivity and investor confidence. Furthermore, the program's focus on maintaining and enhancing capacity ensures that Hydro Ottawa can accommodate the growing energy demands of expanding businesses and new developments, enabling future economic growth within its operational area. Prioritizing projects based on asset condition and risk secures the uninterrupted operation of critical infrastructure, which are fundamental to the community's well-being. Ultimately, this program strengthens the economic landscape within Hydro Ottawa's service area by demonstrating a commitment to a modern, reliable power grid, fostering a favorable environment for investment and sustainable economic development.

2.4.7. Environment

Hydro Ottawa minimizes the risk of environmental contamination by replacing a select population of at-risk station transformers that have reached or exceed their TUL and installing advanced oil containment systems beneath each transformer. These containment units are designed to capture any potential oil leaks, thereby reducing the risk of oil entering the surrounding environment.

The replacement of end-of-life station switchgear mitigates the risk of SF_6 leaks in the event of a switchgear failure.

2.5. PROGRAM COSTS

Table 3 shows the historical and future spending by Budget Programs, as a part of the Station and Building Infrastructure Renewal program. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to reach $107.7M, compared to $31.4M in the 2021-2025 period. There are considerations around equipment and resource availability as well as project prioritization and scheduling which results in some variability in the projected annual spend between 2026 and 2030.

Table 3 - Historical, Bridge and Test Year Expenditure per Station Renewal Budget Program ($000 000s)[2]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Station Transformer Renewal	$ 1.2	$ 0.6	$ 0.7	$ 0.6	$ 0.1	$ 0.2	$ 0.8	-	-	-
Station Switchgear Renewal	$ 3.5	$ 2.2	$ 1.4	$ 0.4	-	$ 6.0	$ 7.0	$ 0.6	$ 0.6	$ 9.3
Station Battery Renewal	$ 0.0	$ 0.0	$ 0.0	$ 0.1	$ 0.1	$ 0.2	$ 0.1	$ 0.1	$ 0.1	$ 0.2
Station P&C Renewal	$ 1.0	$ 1.1	$ 0.1	$ 0.2	-	$ 2.4	$ 2.3	$ 2.1	$ 1.0	$ 1.0
Station and Building Minor Assets Renewal	$ 0.4	$ 0.7	$ 1.1	$ 0.6	$ 0.4	$ 2.0	$ 1.9	$ 1.9	$ 1.9	$ 1.7
Station Major Rebuild	$ 2.6	$ 6.4	$ 1.6	$ 0.5	$ 0.1	-	-	-	-	-
EOL Voltage Conversion	$ 0.4	$ 1.0	$ 0.5	$ 1.8	-	$ 14.7	$ 11.2	$ 12.2	$ 14.3	$ 11.9
ANNUAL TOTAL	**$ 9.1**	**$ 12.0**	**$ 5.4**	**$ 4.2**	**$ 0.7**	**$ 25.4**	**$ 23.3**	**$ 16.9**	**$ 17.9**	**$ 24.0**
5-YEAR TOTAL					**$ 31.4**					**$ 107.7**

[2] Totals may not sum due to rounding

Table 4 - Detailed Unit Replacement and Removal (through EOL voltage conversion) Overview per Station Asset Class[3]

Station Asset Class	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Station Transformers (Replacement)	-	2	3	-	-	-	1	-	-	-
Station Transformers (Removed through EOL Voltage Conversion)	-	-	-	-	-	3	-	3	2	2
Station Switchgear (Replacement)	10	18	8	2	-	7	8	2	14	14
Station Switchgear (Removed through EOL Voltage Conversion)	-	-	-	-	-	13	4	7	8	6
Station Batteries (Replacement)	-	2	2	2	3	3	2	2	2	2
Station Batteries (Removed through EOL Voltage Conversion)	-	-	-	-	-	1	-	-	1	1
Station Relays (Replacement)	-	28	-	7	4	35	55	55	-	-
Station Relays (Removed through EOL Voltage Conversion)	-	-	-	-	-	39	-	-	38	30
Station RTUs (Replacement)	-	-	-	-	2	1	1	1	-	-
Station RTUs (Removed through EOL Voltage Conversion)	-	-	-	-	-	1	-	-	1	1

[3] During the 2021-2025 period Hydro Ottawa has begun voltage conversion plans for Fisher AK and Dagmar AC on the distribution side and no station assets have been decommissioned yet.

2.5.1. Station Transformer Renewal

The Station Transformers Renewal program's spending is forecasted to decrease from $3.3M in 2021-2025 to $1M in 2026-2030, to only complete the Longfields T2 renewal project. Ten station transformers proposed for decommissioning/removal will be addressed through the EOL Voltage Conversion program, which is introducing 13kV feeders to these 4kV regions, to increase capacity. Decommissioning 4kV transformers will also include decommissioning their connected switchgear and protection & control apparatus.

2.5.2. Station Switchgear Renewal

The Station Switchgear Renewal program's budget is forecasted to increase from $7.4M in 2021-2025 to $23.4M in 2026-2030. During 2021-2025, 36 breakers at Overbrook TO were replaced under the Station Switchgear Renewal program; with the remaining two breakers replaced at Bronson SB substation. The 2026-2030 plan includes the replacement of 45 station breakers at four different stations, all under the Station Switchgear Renewal program. The increase in average cost per breaker can be attributed to the need for mobilization at four different stations, increased material costs with inflation observed since 2023 and budget allocation to also replace/upgrade any related obsolete P&C systems. In 2023, Hydro Ottawa observed an increase in the material cost for a switchgear lineup by about $1.3M as compared to the 2022 estimate, which has been included in the costing consideration for the 2026-2030 station switchgear renewal program, resulting in at least a $220k/breaker unit cost increase. Increased equipment costs are not the only driver of switchgear renewal project expenses. Costs are also impacted by unique aspects like building modifications or additions, complex distribution and medium voltage ties, and station-specific custom engineering, the effort of which is proportional to project complexity

2.5.3. Station Battery Renewal

The Station Battery Renewal program's spending is forecast to increase from $0.3M in 2021-2025 to $0.8M in 2026-2030. Based on an observed trend of increased expenditures for emergency and critical battery replacements towards the end of the 2021-2025 rate application period (in addition to the condition/risk projections), 11 battery bank replacements are recommended for the 2026-2030 period.

2.5.4. Station P&C Renewal

The Station P&C Renewal program's spending is forecasted to increase from $2.5M in 2021-2025 to $8.9M in 2026-2030. Traditionally, P&C equipment replacements were incorporated into broader station infrastructure initiatives, such as the Station Switchgear Replacement Program and the EOL Voltage Conversion Program. However, an enhancement to the traditional approach through dedicated P&C renewal projects is deemed necessary to address the growing need to target obsolescence, particularly within RTU equipment. This enhancement is in response to the evolving needs to maintain critical infrastructure and cyber security requirements. The increasing prevalence of obsolescence specifically impacting RTU equipment, independent of other station components, necessitates a focused and strategic response. This dedicated approach will ensure the timely replacement and modernization of these critical assets.

Targeted projects under this program will enable timely and focused mitigation, directly addressing the vulnerability of these critical P&C assets. In particular, the obsolescence of SCOUT RTUs at select stations, which currently are not within the scope of existing renewal programs, necessitate immediate action. These RTUs are critical for station-to-control center communication, and their obsolescence poses a significant operational risk.

Furthermore, high-priority transfer trip installations at the Lemieux Island and Britannia filtration plants, commissioned in 2004, require an intervention due to the failure risk around aging, after consultation with the customer.

Beyond addressing immediate obsolescence, projects under this budgeted program allow for the timely integration of modern P&C technologies, thereby enhancing grid resilience and operational efficiency. This focused approach also optimizes planning and execution, ensuring timely resolution of critical obsolescence issues. The augmented budget allocation reflects the imperative to modernize aging P&C infrastructure, driven by specific obsolescence risks and the need to maintain a robust and reliable electrical grid. This transition ensures targeted, efficient, and timely P&C system upgrades, ultimately safeguarding the integrity of the electrical network.

2.5.5. Station & Building Minor Assets Renewal

The Station & Building Minor Assets Renewal program is subdivided into the following distinct classifications:

- Station Minor Assets
- Station Buildings
- Operations Facilities

The Station & Building Minor Assets Renewal program's spending is expected to increase from $3.2M in 2021-2025 to $9.3M in 2026-2030. Of this increase, the majority ($5.3M) is allocated to Operations Facilities. In the previous 2021-2025 application, this parent program and the associated expenditures for the Maple Grove and Diblee facilities were grouped with general plant expenditures. However, because there are no administrative functions at these facilities, they are now grouped with distribution facilities. This includes spending for facility assets reaching their end of life, and upgrades to the electrical service to support increased load for electrification and sustainability.

Station Minor Assets

The Station Minor assets program funds necessary investments in targeted renewal and upgrades across multiple stations, encompassing critical minor asset components that are essential for preserving the safety and reliability of the electrical distribution system. These strategic investments mitigate the risk of future failures and ensure optimal system performance. Key initiatives include:

- Prioritized replacement of outdoor reclosers at stations with known failures and persistent operational deficiencies, such as Janet King DS.

- Targeted replacement of lightning arresters, insulators, and online DGA monitoring equipment with operational issues.

Station Buildings

The Station Buildings program proposes investments in station building infrastructure, such as:

- **Roof Replacements:** Maintaining building integrity and protecting electrical equipment.
- **Exterior and Yard Upgrades:** Improving station safety, security, and appearance, including storage yards and access.
- **Lighting and Mechanical Renewal:** Upgrading lighting for better visibility and efficiency and replacing/refurbishing essential mechanical components.

These investments are vital to maintaining the reliable and efficient operation of the electricity distribution system. By addressing these essential maintenance and renewal needs, the budget aims to prevent costly equipment failures, safety hazards, and service disruptions, ultimately ensuring that the electricity distribution system continues to meet the needs of customers.

Operations Facilities

Some planned renewal investments around Hydro Ottawa's operations facilities are:

Dibblee Site Renewal Investments

- 2026: Parking lot expansion to accommodate additional employees as outlined in Attachment 4-1-3(C) - Workforce Growth, enclosed office space in warehouse, HVAC system upgrades, and garage door replacement.
- 2028: Installation of automated barriers to regulate vehicle entry (day arms) to enhance site security.
- 2030: Electrical service upgrade to support electrification and sustainability.

Maple Grove Site Renewal Investments

- 2026: Office fit-up and parking expansion to accommodate new employees as outlined in Attachment 4-1-3(C) - Workforce Growth.
- 2027: Main gate and emergency generator replacement (due to end of useful life).
- 2028: Office area roof top unit replacement (due to end of useful life).
- 2029: Electrical service upgrades to support electrification and sustainability.

2.5.6. Station Major Rebuild

The Station Major Rebuild program's spending is expected to decrease from $11.2M in 2021-2025 to $0 in 2026-2030. Through 2021-2025, stations with transformers and switchgears that needed replacement were typically recommended for full station upgrades. However, for the 2026-2030 rate period, all stations requiring major asset replacements are in the 4 kV system, being converted to 13 kV under the EOL Voltage Conversion program.

2.5.7. EOL Voltage Conversion

The EOL Voltage Conversion program's spending is forecasted to increase from $3.6M in 2021-2025 to $64.2M in 2026-2030. Five stations in the 4kV system that require transformer and switchgear replacements will be converted to 13kV under this program. This program also facilitates the retirement of deteriorating poles and underground cables on the distribution side. To decommission the 4kV station assets, 4kV feeders will be converted to 13kV through pole and cable replacements in these regions, alongside the removal of end-of-life station equipment.

As detailed in Section 2.3.2 - Current Issues, Hydro Ottawa plans to prioritize the completion of EOL voltage conversion initiatives at Fisher AK and Dagmar AC substations with a remaining forecasted spend of ~$20M. In addition, the plan includes conversion of the entire distribution system of Henderson UN (~$20.2M) and 50% conversion of Vaughan UG (~$15M) and Church AA (~$9M) adding up to the total forecast of $64.2M under this budget program. The cost estimates for Henderson UN, Vaughan UG and Church AA are based on the quantity of assets in the 4kV distribution system requiring conversion (including poles, transformers, cables, etc) multiplied by the estimated unit costs. For Fisher AK and Dagmar AC, the estimates are based on remaining project scopes scheduled for completion between 2026 and 2030.

2.5.8. Cost Factors

Cost factors that affect station renewal projects are listed below:

- Material prices and lead times of major station equipment (specifically transformers and breakers)
- Delays in the project schedule
- Compatibility with existing equipment

2.6. ALTERNATIVES EVALUATION

2.6.1. Alternatives Considered

In order to address the drivers and achieve the performance objectives of the program, Hydro Ottawa conducted an analysis using Copperleaf PA to evaluate and optimize its station asset renewal strategy with the goal to reduce asset failure risks, improve operational performance, and balance renewal costs with long-term asset sustainability. To develop the station asset renewal strategy, three investment alternatives were considered, as outlined in Table 5, with varying levels of replacement rates and alignment to the Outcomes described in Table 1. The alternatives were developed with the objective of balancing long term-cost impacts with equipment lead-time, resourcing limitations and risk mitigation associated with assets in degraded condition.

Table 5 - Summary of Program Investments of Alternatives Considered

Program Investments	Alternative 1: Cost Containment	Alternative 2: Short Term Risk Mitigation (Preferred)	Alternative 3: Long Term Risk Mitigation
Station Transformers (replacement)	1 (0.2/year)	1 (0.2/year)	1 (0.2/year)
Station Transformers (removed during EOL Voltage Conversion)	5 (1/year)	10 (2/year)	13 (2.6/year)
Station Breakers (replacement)	10 (2/year)	45 (9/year)	90 (18/year)
Station Breakers (removed during EOL Voltage Conversion)	26 (5.2/year)	38 (7.6/year)	59 (11.8/year)
Relays (replacement)	58 (12/year)	145 (29/year)	300 (60/year)
Relays (removed during EOL Voltage Conversion)	77 (15.4/year)	107 (21.4/year)	173 (34.6/year)
Station Batteries (replacement)	5 (1/year)	10 (2/year)	20 (4/year)
Station Batteries (removed during EOL Voltage Conversion)	2 (0.4/year)	3 (0.6/year)	5 (1/year)
RTUs (replacement)	3 (0.6/year)	3 (0.6/year)	8 (1.6/year)
RTUs (removed during EOL Voltage Conversion)	2 (0.4/year)	3 (0.6/year)	5 (1/year)
Transfer Trip	0	2 (0.4/year)	2 (0.4/year)
Minor Station Assets	None	Medium	Highest
Minor Building Assets	None	Medium	Highest
System Observability Investments	Minor	Medium	Highest
TOTAL PROGRAM COST	**$55M**	**$108M**	**$220M**

Alternative 1 - Cost Containment (~$55M): This alternative will provide:

- Cost impacts are minimized during the 2026-2030 period, however replacement rates will not allow Hydro Ottawa to balance long term affordability or effectively manage risk associated with assets in degraded condition:
    - A net 5% increase in the station transformers in degraded condition compared to 2024 levels (refer to Figure 21) and a net 31% increase in station transformers that have reached their typical useful life by 2030 (refer to Figure 20), creating a back-log of station transformers to be replaced in the long term.
    - A net 4% increase in the station switchgears in degraded condition compared to 2024 levels (refer to Figure 23) and a minor 2% decrease in station switchgears that have reached their typical useful life by 2030 (refer to Figure 22), creating a back-log of station switchgears to be replaced in the long term.
    - A net 33% increase in the station batteries in degraded condition compared to 2024 levels (refer to Figure 25) and a net 33% increase in station batteries that have reached their typical useful life by 2030 (refer to Figure 24), creating a back-log of station batteries to be replaced in the long term.
    - A minor 1% decrease in the station relays that have reached their typical useful life by 2030 (refer to Figure 26).
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Minimum ability to increase system observability through the station P&C renewal program
- Very limited risk reduction associated with EOL 4kV assets and limited ability to support growth in 4kV areas

Alternative 2 - Short Term Risk Mitigation (~$108M - Preferred Alternative): This alternative will provide:

- Cost impacts are more significant and replacement rates will allow Hydro Ottawa to mitigate only short term risk associated with assets in degraded condition.
    - A net 4% increase in the station transformers in degraded condition compared to 2024

levels (refer to Figure 21) and a 28% net increase in station transformers that have reached their typical useful life by 2030 (refer to Figure 20), moderately reducing the back-log of station transformers to be replaced in the long term.
  - A net 2% increase in the station switchgears in degraded condition compared to 2024 levels (refer to Figure 23) and a 5% decrease in station switchgears that have reached their typical useful life by 2030 (refer to Figure 22), moderately reducing the back-log of station switchgears to be replaced in the long term.
  - A net 24% increase in the station batteries in degraded condition compared to 2024 levels (refer to Figure 25) and a net 24% increase in station batteries that have reached their typical useful life by 2030 (refer to Figure 24), moderately reducing the back-log of station batteries to be replaced in the long term.
  - A 6% decrease in the station relays that have reached their typical useful life by 2030 (refer to Figure 26), moderately reducing the back-log of station relays to be replaced in the long term.
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Moderate ability to increase system observability through the station P&C renewal program
- Moderate risk reduction associated with EOL 4kV assets and moderate ability to support growth in 4kV areas

Alternative 3 - Long Term Risk Mitigation (~$220M): This alternative will provide:

- Cost impacts are highest however replacement rates will allow Hydro Ottawa to most effectively balance long term affordability and minimize risk associated with assets in degraded condition
  - A net 3% increase in the station transformers in degraded condition compared to 2024 levels (refer to Figure 21) and a net 26% increase in station transformers that have reached their typical useful life by 2030 (refer to Figure 20), reducing the back-log of station transformers to be replaced in the long term.
  - A net 1% decrease in the station switchgears in degraded condition compared to 2024 levels (refer to Figure 23) and a net 12% decrease in station switchgears that have

reached their typical useful life by 2030 (refer to Figure 22), largely reducing the back-log of station switchgears to be replaced in the long term.

- ○ A net 8% increase in the station batteries in degraded condition compared to 2024 levels (refer to Figure 25) and a net 10% increase in station batteries that have reached their typical useful life by 2030 (refer to Figure 24), reducing the back-log of station batteries to be replaced in the long term.
- ○ A 17% decrease in the station relays that have reached their typical useful life by 2030 (refer to Figure 26), largely reducing the back-log of station relays to be replaced in the long term.

- Inability to manage resourcing levels and to procure long-lead items at the rate required
- High ability to increase system observability through the station P&C renewal program
- High risk reduction associated with EOL 4kV assets and moderate ability to support growth in 4kV areas

Figures 20 to 26 show the proportion of station assets that will reach a deteriorated condition by 2030, based on current state and a consideration of the different intervention strategies around managing the station asset population.

Figure 20 - Number of Station Transformers Projected to Reach Typical Useful Life by 2030

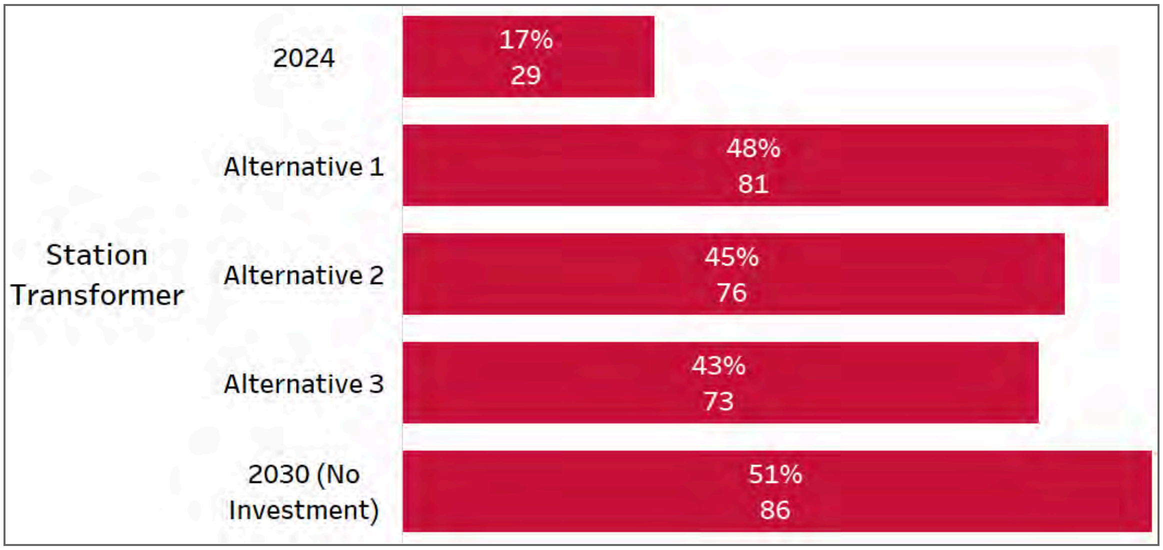


Figure 21 - Number of Station Transformers Projected to Reach a Deteriorated Condition by 2030

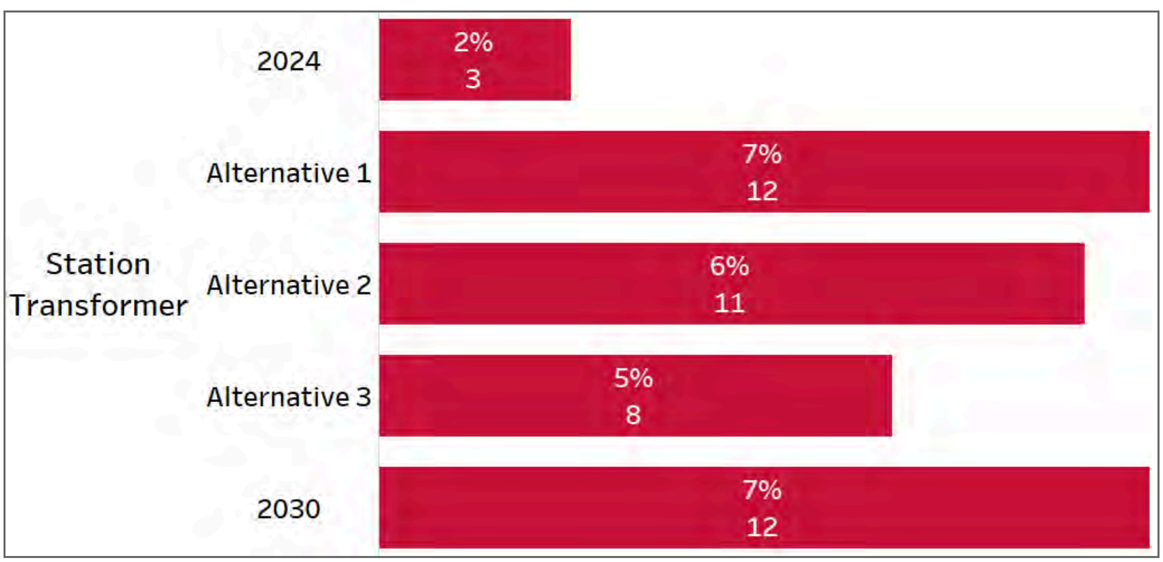


Figure 22 - Number of Station Switchgears Projected to Reach Typical Useful Life by 2030

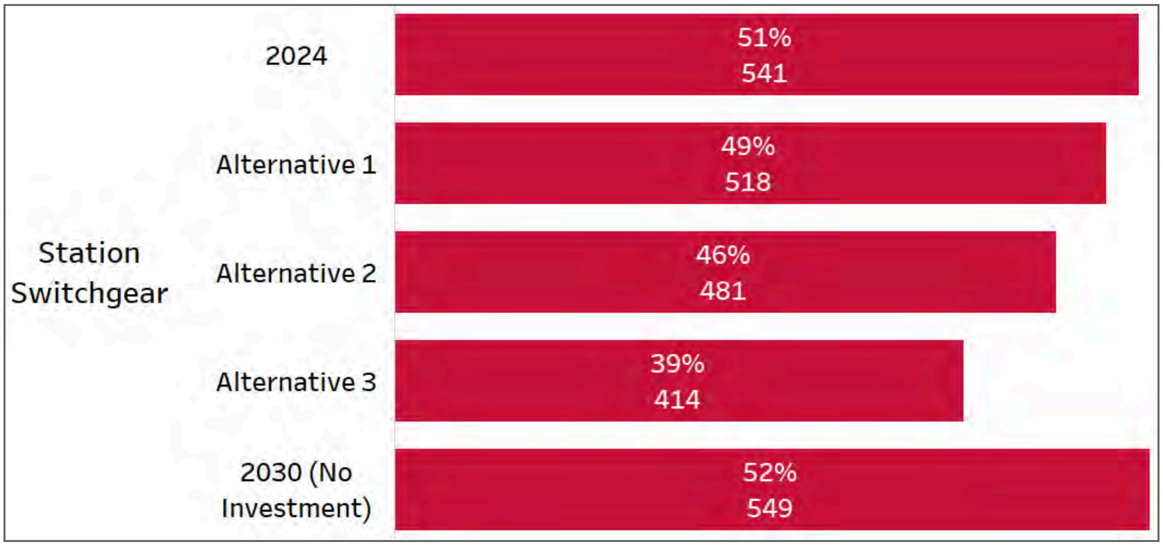


Figure 23 - Number of Station Switchgears Projected to Reach a Deteriorated Condition by 2030

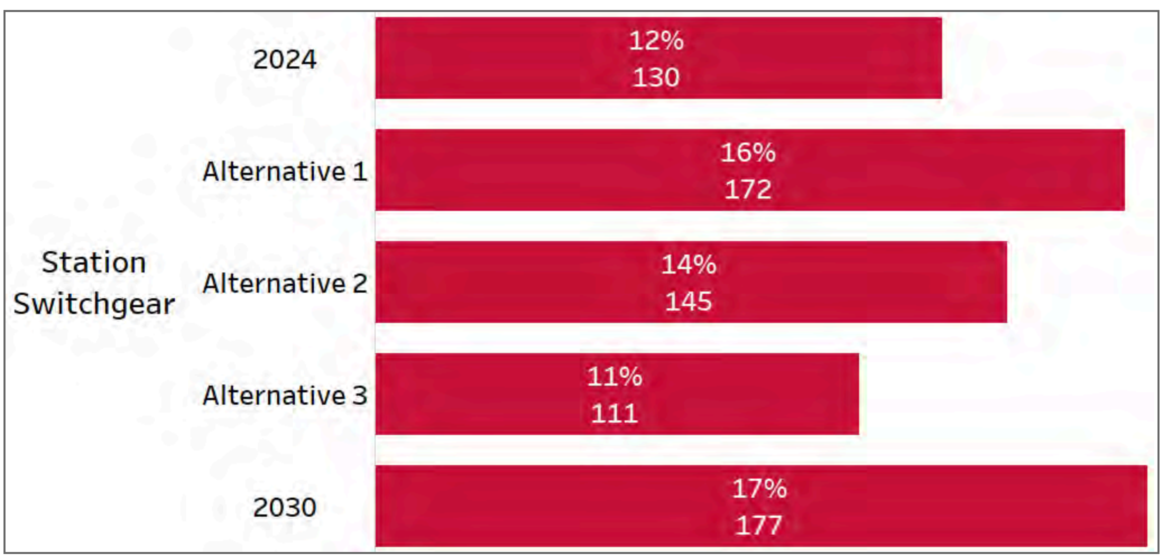


Figure 24 - Number of Station Batteries Projected to Reach Typical Useful Life by 2030

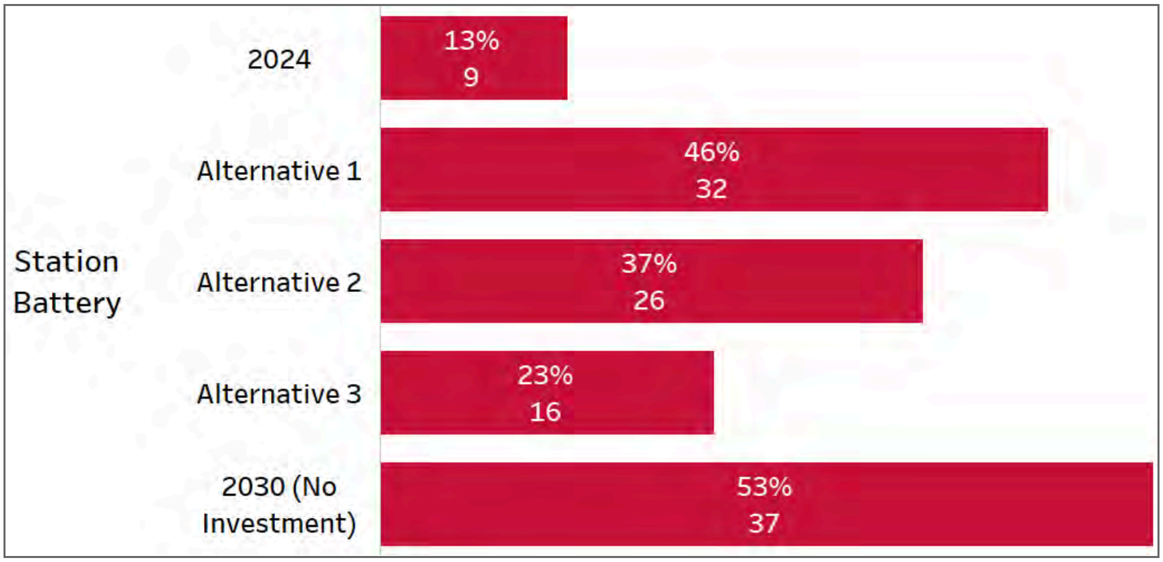


Figure 25 - Number of Station Batteries Projected to Reach a Deteriorated Condition by 2030

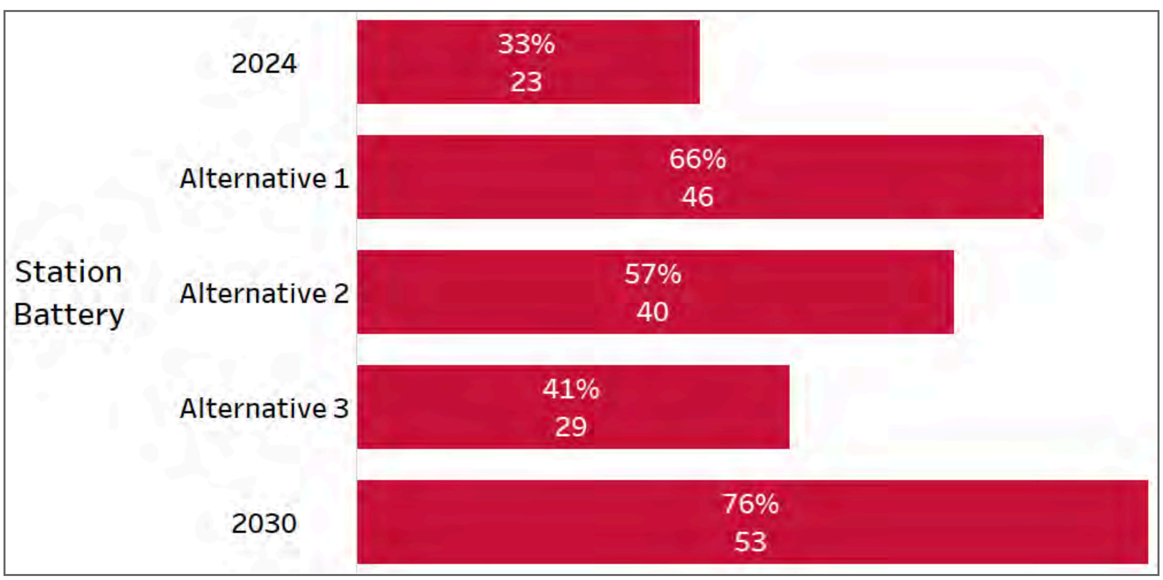
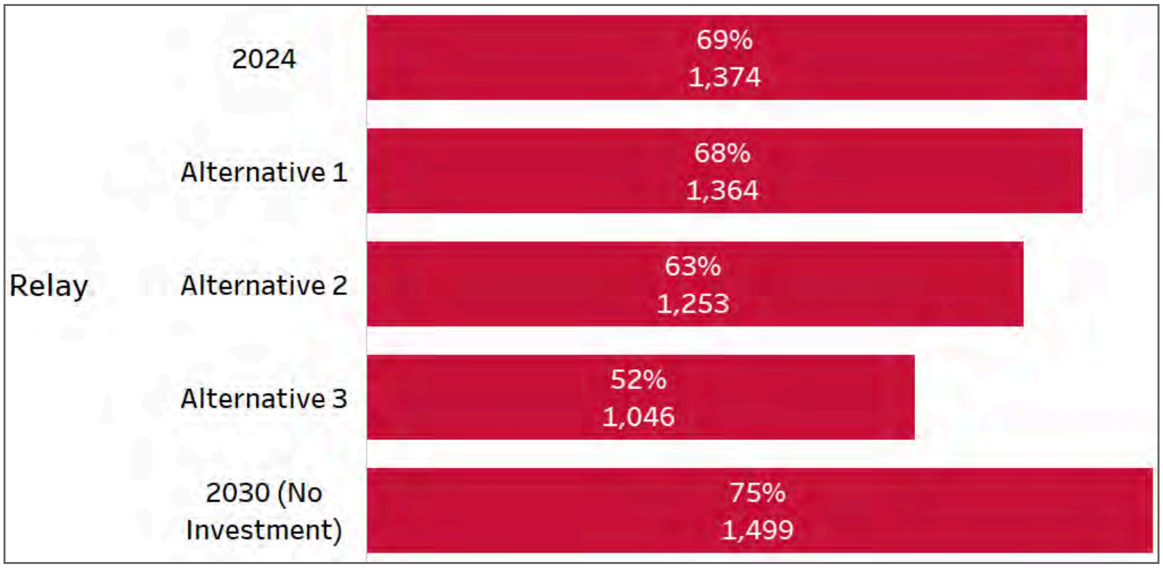


Figure 26 - Number of Station Relays Projected to Reach Typical Useful Life by 2030



2.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. The preferred alternative must mitigate any risks to Hydro Ottawa's employees and public safety.

Reliability

The increased potential of failure posed by deteriorating station assets will impact Hydro Ottawa's ability to deliver reliable power. The selected alternative shall help manage asset performance by reducing the reliability risk posed by station assets and mitigate the risk of failure.

Financial

This criterion assesses the ability to manage long-term financial needs for station assets. This helps to avoid large spikes in asset renewal spending and the associated rate impacts on customers. The selected alternative should ensure a levelized spending profile, manage long-term asset performance, and prevent significant service disruptions due to deteriorating station asset failures.

System Accessibility (Capacity)

The preferred alternative should improve system capacity and accessibility, thereby enhancing the quality and reliability of electric power delivery. This would enable Hydro Ottawa to satisfy increasing power demands resulting from intensification, electrification and large load requests, alongside improving the visibility and control of substations, specifically addressing the capacity needs on the 4kV system as outlined in Section 9.1.4.6 of Schedule 2-5-4 - Asset Management Process.

System Observability

With approximately 36% digital relays currently in Hydro Ottawa's substations, this criterion assesses the ability to enhance the monitoring or diagnosis of substation conditions within the scope of the station switchgear and P&C programs. The objective is to support Hydro Ottawa's grid modernization initiatives by increasing the number of digital relays by at least 5% relative to the existing number.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

2.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 2.6.1 - Alternatives Considered under the evaluation criteria of Section 2.6.2 - Evaluation Criteria.

The recommended approach, Alternative Two, involves replacing 45 station breakers, 145 relays, 10 station batteries, 3 obsolete RTUs, 2 obsolete transfer trip installations, a medium volume of minor station assets and complete necessary upgrades to station buildings, in addition to tackling 10 station transformers and other station assets through the EOL voltage conversion program.

The rate at which Hydro Ottawa's stations (particularly 4kV stations assets) are deteriorating exceeds the pace at which Hydro Ottawa can reasonably intervene. The 4kV EOL Voltage Conversion projects are particularly resource intensive and costly, as described in Section 3.1.2.2 of Attachment 4-1-3(C) - Workforce Growth. To this end, Alternative Two is optimized to account for supply chain and resource management considerations (both internal and external) and is also in alignment with Hydro Ottawa's workforce growth strategy for 2026-2030, to execute on the EOL voltage conversion initiatives. Alternative Two also results in a well phased out voltage conversion strategy that is manageable to the customers and results in short-term failure risk mitigation.

In light of this reality and subsequent to the decision in 2023 to defer two voltage conversion projects to the 2026-2030 period, Hydro Ottawa expanded its stations monitoring and maintenance program, to manage station asset performance. Key improvements included advanced diagnostic testing and increased maintenance activities of 4kV assets. Furthermore, unlike distribution assets, stations assets are conducive to remediation/refurbishment activities in the event of a failure. Through 2026-2030, Hydro Ottawa has provisioned for incremental reactive maintenance to support these efforts. The new and expanded programs will require incremental station electricians and technicians, distribution engineers, and project engineers. More information on the Stations Maintenance program for 2026-2030 is outlined in Section 3.4 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

Over half of station switchgear units have currently reached or exceeded their TUL with some degree of deterioration. Alternative Two also includes plans for the replacement of SF_6 and air-type switchgear with known issues at critical stations, further resulting in a 5% reduction in the number of station switchgear projected to reach TUL by 2030 and allowing for only a minor 2% increase in the number of switchgears in deteriorated condition.

Alternative Two allows for addressing the station batteries with known functional issues, having reached their TUL and in a deteriorated condition. It also allows for a moderate reduction in the back-log of station batteries reaching their TUL and in a deteriorated condition in the long run.

Approximately 69% of the station relays have currently reached or exceeded their TUL, with obsolete SCOUT RTUs causing operational issues. Alternative Two allows for a 6% reduction in the number of station relays that have reached or exceeded the TUL, alongside addressing the functional obsolescence of SCOUT RTUs at major stations. It also allows for a moderate improvement to the station level observability, based on increasing the number of digital relays.

Alternative Two also allows Hydro Ottawa to handle issues with minor station assets such as insulator failures, operational problems with online dissolved gas analysis (DGA) monitors, and deteriorating station infrastructure (buildings and roofs), through a medium level of investment.

Alternative Two provides a middle ground, allowing Hydro Ottawa to tackle critical station asset issues without an unsustainable spike in costs, and improving the related asset performance by:

- Mitigating short-term station asset failure risks
- Moderately reducing the backlog of station assets needing replacement
- Increasing station level observability through P&C renewals
- Executing EOL voltage conversion plans in a manageable, phased-out manner

2.7. PROGRAM EXECUTION AND RISK MITIGATIONS

2.7.1. Implementation Plan

The station renewal projects to be executed between 2026 and 2030 were obtained based on using Copperleaf PA for risk-based investment planning, as outlined in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

The station renewal projects typically span 3-5 years and Table 6 shows the projects proposed for the 2026-2030 period, as a part of the stations and buildings infrastructure renewal program.

Table 6 - Proposed Projects under the Stations and Buildings Infrastructure Renewal Program

Year	Proposed Projects
2026	• Longfields T2 Transformer Renewal • Rideau Heights DS Switchgear Renewal • Parkwood Hills DS Switchgear Renewal • Hinchey TH Switchgear Renewal • Carling TM Electromechanical Relay Renewal • King Edward TK Electromechanical Relay Renewal • Centrepointe DS RTU Renewal • Transfer Trip Renewal (Placeholder): Lemieux Island Filtration Plant/ Britannia Filtration Plant • Augusta UD, Beechwood UB and Bronson SB Battery Renewal • Station Minor Renewal (Janet King DS Recloser Replacement, Lightning Arrester Replacement, Kelman Online DGA Monitor Replacement, Buildings/operations facilities upgrade) • Fisher AK EOL Voltage Conversion • Dagmar AC EOL Voltage Conversion • Henderson UN EOL Voltage Conversion • Church AA EOL Voltage Conversion • Vaughan UG EOL Voltage Conversion
2027	• Longfields T2 Transformer Renewal • Parkwood Hills DS Switchgear Renewal • Rideau Heights DS Switchgear Renewal • Hinchey TH Switchgear Renewal • Carling TM Electromechanical Relay Renewal • King Edward TK Electromechanical Relay Renewal • Jockvale DS RTU Renewal • Transfer Trip Renewal (Placeholder): Lemieux Island Filtration Plant/ Britannia Filtration Plant • Bantree AL and Woodroffe DS Battery Renewal • Station Minor Renewal (Lightning Arrester Replacement, Kelman Online DGA Monitor Replacement, Buildings/operations facilities upgrade) • Vaughan UG EOL Voltage Conversion • Dagmar AC EOL Voltage Conversion • Henderson UN EOL Voltage Conversion • Church AA EOL Voltage Conversion
2028	• Rideau Heights DS Switchgear Renewal • Carling TM Electromechanical Relay Renewal • King Edward TK Electromechanical Relay Renewal • QCH DS RTU Renewal • Bayswater UJ and Florence UF Battery Renewal • Station Minor Renewal (Lightning Arrester Replacement, Kelman Online DGA

Year	Proposed Projects
	Monitor Replacement, Buildings/operations facilities upgrade) ● Vaughan UG EOL Voltage Conversion ● Dagmar AC EOL Voltage Conversion ● Henderson UN EOL Voltage Conversion ● Church AA EOL Voltage Conversion
2029	● Russell TB Switchgear Renewal ● Holland SH and Urbandale AE Battery Renewal ● Station Minor Renewal (Lightning Arrester Replacement, Kelman Online DGA Monitor Replacement, Buildings/operations facilities upgrade) ● Vaughan UG EOL Voltage Conversion ● Dagmar AC EOL Voltage Conversion ● Henderson UN EOL Voltage Conversion ● Church AA EOL Voltage Conversion
2030	● Russell TB Switchgear Renewal ● Centrepointe DS and Moulton MS Battery Renewal ● Station Minor Renewal (Lightning Arrester Replacement, Kelman Online DGA Monitor Replacement, Buildings/operations facilities upgrade) ● Vaughan UG EOL Voltage Conversion ● Henderson UN EOL Voltage Conversion ● Church AA EOL Voltage Conversion

Aside from the aforementioned projects to be implemented during the 2026-2030 rate app period, the renewal of the Longfields station transformer T2 is to be completed in 2027, with the order placed for the transformer in 2024.

2.7.2. Risks to Completion and Risk Management Strategies

Hydro Ottawa faces several risks in managing its Stations and Buildings Infrastructure Program, Table 7 outlines the key risks and corresponding mitigation strategies:

1 **Table 7 - Key Risks to Stations and Buildings Infrastructure Program and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment transportation/installation delays) can complicate project planning, increase costs, and impact timelines. Ineffective project management could further exacerbate these issues.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

2.8. RENEWABLE ENERGY GENERATION

As the integration of distributed energy resources (DERs) like solar photovoltaic systems and battery storage increases within Hydro Ottawa's distribution network, it's crucial to address the potential for reverse power flow. Traditionally, distribution systems were designed for unidirectional power flow from substations to consumers. However, DERs can inject power back into the grid, leading to reverse power flow and potential overloading of existing infrastructure.

To mitigate this, Hydro Ottawa ensures that new station transformers have reverse power flow capability, with additional functionality enabled by modern microprocessor relays. This means the transformers are designed to handle power flow in both directions without exceeding their thermal limits. By enabling reverse power flow capability, the transformers are no longer a bottleneck for DER integration.

In addition to new station transformers with reverse power flow capability, voltage conversion projects also enable the connection of more DER's to the distribution system by increasing voltage levels and thereby increasing the distribution systems capacity to carry electricity, ultimately accommodating increased output from DERs.

3. OH DISTRIBUTION ASSET RENEWAL

3.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $43.1M

2026-2030: $67.8M

Budget Programs: Pole Renewal, OH Switch/ Recloser Renewal

Main Driver: Failure Risk

Secondary Driver: Reliability, Safety, Environmental

Outcomes: Operational Effectiveness and Customer Focus

Hydro Ottawa's overhead (OH) distribution system is supported mechanically by a system of poles and fixtures. The continued reliability, safety and resilience of the OH distribution system is dependent on the performance of these assets. To this end, Hydro Ottawa has proposed investments targeted at renewing OH distribution infrastructure over this Application period. This program replaces end-of-life OH distribution assets in a deteriorated condition, ensuring long-term performance and prioritizing projects based on asset condition and risk, as determined through the distribution asset model in Copperleaf PA (described in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process).

Hydro Ottawa's OH Distribution Asset Renewal Program proposes a strategic investment of $67.8M during this Application period. This capital allocation is dedicated to maintaining a high degree of system reliability through the optimization of asset replacement strategies, thereby enhancing the operational performance of the existing OH asset population.

The OH distribution assets renewal program addresses the needs under the following budget programs over the 2026-2030 period:

Pole Renewal: This Budget Program covers the cost of replacing 1,975 poles in degraded condition between 2026-2030 in key areas such as Playfair, Pleasant Park, Ryan Farm, Canterbury, Carlington, Glebe, Alta Vista, Convent Glen, Wood Park, Westboro, Overbrook, Fallowfield, Athlone, Riverside Park, Woodroffe, Wellington Village Presland, Scott, Richmond. The replacement of adjacent assets in poor condition including overhead switches, insulators, and overhead transformers are considered a part of the pole renewal project scoping.

Project scoping within the pole renewal program will also contemplate incremental investments that enhance the resilience of the OH system, inclusive of strategic undergrounding, line relocation, and the fortification of critical overhead sections. This expansion is attributed to the increasing frequency of recent weather events, which have revealed the heightened susceptibility and failure rate of overhead equipment. Vulnerability assessments supported by climate assessments have identified overhead assets as the most vulnerable, due to the direct impact from extreme weather. Based on the assessment and the outcomes of the Resilience Investment Business Case report detailed in Attachment 2-5-4(E) - Resilience Investment Business Case Report, it is recommended that at least one lateral line per year (approximately 30 poles) slated for replacement are amenable to undergrounding or other hardening measures. For further information, please refer to Section 3.6.3 - Preferred Alternative.

OH Switch/Recloser Renewal: This Budget Program involves replacing 340 OH switches between 2026-2030. Project scoping within the OH switch/recloser program will also contemplate incremental investments to convert existing manual switches at open points to SCADAmates in support of grid modernization efforts related to system observability. The proposed plan assumes 40 manual switches would be converted to SCADAmates.

3.2. PERFORMANCE OUTCOMES

Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. With the implementation of the OH Distribution Renewal Program, improvements are expected in the outcomes shown in Table 8 below.

Table 8 - OH Distribution Asset Renewal Program Performance Outcomes

OEB Performance Outcome	Target
Operational Effectiveness	Hydro Ottawa's system reliability objectives are supported by: ● Replacing assets at a pace that allows Hydro Ottawa to achieve 42% of OH distribution assets that have reached their end-of-life by 2040. ● Replacing assets at a pace that allows Hydro Ottawa to minimize the percentage of OH distribution assets in poor and very poor condition by 2040.
	● Contributes to Hydro Ottawa's Grid Modernization Plan by replacing 40 manual OH switches with SCADAmates, resulting in increased observability and controllability of Hydro Ottawa's distribution system.
Customer Focus	● Contributes to Customer Satisfaction by maintaining system reliability and improving system resilience through effective capital deployment during renewal projects

3.3. PROGRAM DRIVERS AND NEED

3.3.1. Main and Secondary Drivers

Primary Driver – Failure Risk: The primary driver for OH distribution renewal is the increasing failure risk due to the number of units (specifically wood poles) in a deteriorated condition or surpassing their TUL. The proposed investments are supported by the Copperleaf PA distribution asset model which considers asset condition as a part of the risk assessment value framework. Further detail on the distribution asset model is provided in Section 5.1.4.2 of Schedule 2-5-4 - Asset Management Process.

Secondary Drivers – Reliability, Safety, and Environmental: The OH distribution asset renewal mitigates the reliability and safety impacts associated with OH distribution asset failures by proactively replacing these assets before they fail, and doing so in a cost efficient, planned manner. Further, the replacement of OH transformers in this program also reduces the environmental risk of oil spills due to unanticipated failures.

3.3.2. Current Issues

The primary focus of the OH distribution asset renewal program is to mitigate the risks associated with asset failure. The age and condition demographics of major OH assets considered as a part of the OH distribution asset renewal program are shown in Figures 29 to 35, with the overall summary highlighted in Figure 27 and Figure 28.

Figure 27 - Overall Age Demographics Profile of OH Distribution Assets

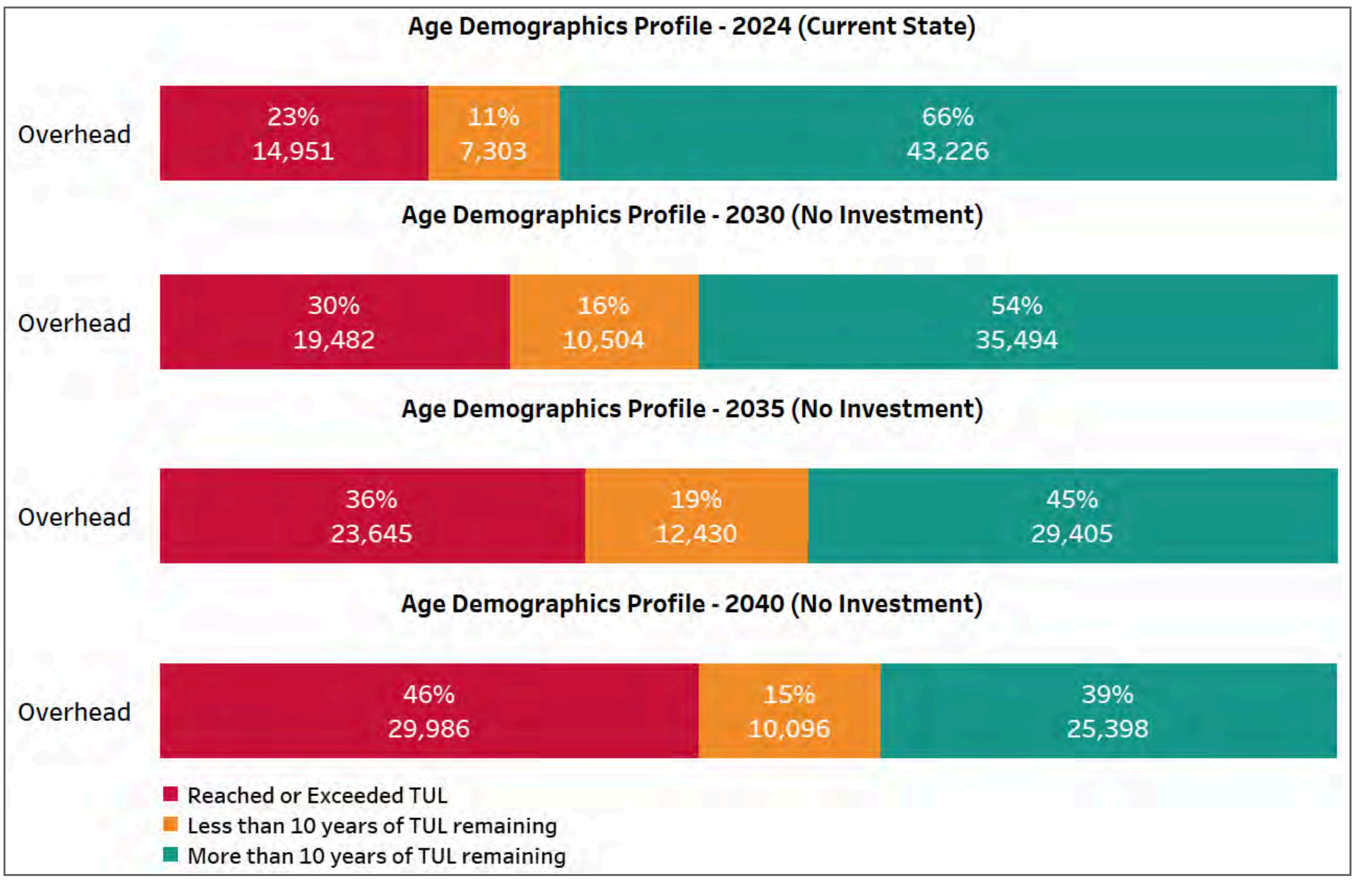
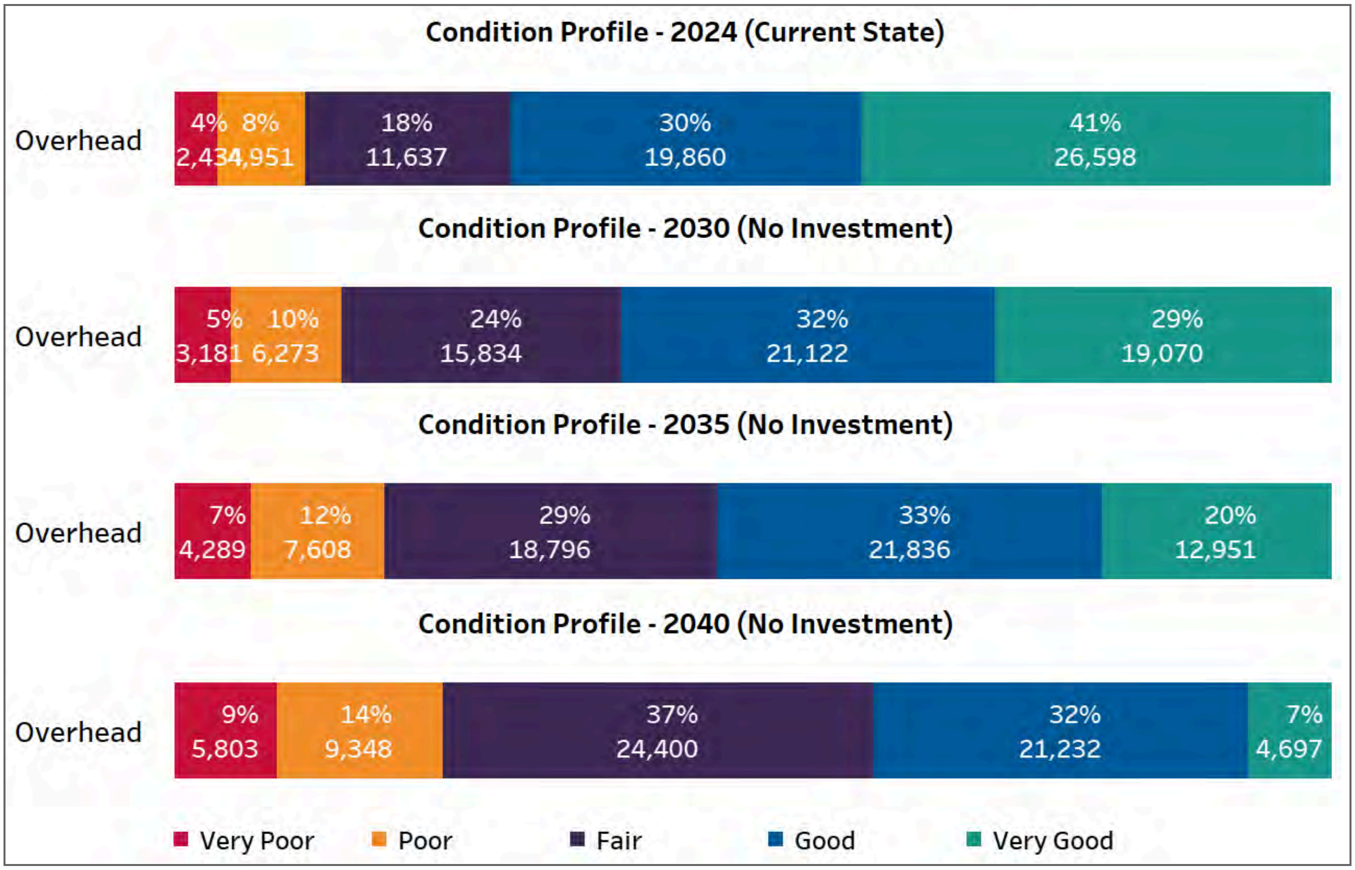


Figure 28 - Overall Condition Profile of OH Distribution Assets



TUL refers to the expected duration an asset can reliably operate before it requires replacement or refurbishment. Condition ranges provide a way to assess the actual state of an asset to determine the urgency of any necessary interventions. Hydro Ottawa uses a health index, which is a score from 0% to 100%, to evaluate the condition of an asset from Very Poor to Very Good for condition ranges. More details on Hydro Ottawa's condition assessment framework is presented in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process.

Through Copperleaf PA, Hydro Ottawa established the unique degradation pattern of each individual asset in the system to 2040. From Figure 27, it can be observed that without intervention the percentage of Hydro Ottawa's OH assets that have reached their end of life will continue to grow at a rate of approximately 8% every five years. Likewise, without intervention, the percentage of assets in degraded condition (poor or very poor) will continue to grow at a rate of approximately 4% every 5 years.

The following sub-sections summarize some of the challenges faced by Hydro Ottawa specific to its existing OH distribution asset categories.

3.3.3. Poles and OH Distribution Transformers

OH Poles

Figures 29 and 30 demonstrate that Hydro Ottawa's poles are reaching end of life and are projected to degrade at a high rate through to 2040. Specifically, Copperleaf PA forecasts that without intervention the percentage of poles that have reached their end of life will continue to grow at a rate of approximately 8% every five years. Likewise, without intervention, the percentage of poles in a degraded condition (poor or very poor) will continue to grow at a rate of approximately 3% every 5 years.

Figure 29 - Age Demographics Profile of Poles

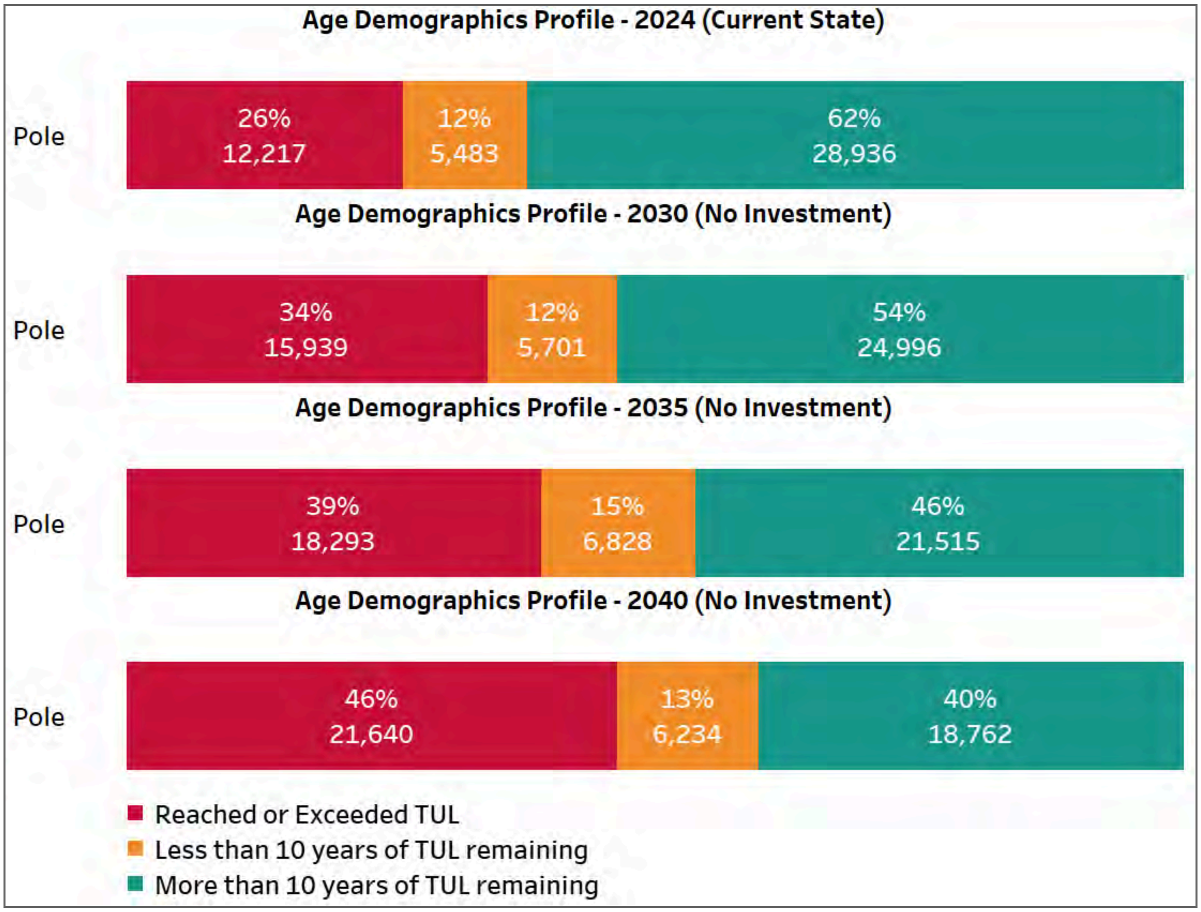
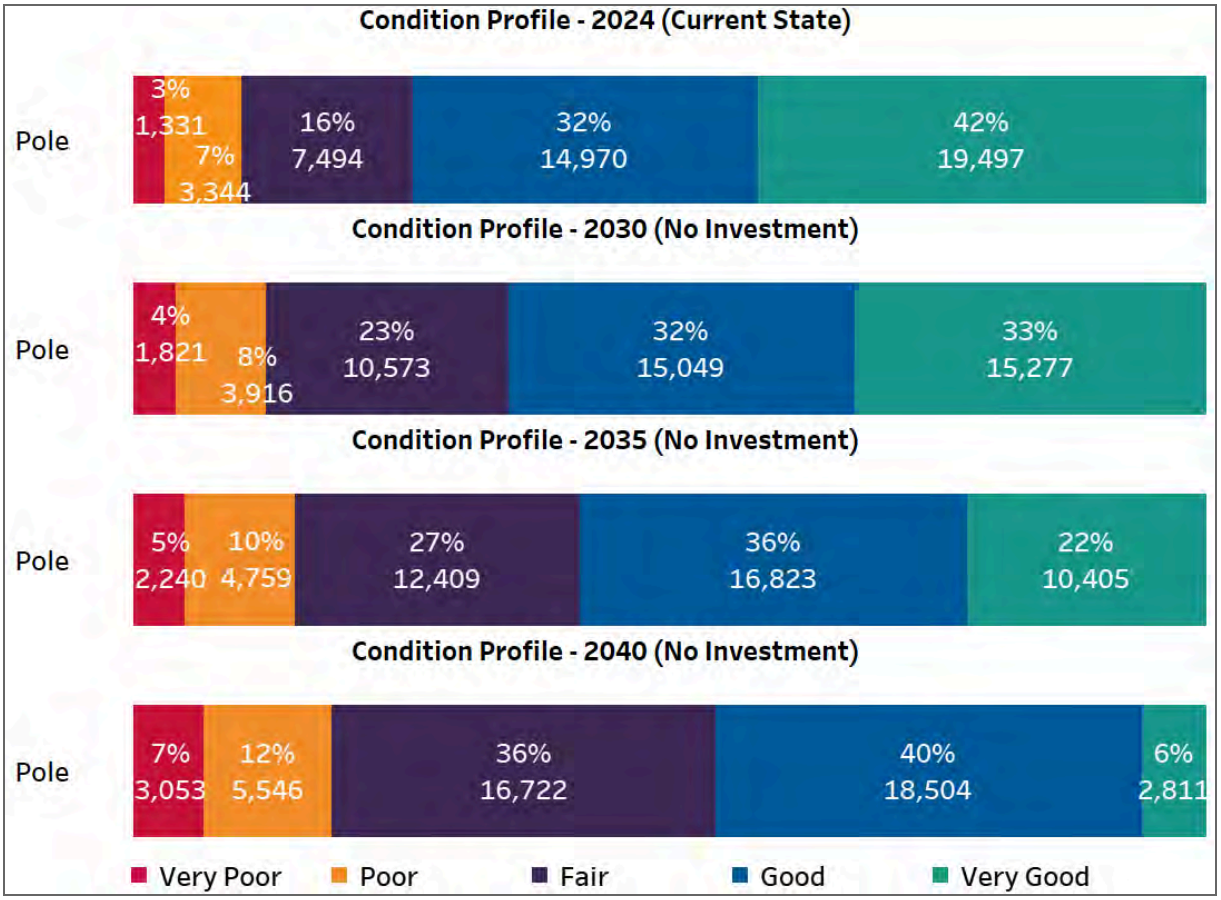
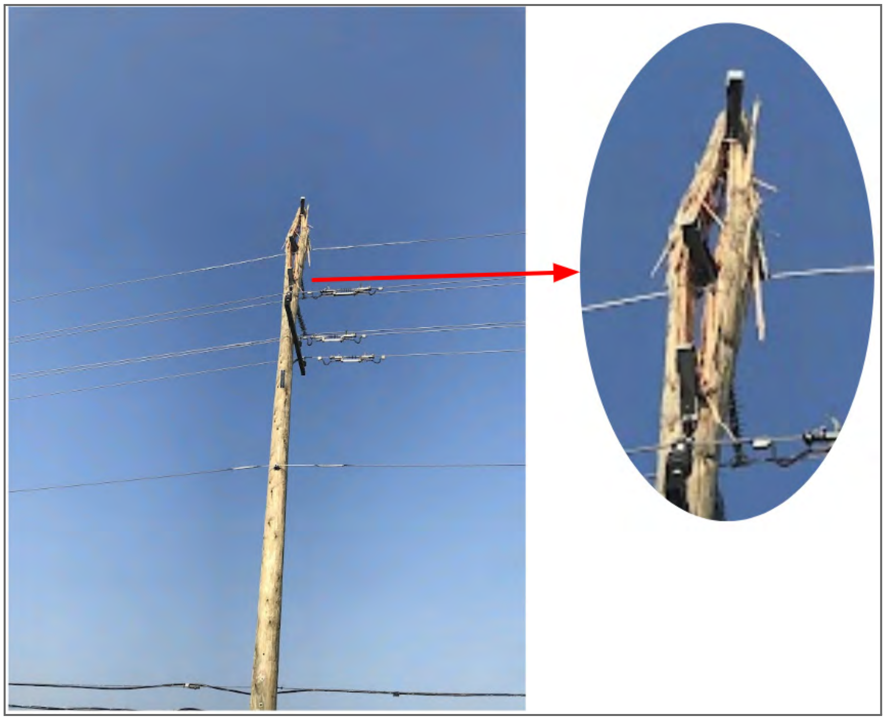


Figure 30 - Condition Profile of Poles



Poles in a degraded condition pose significant risk to Hydro Ottawa's system highlighted by the steady trend of outages due to poles and pole attachments (an average of 18 outages per year between 2019 and 2023) as detailed in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. This shows a consistent impact to reliability each year based on the unanticipated failure of in-service poles. Hydro Ottawa has also been experiencing the lingering impact of extreme weather events on its OH asset population. There are OH assets such as wood poles that haven't failed as a result of an adverse weather event, but have certain components (e.g. pole top, OH switchgear, OH conductor etc.) impacted/degrading faster than expected which may lead to power interruption to customers if not managed proactively. Figure 31 shows an example of a pole top that had been damaged following a storm event (but not failed), making it a high risk to support multiple OH circuits.

Figure 31 - Example of an Impacted Pole Top Following an Extreme Weather Event



OH Transformers

Hydro Ottawa has also observed a steady trend with respect to the annual number of OH transformer failures resulting in an outage (an average of 25 outages per year between 2019 and 2023), as outlined in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Approximately 17% of the OH transformers owned by Hydro Ottawa have reached their TUL. The number of OH transformers which have surpassed their TUL will continue to increase at a rate of over 8% every 5 years without the proposed level of investment in the pole renewal program (shown in Figure 32). The data on the condition of OH transformers is improving and is primarily based on the translation of age to condition through Copperleaf PA. To enhance condition assessment data, there are suggested improvements to the OH transformer maintenance program through drone-based inspections, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

Figure 32 - Age Demographics Profile of OH Transformers

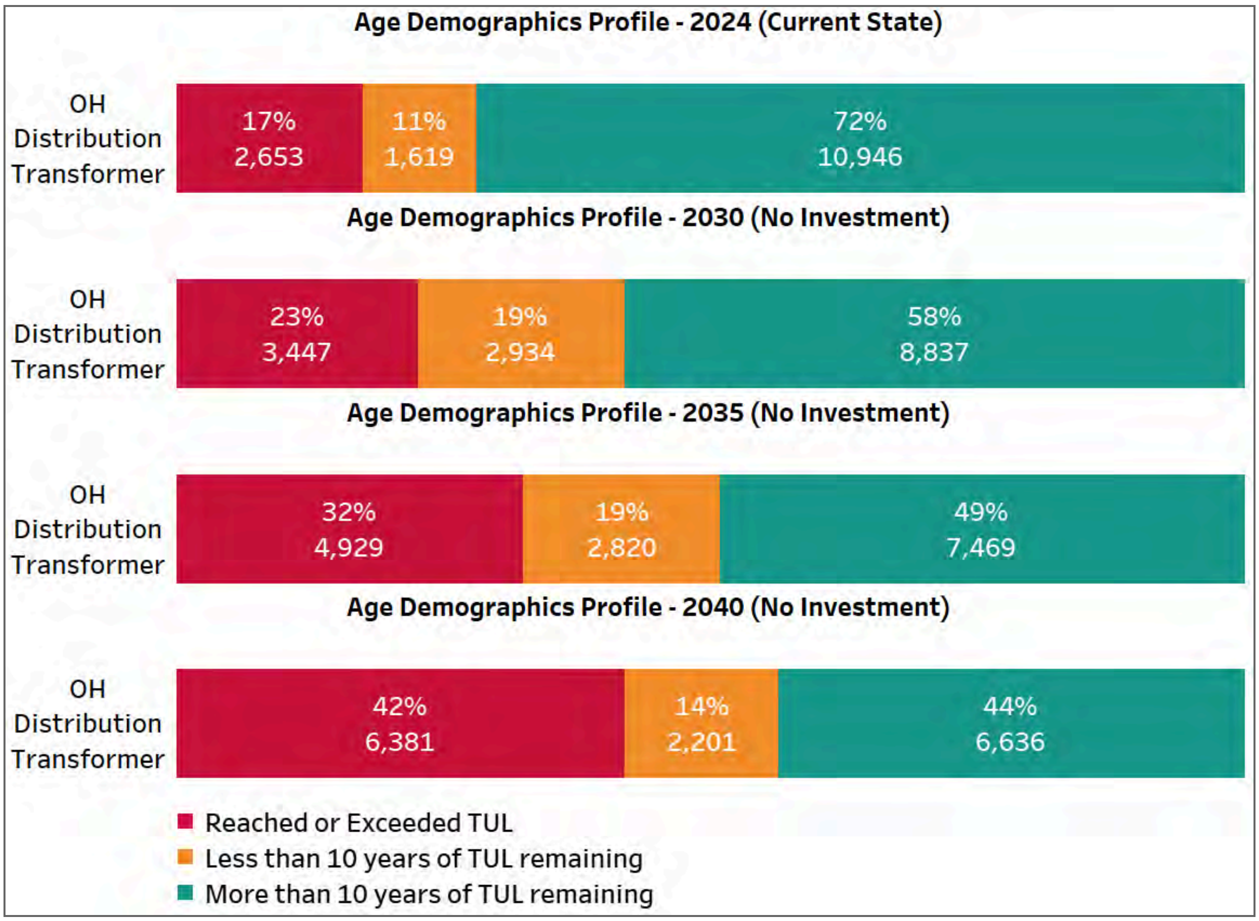
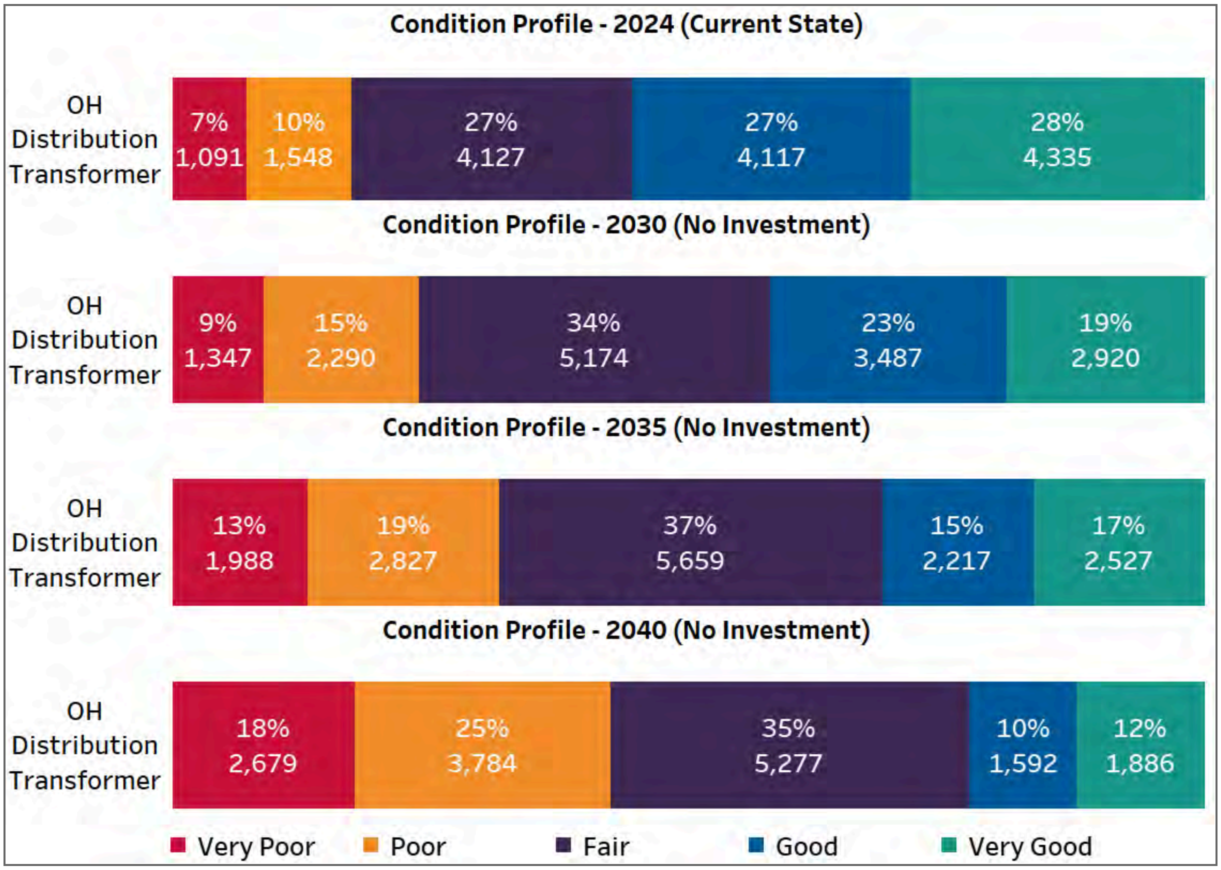


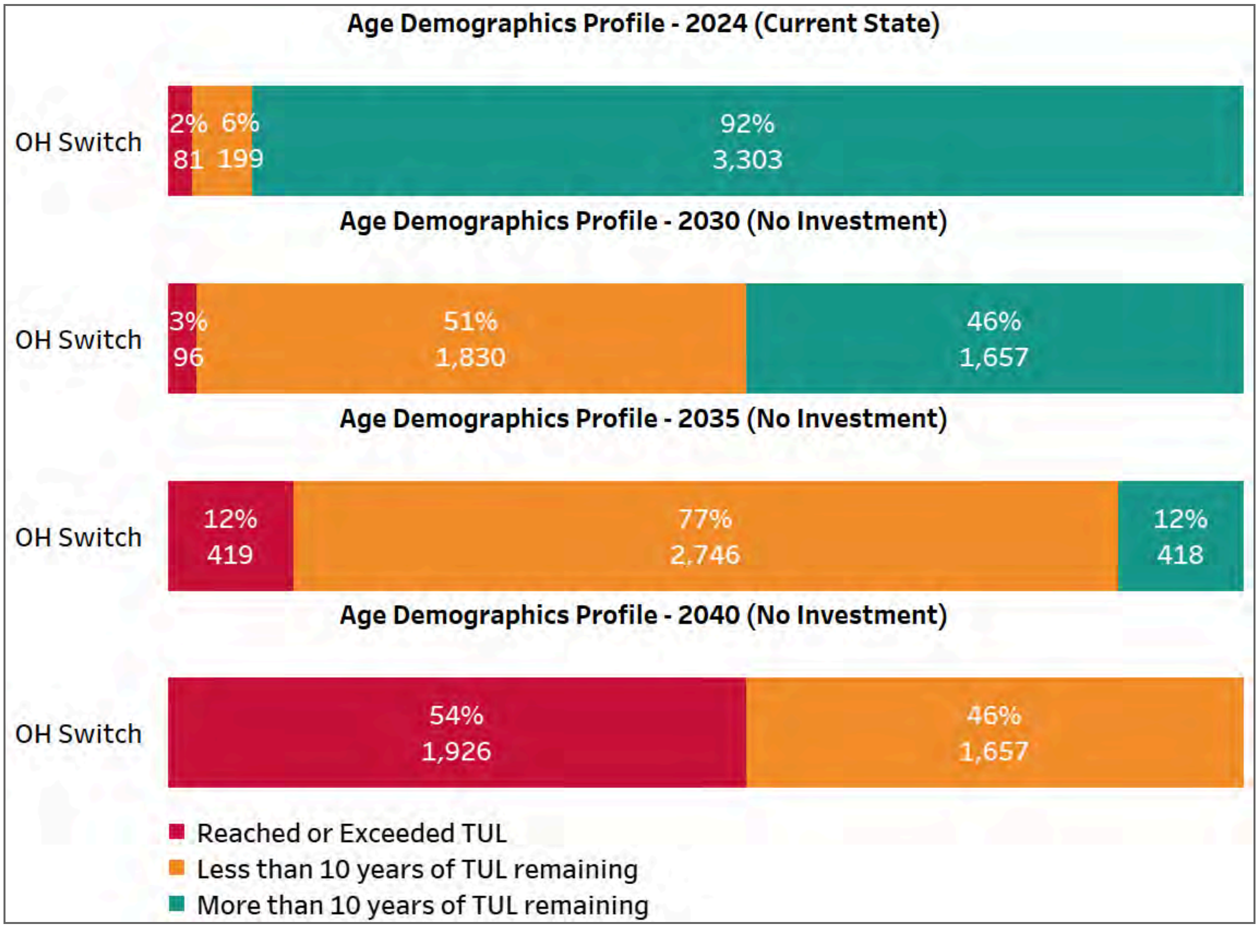
Figure 33 - Condition Profile of OH Transformers



3.3.4. OH Switches/Reclosers

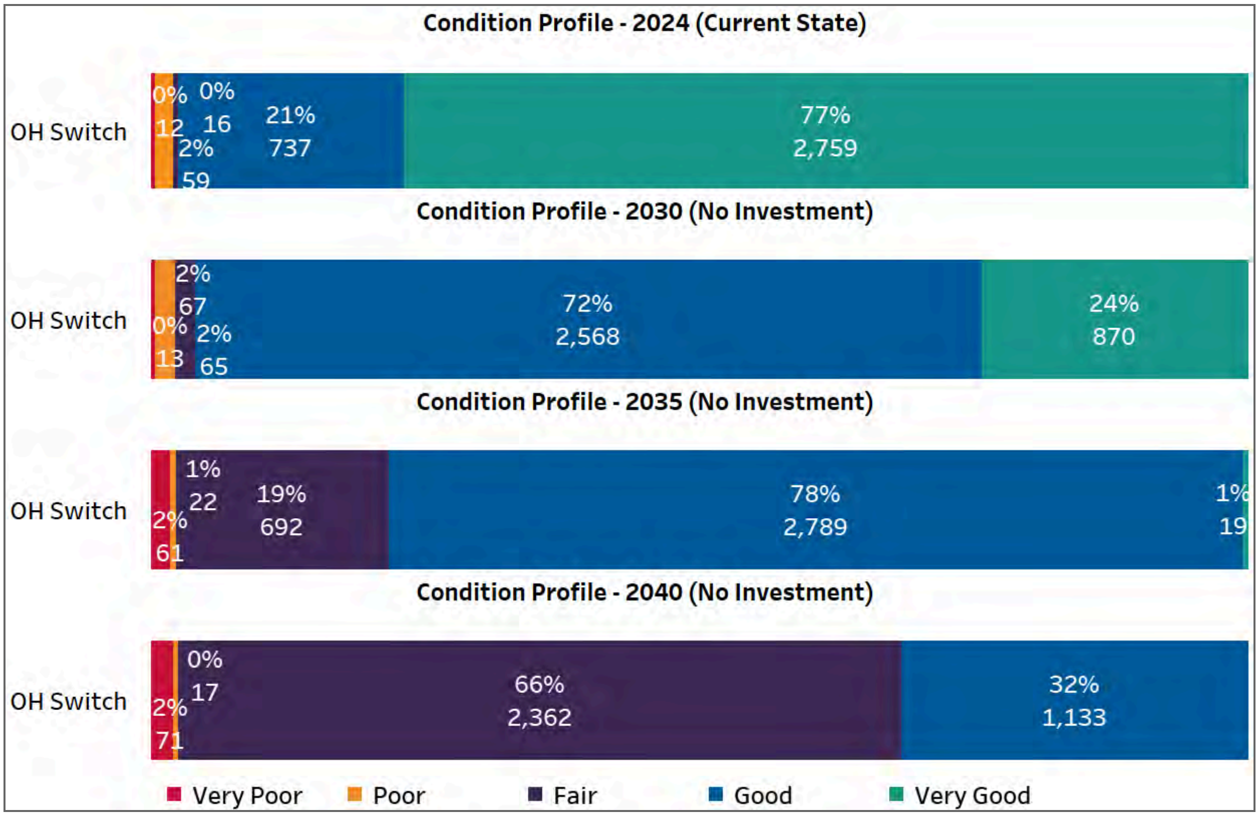
Hydro Ottawa did not historically have a capital program in place to renew 3-phase OH switches. Reviewing the age demographics of OH switches (excluding fuse cut-outs), approximately 3% of OH switches will reach or exceed the TUL by 2030, without any intervention. However, there is a sharp increase in the number of OH switches reaching their TUL by 2035 (at 12%), and further increasing to more than half (54%) of the OH switches reaching their TUL by 2040. This shows the need for intervention now, to avoid a backlog in the future.

1 **Figure 34 - Age Demographics Profile of OH Switches**



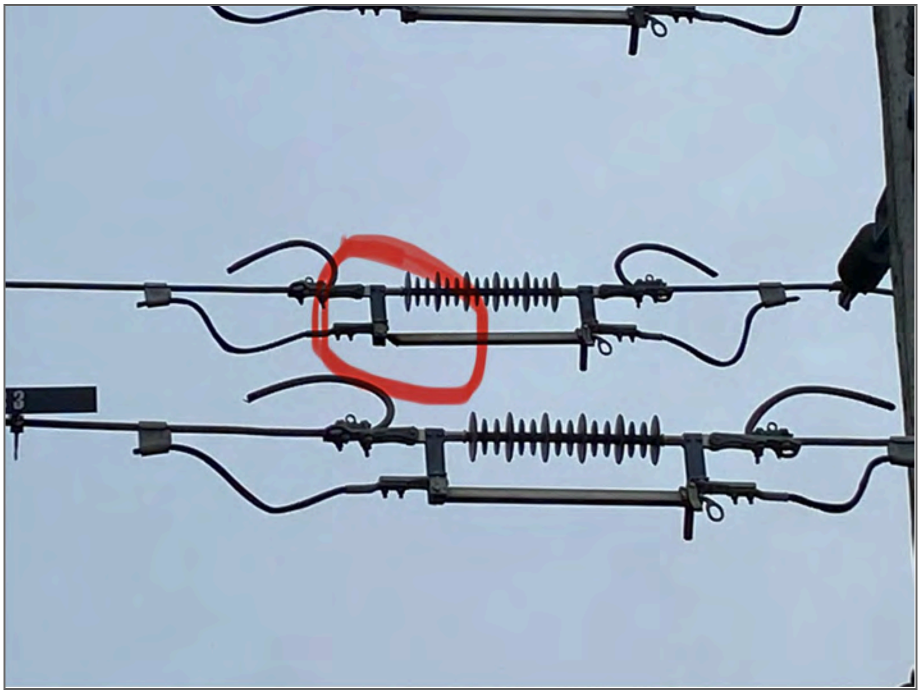
2

Figure 35 - Condition Profile of OH Switches



Hydro Ottawa has experienced a relatively high number of outages each year (an average of 32 outages per year between 2021 and 2025) due to OH switchgear as detailed in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Further investigation has found a lack of correlation between the condition information on OH switches and outages due to OH switch failures, further emphasizing the need for increased investment in an improved maintenance program for OH switches, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. An example of a burnt OH switch (post thermal failure) is shown in Figure 36.

Figure 36 - Burnt Switch Failure



3.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the OH distribution renewal program are summarized in the section below.

3.4.1. Safety

The replacement of deteriorated OH distribution equipment reduces the risk of in-service equipment failure and consequently, reduces the potential safety risk to employees and the public from catastrophic equipment failures.

3.4.2. Customer

The OH distribution asset renewal program focuses on replacing deteriorating and failing OH distribution assets with the aim to maintain the number of outages due to equipment failures below levels experienced between 2021 to 2025. The program also considers incremental investment to improve resilience through strategic undergrounding or other hardening measures, which is an important outcome for customers.

3.4.3. System Operation Efficiency and Cost Effectiveness

Upgrading manual OH switches to SCADAmates will improve system observability and allow for efficient system operations and control, and reducing truck rolls to operate manual switches. Additionally, the replacement of related pole-mounted hardware (such as OH transformers) as a part of the pole renewal program drives cost savings and efficiencies through the synergy gained by Hydro Ottawa replacing these deteriorated assets in conjunction with pole replacements.

3.4.4. Economic Development

Robust and reliable electric distribution infrastructure is essential for Ottawa's economic stability and growth. Hydro Ottawa's OH distribution asset renewal program contributes to consistent and dependable power which businesses need to thrive, supporting job retention and creation, furthermore the ability to provide stable power will continue to attract commercial investment in Ottawa.

3.4.5. Environment

Hydro Ottawa will be replacing a select population of at-risk OH oil-filled distribution equipment that have reached or exceeded the TUL and are in a deteriorated condition, minimizing the risk of environmental contamination.

3.5. PROGRAM COSTS

Table 9 shows a budget program breakdown of the historical and future investments in the OH distribution asset renewal program. In the 2026-2030 period Hydro Ottawa forecasts expenditures in this program of $67.8M, compared to $43.1M in the 2021-2025 period. There are considerations around equipment/resource availability as well as project prioritization/scheduling which results in some variability in the projected spending between 2026 and 2030.

Table 9 - Historical, Bridge and Test Year Expenditures per OH Distribution Asset Renewal Budget Program ($'000 000s)[4]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Pole Renewal	$ 9.1	$ 8.2	$ 8.8	$ 7.3	$ 8.8	$ 11.3	$ 11.3	$ 11.8	$ 12.3	$ 12.5
OH Switch / Recloser Renewal[5]	$ 0.2	$ 0.6	-	$ 0.1	-	$ 1.6	$ 1.7	$ 1.7	$ 1.8	$ 1.8
ANNUAL TOTAL	**$ 9.3**	**$ 8.8**	**$ 8.8**	**$ 7.4**	**$ 8.8**	**$ 12.9**	**$ 12.9**	**$ 13.5**	**$ 14.1**	**$ 14.3**
5-YEAR TOTAL					**$ 43.1**					**$ 67.8**

Table 10 shows the detailed historical and future units (either replaced or forecasted) by the underlying OH distribution asset class, as a part of OH distribution asset renewal program. The count for OH transformers shows the forecasted units to be replaced under the pole renewal program between 2026 and 2030. The OH switch/recloser renewal program between 2021-2025 aimed at replacing porcelain insulated cut-outs, in-line switches and re-fusing of adjacent taps on select feeders. The focus of the 2026-2030 OH switch renewal program is around replacing aged 3-phase OH switches.

Table 10 - Detailed Unit Replacements per OH Distribution Asset Class

Asset Class	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Poles	370	419	283	330	330	395	395	395	395	395
OH Transformers	85	54	46	62	62	80	80	80	80	80
OH Switches / Reclosers	-	43	-	13	-	68	68	68	68	68

[4] Totals may not sum due to rounding
[5] 2021-2025 units include loadbreak/non loadbreak switches, inline switches and disconnects whereas the units proposed for the 2026-2030 rate app only consider loadbreak/ non loadbreak switches planned for replacement.

3.5.1. Pole Renewal

The Pole Renewal program's spending is forecasted to increase by $16.9M from $42.3M in 2021-2025 to $59.2M in 2026-2030, of which $9M is due to support incremental investments in resilience related activities, such as strategic undergrounding. The remaining nearly $8M increase is related to the increased volume of poles being proposed for replacement. Hydro Ottawa made significant productivity improvements to the pole renewal program over the 2021-2025 period, as outlined in Schedule 1-3-4 - Facilitating Continuous Improvement and Innovation. As a result, Hydro Ottawa has maintained the baseline cost per pole for the 2026-2030 period, accounting for continued inflation. The 2026-2030 pole renewal program allows Hydro Ottawa to replace 395 poles per year, which is in line with the targeted rate of 400 poles per year that was approved for the 2021-2025 rate period. Further details related to Hydro Ottawa's decision to defer pole replacements through the 2021-2025 period are provided in Section 4.1 of Schedule 2-5-5 - Capital Expenditure Plan.

The renewal of OH transformers do not have a distinct program budget as the cost for replacement is contemplated within the pole renewal budget.

3.5.2. OH Switch/Recloser Renewal

The OH switch/recloser renewal program spending is forecasted to increase by $7.7M from $0.9M in 2021-2025 to $8.6M in 2026-2030. Between 2021-2025, the only planned replacements and expenditures for overhead switches and reclosers were for replacing porcelain insulated cut-outs, in-line switches and re-fusing of adjacent taps on select feeders. Any other overhead switch replacements during this period were done as part of pole renewals or other programs, as there was no specific plan to renew OH switches and reclosers.

The historical strategy of replacing 3-phase OH switches under the pole renewal program is no longer reasonable primarily due to a misalignment in asset lifespans: the typical useful life (TUL) of switches is 25 years, while poles have a significantly longer TUL of 53 years, resulting in a large number of switches reaching their end-of-life well before the poles (see Figure 34). This issue is compounded by the high reliability impact Hydro Ottawa has experienced due to OH switch failures, averaging 32 outages per year between 2021 and 2025. This has also resulted in a Corrective Renewal spending of $2.5M (on an emergency and critical basis) for OH switches between 2021 and 2023, thereby having a considerable financial impact. As a result, Hydro Ottawa has set a budget for the proactive replacement of 3-phase OH switches under the OH Switch/Recloser renewal program. This program allows Hydro Ottawa to replace 340 manual switches and also contemplates upgrading 40 manual switches to remote controllable switches, refer to Section 3.6.3 - Preferred Alternative for OH switch replacement rationale.

3.5.3. Cost Factors

Cost factors that affect OH distribution asset renewal are listed below:

- Location and number of circuits being supported
- Type and quantity of distribution assets installed on a pole
- Nature of renewal: like-for-like or like-for-better (e.g. wood pole with a wood pole or a wood pole replaced with a composite pole)

3.6. ALTERNATIVES EVALUATION

3.6.1. Alternatives Considered

In order to address the drivers and achieve the performance objectives of the program, Hydro Ottawa conducted an analysis using Copperleaf PA to optimize the number of units renewed as part of OH distribution asset renewal projects, with the goal of minimizing the number of asset failures and managing long term operational performance. As a result of the low relative replacement cost compared to the value of mitigated risk and Copperleaf PA's focus on individual asset performance, the PA analysis recommended that Hydro Ottawa replace all assets in degraded condition over the 5-year period. To achieve this objective, Hydro Ottawa would need to invest $199M in the OH renewal program, far exceeding the $43M investment levels of the 2021-2025 period. This level of investment would result in customer rate and resourcing impacts that do not align with the overall objectives of this Distribution System Plan.

In this regard, three investment alternatives were considered, as outlined in Table 11, with varying levels of replacement rates and alignment to the outcomes detailed in Table 8 with the objective of balancing long term-cost impacts with the risks associated with assets in a degraded condition.

Table 11 - Summary of Program Investments of Alternatives Considered

Program Investments	Alternative 1: Cost Containment	Alternative 2: Short Term Risk Mitigation	Alternative 3: Long Term Risk Mitigation (Preferred)
Poles	1100 (220/year)	1475 (295/year)	1975 (395/year)
OH Transformers	225 (45/year)	300 (60/year)	400 (80/year)
3-Phase OH Switches/Reclosers	110 (22/year)	220 (44/year)	340 (68/year)
Incremental Resilience Investments	No	No	Yes ($1.6M/year)
System Observability Investments	Minor (2/year)	Medium (4/year)	Highest (8/year)
TOTAL PROGRAM COST	**$35M**	**$50M**	**$68M**

Alternative 1: Cost Containment (~$35M): This alternative will provide:

- Cost impacts are minimized during the 2026-2030 period, however replacement rates will not allow Hydro Ottawa to balance long term affordability or effectively manage risk associated with assets in degraded condition:
    - No reduction in the percent of poles in degraded condition compared to 2024 levels (refer to Figure 38) and a net 6% increase in poles that have reached their typical useful life by 2030 (refer to Figure 37), creating a back-log of poles to be replaced in the long term.

    - A 4% net increase in the number of OH transformers that have reached their typical useful life (refer to Figure 39).
    - Replacement of all 3-phase OH Switches that have reached their typical useful life (refer to Figure 41).
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Minimum ability to increase system observability through the OH asset renewal program
- Inability to enhance system resilience through the OH asset renewal program

Alternative 2: Short Term Risk Mitigation (~$50M): This alternative will provide:

- Cost impacts are more significant and replacement rates will allow Hydro Ottawa to mitigate only short term risk associated with assets in degraded condition:
    - A minor 1% reduction in the percent of poles in degraded condition compared to 2024 levels (refer to Figure 38) and a 5% net increase in poles that have reached their typical useful life by 2030 (refer to Figure 37), creating a back-log of poles in deteriorated condition to be replaced in the long term.
    - A 4% net increase in the number of OH transformers that have reached their typical useful life (refer to Figure 39).
    - Replacement of all 3-phase OH Switches that have reached their typical useful life (refer to Figures 41).
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Minimum ability to increase system observability through the OH asset renewal program
- Inability to enhance system resilience through the OH asset renewal program

Alternative 3 - Long Term Risk Mitigation (~$68M - Preferred Alternative): This alternative will provide:

- Cost impacts are highest however replacement rates will allow Hydro Ottawa to most effectively balance long term affordability and risk associated with assets in degraded condition:
    - A more significant 2% reduction in the percent of poles in degraded condition compared

  - to 2024 levels (refer to Figure 38) and a 4% net increase in poles that have reached their typical useful life by 2030 (refer to Figure 37), reducing the back-log of poles to be replaced in the long term.
  - A 3% net increase in the number of OH transformers that have reached their typical useful life (refer to Figure 39).
  - Replacement of all 3-phase OH Switches that have reached their typical useful life (refer to Figures 41).
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Ability to maximize system observability through efficient deployment of capital, replacing an estimated 40 switches with remote controllable switches during renewal efforts
- Ability to increase system resilience by including a plan to underground approximately 30 poles per year

Figures 37 to 42 show the proportion of OH distribution assets that will reach the TUL and deteriorating condition by 2030, based on current state and a consideration of the different intervention strategies around managing the OH distribution asset population.

Figure 37 - Number of Poles Projected to Reach Typical Useful Life by 2030

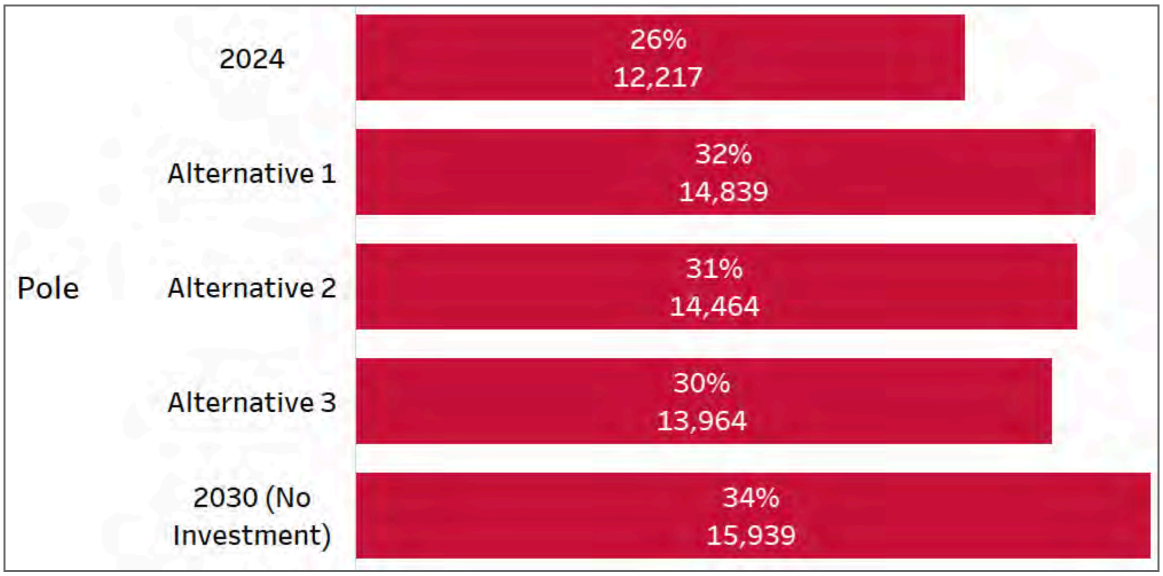


Figure 38 - Number of Poles Projected to Reach a Deteriorated Condition by 2030

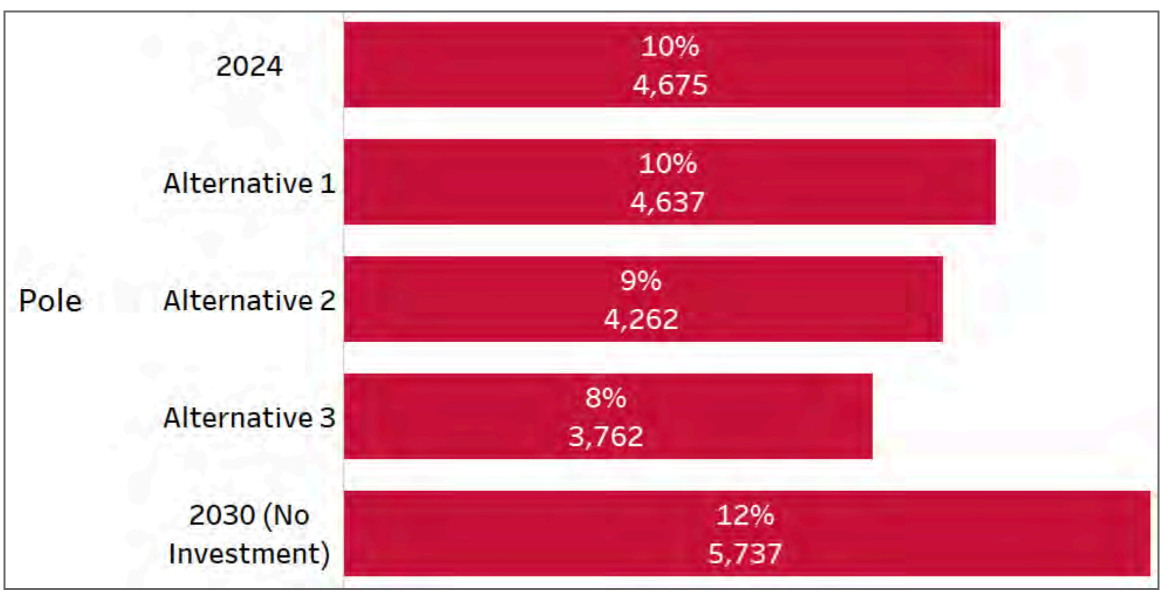


Figure 39 - Number of OH Transformers Projected to Reach Typical Useful Life by 2030

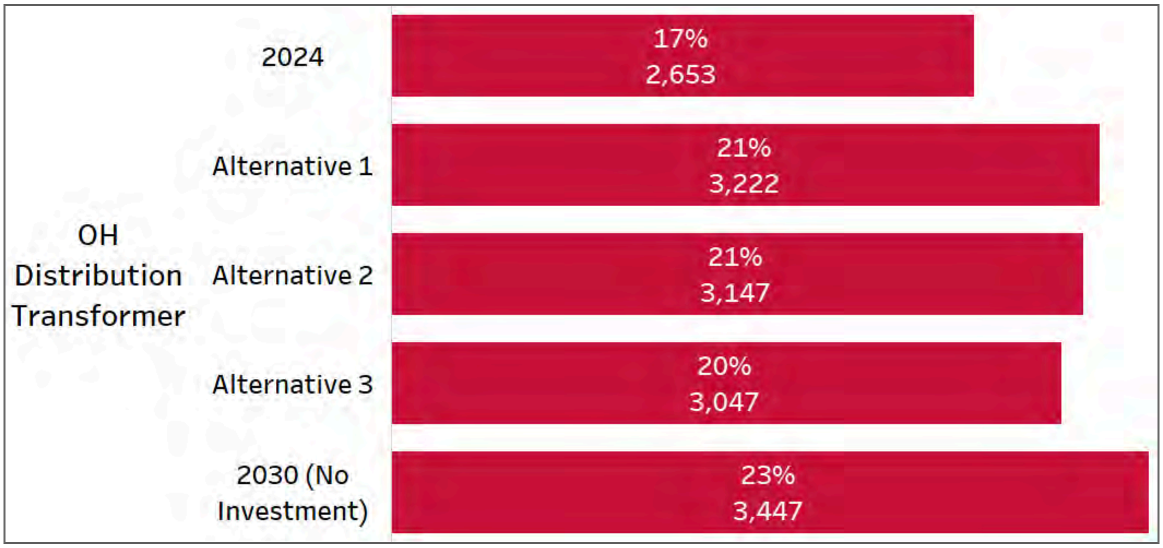


Figure 40 - Number of OH Transformers Projected to Reach a Deteriorated Condition by 2030

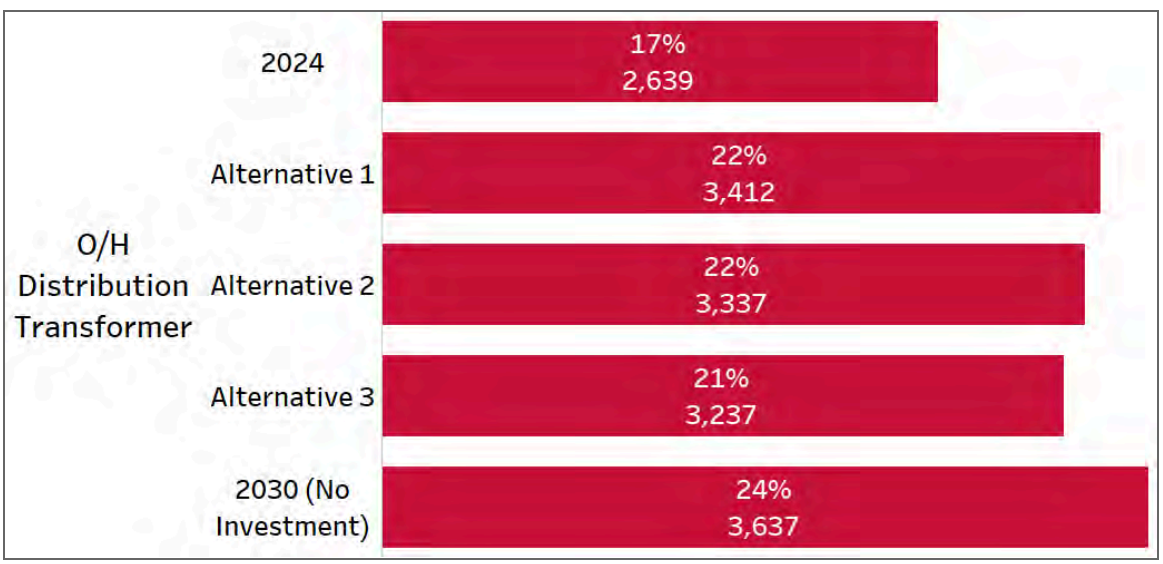


Figure 41 - Number of Overhead Switch/Recloser Projected to Reach Typical Useful Life by 2030

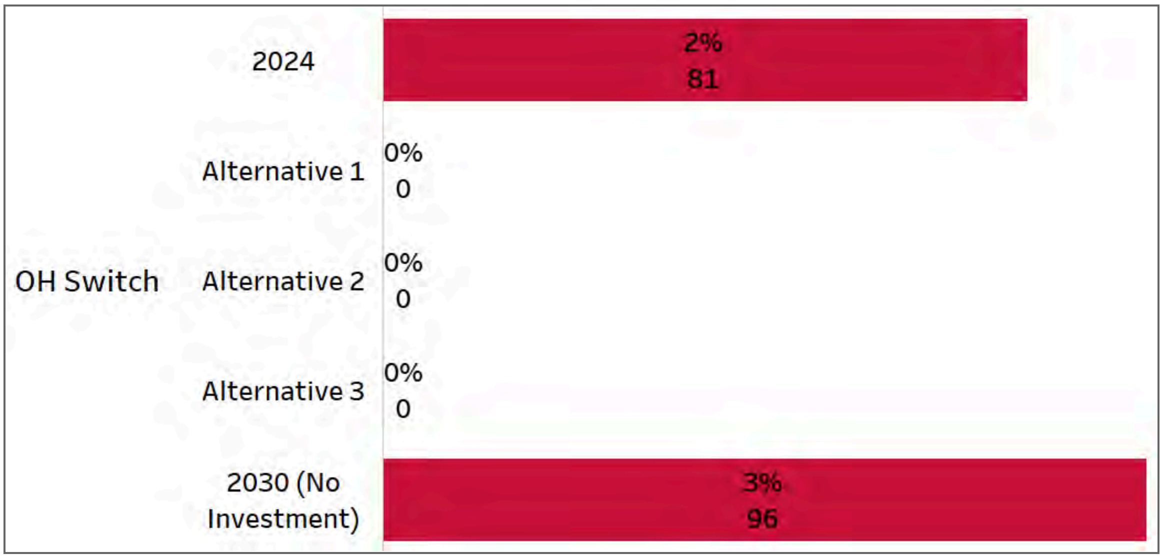
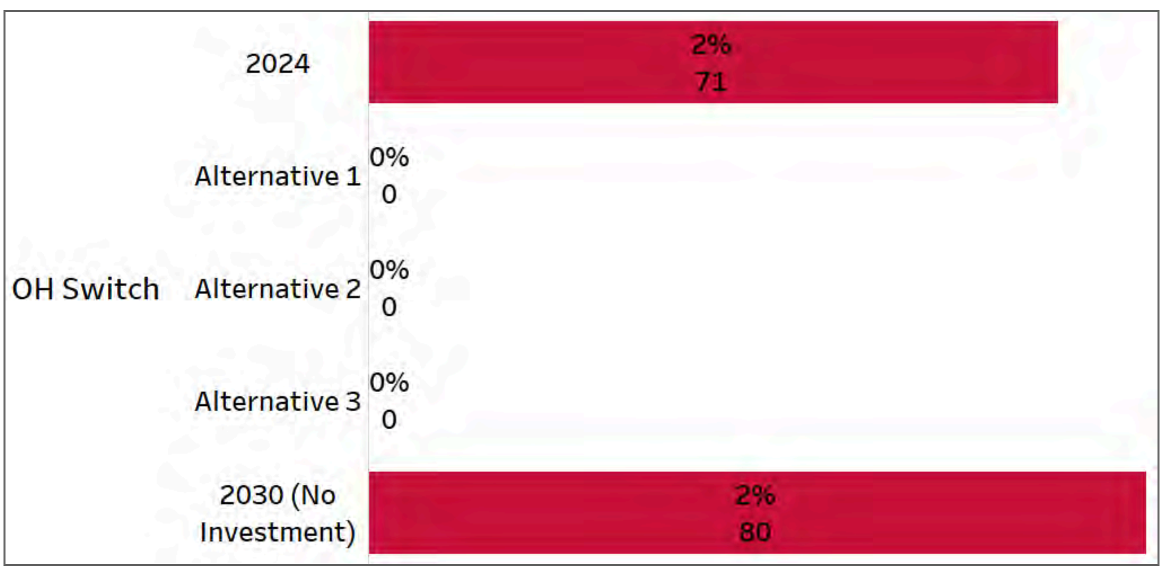


Figure 42 - Number of OH Switches Projected to Reach a Deteriorated Condition by 2030



3.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. The increased risk of failure posed by deteriorating poles can impact Hydro Ottawa's ability to protect workers and public safety. This criterion assesses the ability to maintain or improve the safety of Hydro Ottawa's employees and the public.

Reliability

The increased potential of failure posed by deteriorating OH distribution assets will impact Hydro Ottawa's ability to deliver reliable power. This criterion assesses the ability to maintain or improve the reliability performance of deteriorating OH distribution assets.

Financial

This criterion assesses the ability to manage long-term financial needs for OH distribution assets. This helps to avoid large spikes in asset renewal spending and the associated rate impacts on customers. The selected alternative should ensure a levelized spending profile, manage long-term asset performance, and prevent significant service disruptions due to deteriorating OH distribution asset failures.

System Observability

This criterion assesses the ability to increase the overall system observability and control (through the introduction of SCADAmates), in line with Hydro Ottawa's grid modernization initiatives/efforts.

Resilience

Weather resilience is a crucial factor in planning renewal investments for OH distribution assets because extreme weather events can significantly impact these assets, leading to failures and customer interruptions. This criterion assesses the ability to enhance the resilience of OH infrastructure in response to the increasing impact of extreme weather events such as ice storms, Derechos, and tornadoes.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

3.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 3.6.1 - Alternative Considered under the evaluation criteria of Section 3.6.2 - Evaluation Criteria.

The recommended approach, Alternative Three, involves replacing 1,975 poles, 400 OH transformers, and 340 OH switches/reclosers (including replacement of an estimated 40 manual switches with SCADAmates). This alternative also includes a strategic approach to improve overhead line resilience by evaluating resilience measures, such as strategic undergrounding, line reinforcements, feeder reconfigurations, and line relocations.

As demonstrated in Figure 30, Hydro Ottawa projects a 3% increase in poles in degraded condition every 5 years between 2026 and 2040. The proposed replacement rate allows Hydro Ottawa to keep pace with long term risk associated with poles in degraded condition, however with 3,700 additional poles reaching their TUL by 2030, the percentage of Hydro Ottawa's poles that have reached their TUL will continue to grow. To mitigate against the risk associated with an aging population, Hydro Ottawa has proposed changes to the inspection cycle from 10 years to 5 years for selected poles which have reached or exceeded their TUL (as described in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs). The replacement rate of 1,975 poles under Alternative Three strategically balances the imperative to address immediate risks posed by degraded poles with the proactive management of increased failure probability associated with assets exceeding their TUL.

While only a small percentage of OH switches currently exceed their TUL, a significant increase is anticipated in the coming years. Specifically, there is a sharp increase in the number of OH switches reaching their TUL by 2035 (at 12%, 419 switches), further resulting in more than half (54%) of the OH switches reaching their TUL by 2040. Hydro Ottawa's understanding of OH switch/transformer condition is evolving and drone-based inspections are recommended through 2026-2030, to capture more accurate data, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. However, Hydro Ottawa has experienced a high number of outages due to OH switchgear failures, reinforcing the need for planned replacements, in addition to the aging consideration. To this end, Alternative three allows Hydro Ottawa to mitigate the growing risk associated with asset failures and maintain the age demographics of OH switches to avoid a substantial backlog in the future.

Although resilience-related investments during pole renewal increase initial costs, they offer a cost-effective way to enhance system resilience against increasingly frequent and severe weather events, aligning with the expanded program supported by Alternative Three.

Alternative Three also positions Hydro Ottawa to efficiently deploy capital in support of Grid Modernization. Switches that will be targeted for observability will be upgraded to remote operable switches while undergoing planned renewal. Remote operable switches contribute to increased system observability and control to better manage outage responses and reduce the related customer interruption impact.

Ultimately, the selected OH distribution asset investment program translates to manageable long term costs and asset condition levels as well as efficient deployment of capital, leading to increased customer satisfaction and a sustainable grid.

3.7. PROGRAM EXECUTION AND RISK MITIGATIONS

3.7.1. Implementation Plan

Planned OH distribution replacements are prioritized based on the related equipment's condition and level of risk posed to Hydro Ottawa. Using the recommended rate of planned renewal, OH asset renewal investments will begin in 2026 addressing OH equipment whose condition poses the highest level of risk. The renewal of deteriorated OH infrastructure to withstand climatic forces from storm events is key to resilience over the long term for the system. As such, Hydro Ottawa will enhance the impact of the OH distribution renewal program over the 2026-2030 period by evaluating alternative design standards (anti-cascade) capable of withstanding increased loading, and creating risk based application guides to further mitigate potential damage in high risk installations.

3.7.2. Risks to Completion and Mitigation Strategies

Hydro Ottawa faces several risks in managing its OH distribution asset renewal program, Table 12 outlines the key risks and corresponding mitigation strategies.

Table 12 - Key Risks of OH Distribution Asset Renewal Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.

Category	Risk	Mitigation
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

4. UG DISTRIBUTION ASSETS RENEWAL

4.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $63.3M

2026-2030: $103M

Budget Programs: UG Switchgear Renewal, Cable Renewal, Civil Renewal, Vault Renewal

Main Driver: Failure Risk

Secondary Driver: Reliability, Safety, Environmental

Outcomes: Operational Effectiveness and Customer Focus

Hydro Ottawa's underground (UG) distribution system is supported by a network of UG cables, transformers and switchgear (with the related UG civil infrastructure), ensuring power delivery to the end customer. The continued reliability and safety of the UG distribution system is dependent on the performance of these assets. Hydro Ottawa has proposed investments targeted at renewing UG distribution infrastructure over this Application period. This program replaces end-of-life UG distribution assets in a deteriorated condition, ensuring long-term performance and prioritizing projects based on asset condition and risk, as determined through the distribution asset model in Copperleaf PA (described in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process).

Hydro Ottawa proposes to invest $103M to renew UG distribution assets over this Application period. This capital allocation is dedicated to maintaining a high degree of system reliability through the optimization of asset replacement strategies, thereby enhancing the operational performance of the existing UG asset population. Also, a major focus in defining these measures is the positive impact on customers. This program aims to mitigate the risk of UG distribution equipment failures and improve reliability, reducing customer interruptions due to failures.

This UG Distribution Renewal Program addresses the UG system needs under the following budget programs over the 2026-2030 period:

UG Cable Renewal: This budget program involves the replacement of approximately 61.4 km of UG cables in the Beaverbrook and Bilberry regions of Ottawa. The program also includes the replacement of adjacent end-of-life assets including pad-mounted transformers and pad-mounted switchgear.

UG Switchgear Renewal: This budget program involves the replacement of 30 UG switchgear, specifically, existing air-insulated underground switchgear and select gas type switchgear in a deteriorated condition. This program may also require the replacement of adjacent assets in poor condition, including UG cables.

Civil Renewal: This budget program involves performing a variety of civil renewal activities including replacing worn cable chamber lids, collar replacements, roof replacements, and complete cable chamber replacements. This program may also include the renewal of additional cable chambers in conjunction with City of Ottawa road projects and Hydro Ottawa's UG cable renewal, UG switchgear renewal and EOL voltage conversion programs. Hydro Ottawa plans to replace 30 cable chambers between 2026-2030.

Vault Renewal: This budget program involves the replacement of Hydro Ottawa owned vault transformers deemed to pose an increased risk to safety or system reliability. In addition to this, customer-owned vault switchgear will also be combined/considered for replacement (especially those units that pose a major reliability risk and are in a degraded condition), with Hydro Ottawa taking ownership of the identified customer equipment for further intervention and management. Hydro Ottawa shall strategize combining vault transformer and switchgear replacements for efficiencies, after a close evaluation of the corresponding risk/condition posed by the corresponding units. Hydro Ottawa plans to replace 90 single phase vault transformers and 30 vault switchgear units (contingent on Hydro Ottawa taking ownership of the assets), through 2026-2030.

4.2. PERFORMANCE OUTCOMES

Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. With the implementation of the UG distribution asset renewal program, improvements are expected in the outcomes shown in Table 13 below.

Table 13 - UG Distribution Asset Renewal Program Performance Outcomes

OEB Performance Outcome	Target
Operational Effectiveness	Hydro Ottawa's system reliability objectives are supported by: ● Replacing assets at a pace that allows Hydro Ottawa to achieve 36% of UG distribution assets that have reached their end-of-life by 2030. ● Replacing assets at a pace that allows Hydro Ottawa to minimize the percentage of UG distribution assets in poor and very poor condition by 2030.
	● Contributes to Hydro Ottawa's Grid Modernization Plan by replacing 10 UG switchgear with remote operability, resulting in increased observability and controllability of Hydro Ottawa's distribution system
Customer Focus	● Contributes to Customer Satisfaction by maintaining system reliability

4.3. PROGRAM DRIVERS AND NEED

4.3.1. Main and Secondary Drivers

Primary Driver – Failure Risk: The primary driver for UG distribution assets renewal is the increasing failure risk due to the number of units in a deteriorated condition or surpassing their TUL. The proposed investments are supported by the Copperleaf PA distribution asset model which considers asset condition as a part of the risk assessment value framework. Further detail on the distribution asset model is provided in Section 5.1.4.2 of Schedule 2-5-4 - Asset Management Process.

Secondary Drivers – Reliability, Safety and Environmental: The UG distribution asset renewal program is important to minimize the impact failed UG distribution assets have on reliability, and by extension SAIFI and SAIDI (by replacing them before they fail), and to mitigate the associated safety impact to the public around catastrophic failure, while undertaking the renewal in a cost efficient planned manner. UG distribution assets pose a huge safety risk mainly to Hydro Ottawa's personnel and the public/contractors, due to the potential for asset failure. The failure of UG and vault transformers poses a huge environmental risk, due to the related oil leak. The failure of UG and vault SF_6 gas switchgear will also result in SF_6 gas leaks, which has a huge environmental impact, since SF_6 is considered to be a greenhouse gas.

4.3.2. Current Issues

The primary focus of the UG distribution asset renewal program is to mitigate the risks associated with asset failure. The age and condition demographics of the major UG distribution assets considered as a part of the UG distribution asset renewal program are provided in Figures 45 to 59, with the overall summary provided in Figure 43 and Figure 44.

Figure 43 - Overall Age Demographics Profile of UG Distribution Assets

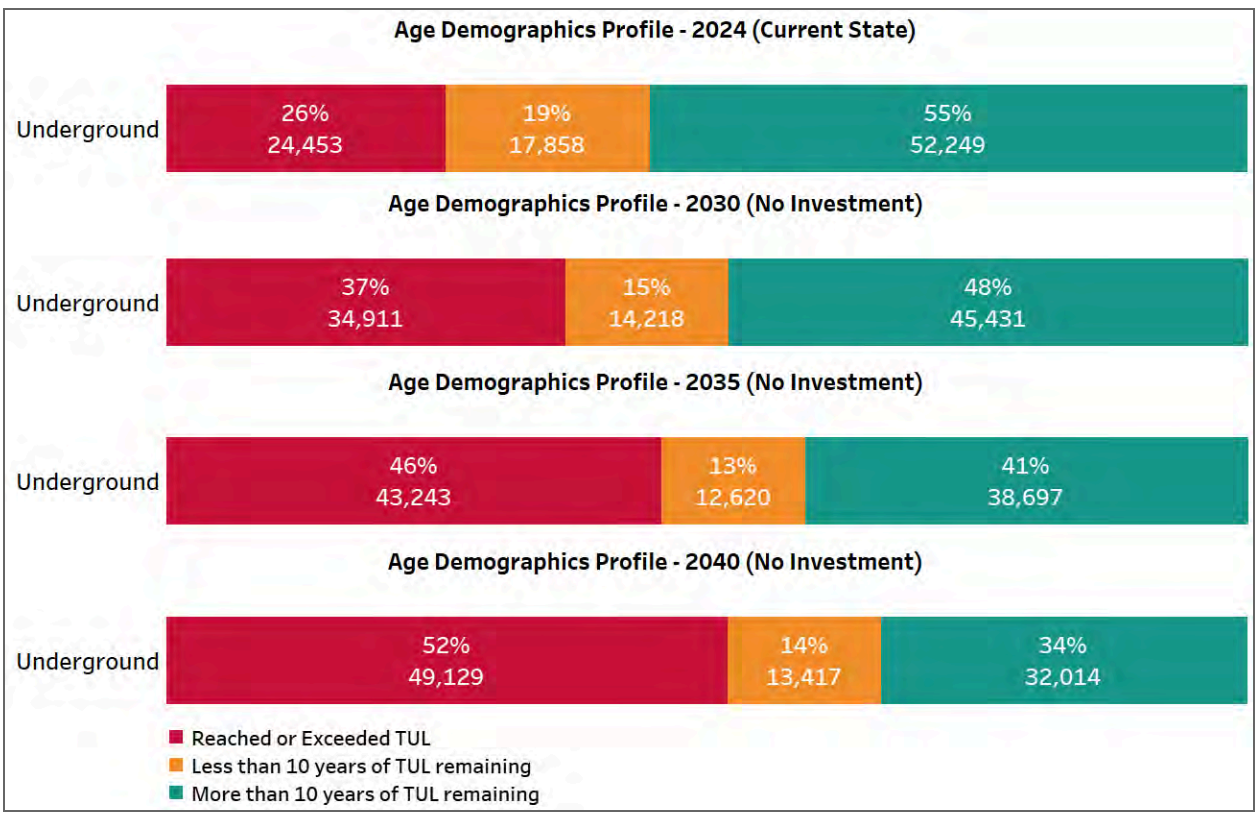
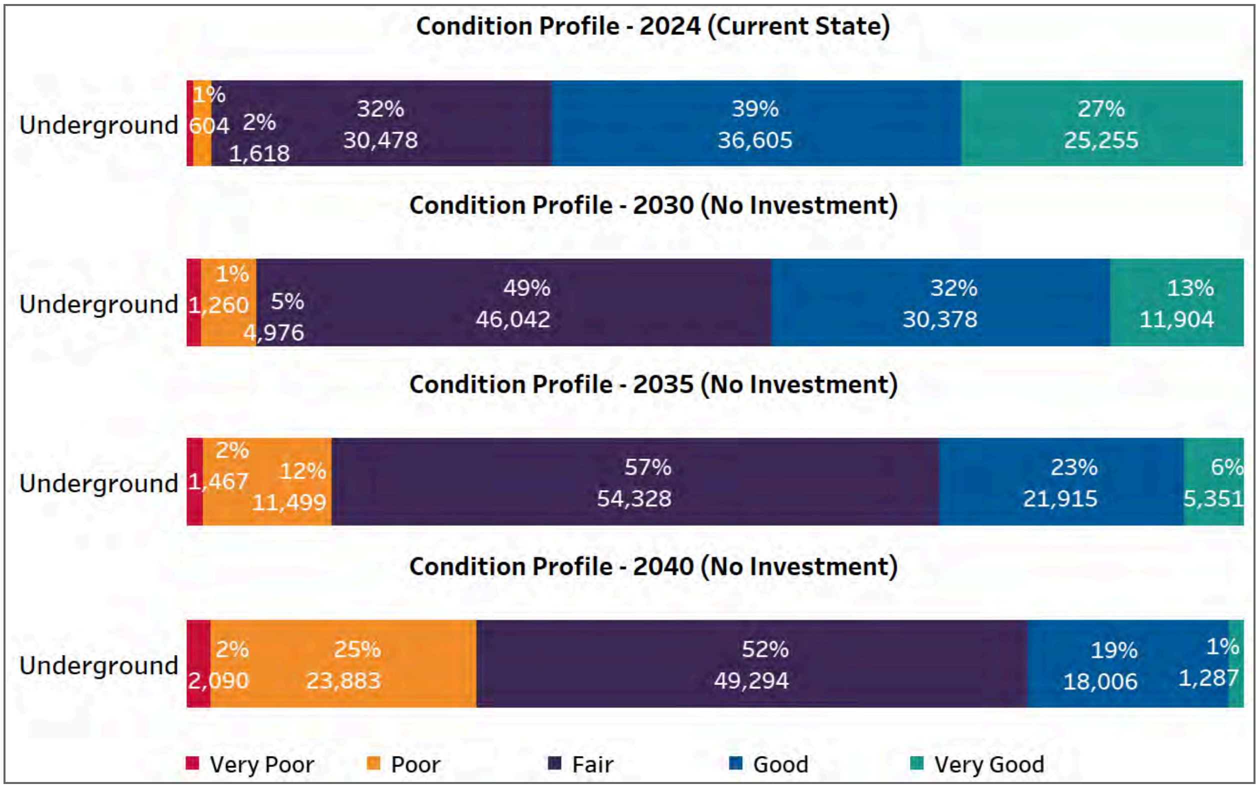


Figure 44 - Overall Condition Profile of UG Distribution Assets



For context, TUL refers to the expected duration an asset can reliably operate before it requires replacement or refurbishment. Condition ranges, in addition, provide a way to assess the state of an asset and determine the urgency of any necessary interventions. To this end, Hydro Ottawa uses a health index, which is a score from 0% to 100%, to evaluate the condition of an asset from Very Poor to Very Good. More details on Hydro Ottawa's condition assessment framework is presented in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process.

Through Copperleaf PA, Hydro Ottawa established the unique degradation pattern of each individual asset in the system into 2040. From Figure 43, it can be observed that without intervention the percentage of Hydro Ottawa's UG assets that have reached their end of life will continue to grow at a rate of approximately 9% every five years. Likewise, without intervention, the percentage of assets in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years.

The following sub-sections summarize some of the challenges faced by Hydro Ottawa specific to its existing UG distribution asset fleet.

4.3.3. UG Switchgear

Figures 45 and 46 demonstrate that Hydro Ottawa's UG Switchgear units (mainly air type) are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of UG Switchgear units that have reached their end of life will continue to grow at a rate of approximately 15% every five years. Likewise, without intervention, the percentage of UG Switchgear units in degraded condition (poor or very poor) will continue to grow at a rate of approximately 2% every 5 years.

Figure 45 - Age Demographics Profile of UG Switchgear

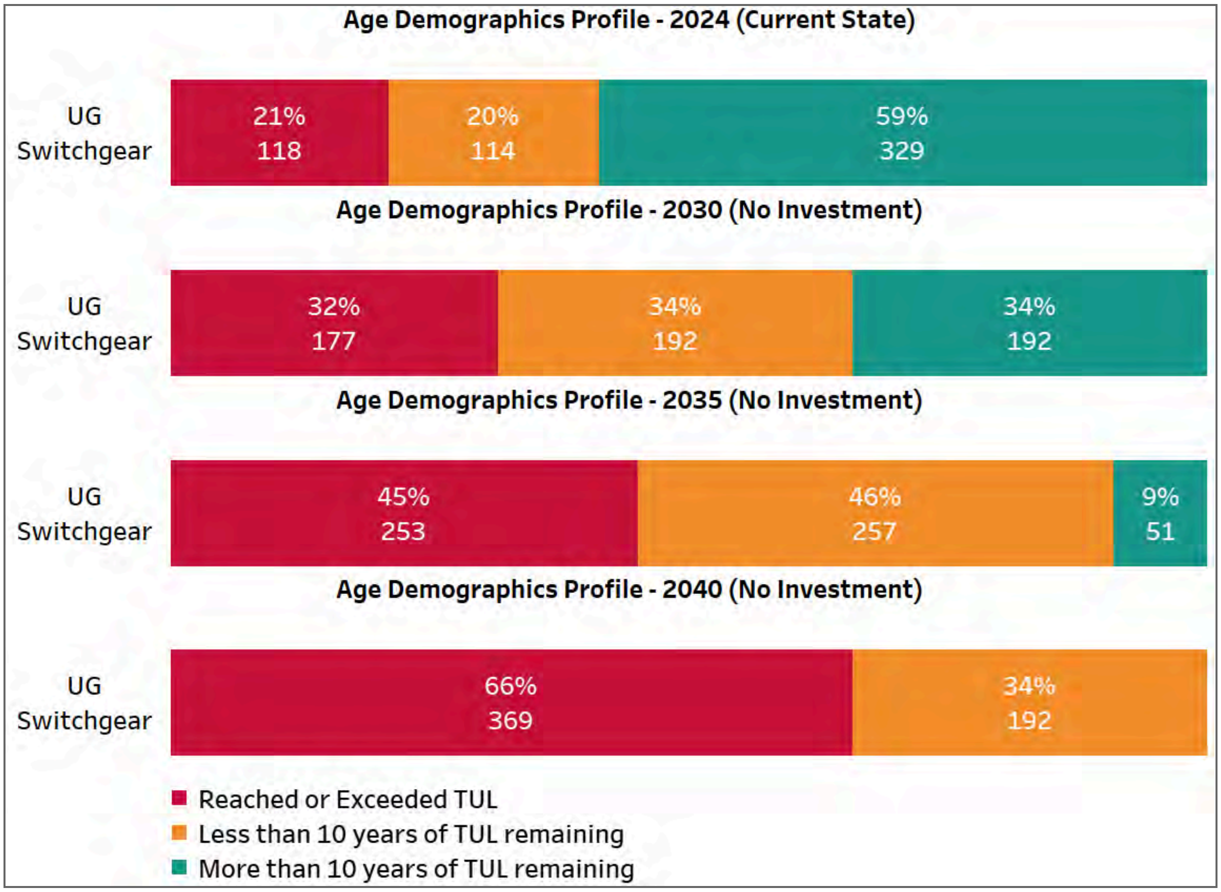
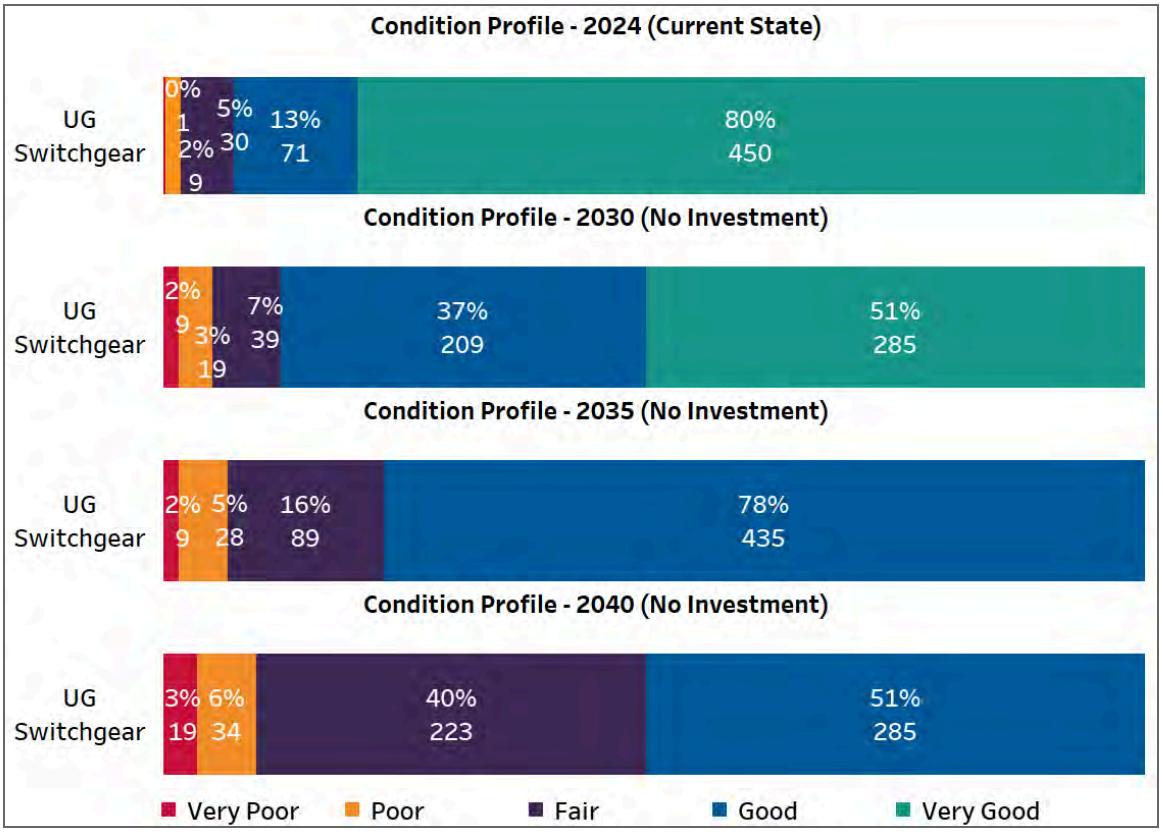


Figure 46 - Condition Profile of UG Switchgear



Hydro Ottawa is experiencing an increase in the number of air-type switchgear failures as compared to previous years since 2022 (with six and three failures in 2022 and 2023 respectively) as outlined in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. These failures have been related to electrical failure as a result of flashover. Hydro Ottawa had implemented inspection enhancements in 2024 to capture more UG switchgear inspection data (down to the component level), which will continue through 2026-2030 to further advance the condition assessment of UG switchgears for preventing unanticipated failures as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

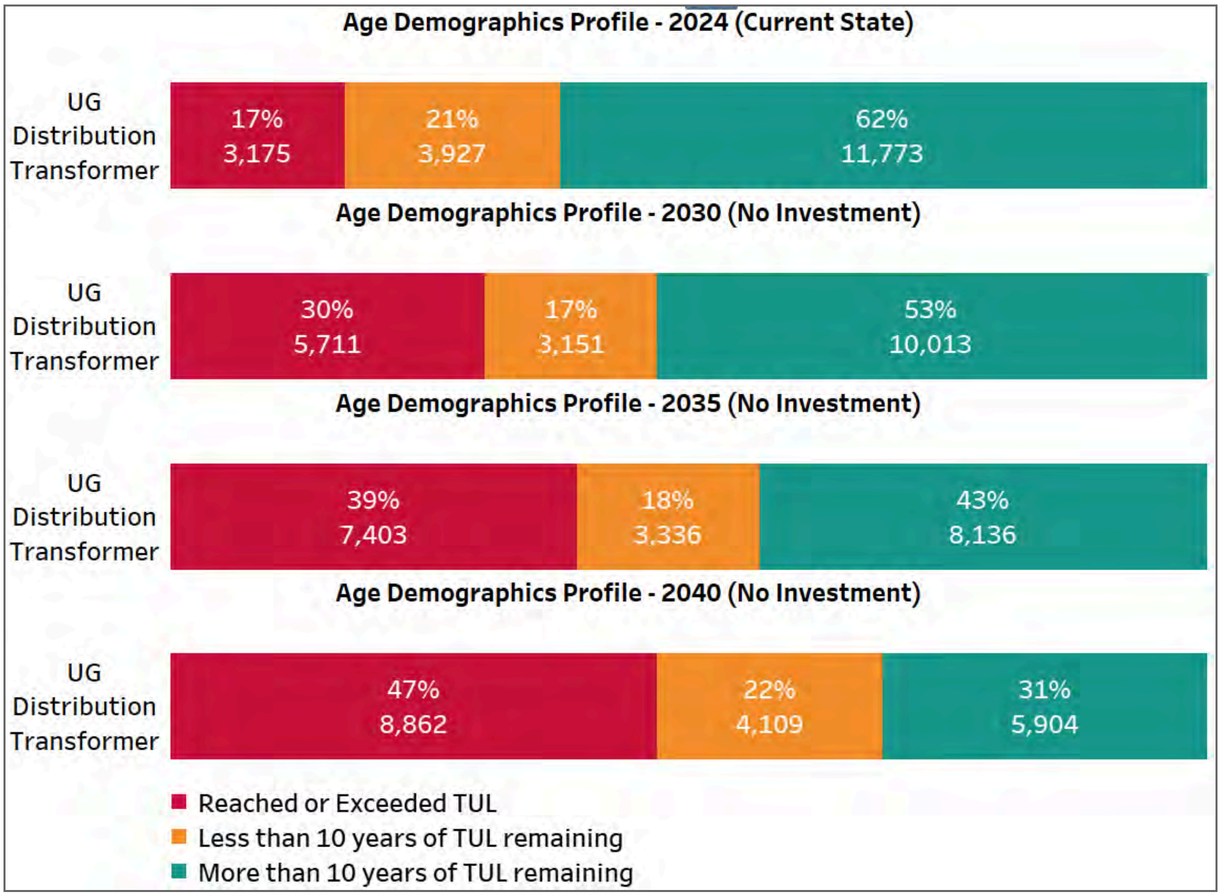
There have also been some premature SF_6 leaks with the UG gas insulated switchgear fleet, tied to a specific manufacturer, thereby increasing the environmental impact due to SF_6 gas emissions. These switchgear failures had to be tackled under the Emergency Renewal budget program, as outlined in Section 6 - Corrective Renewal.

Figure 47 - UG Air Type Switchgear Failure

4.3.4. UG Transformers and Cables

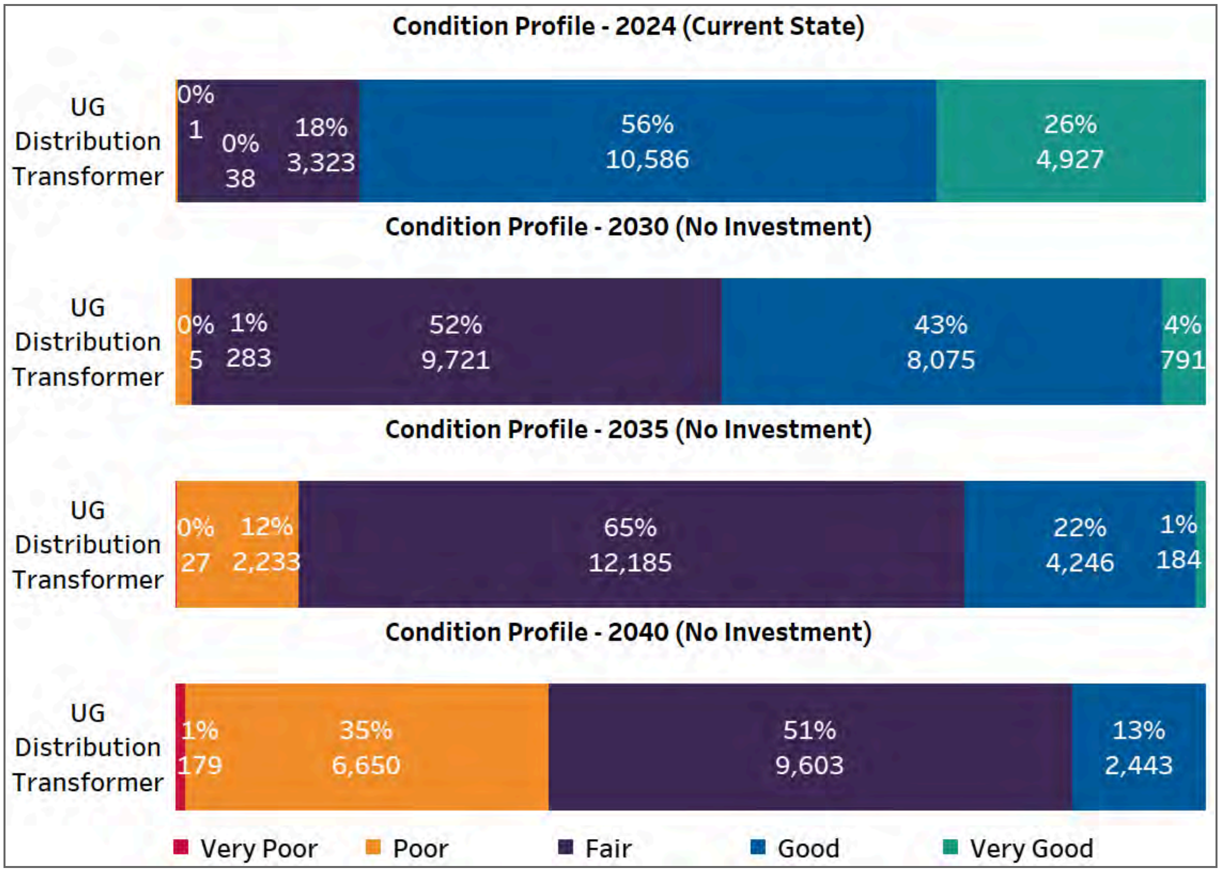
Figures 48 and 49 demonstrate that Hydro Ottawa's UG transformers are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of UG transformers that have reached their end of life will continue to grow at a rate of approximately 10% every five years. Likewise, without intervention, the percentage of UG transformers in degraded condition (poor or very poor) will continue to grow at a rate of approximately 12% every 5 years.

1 **Figure 48 - Age Demographics Profile of UG Transformers**



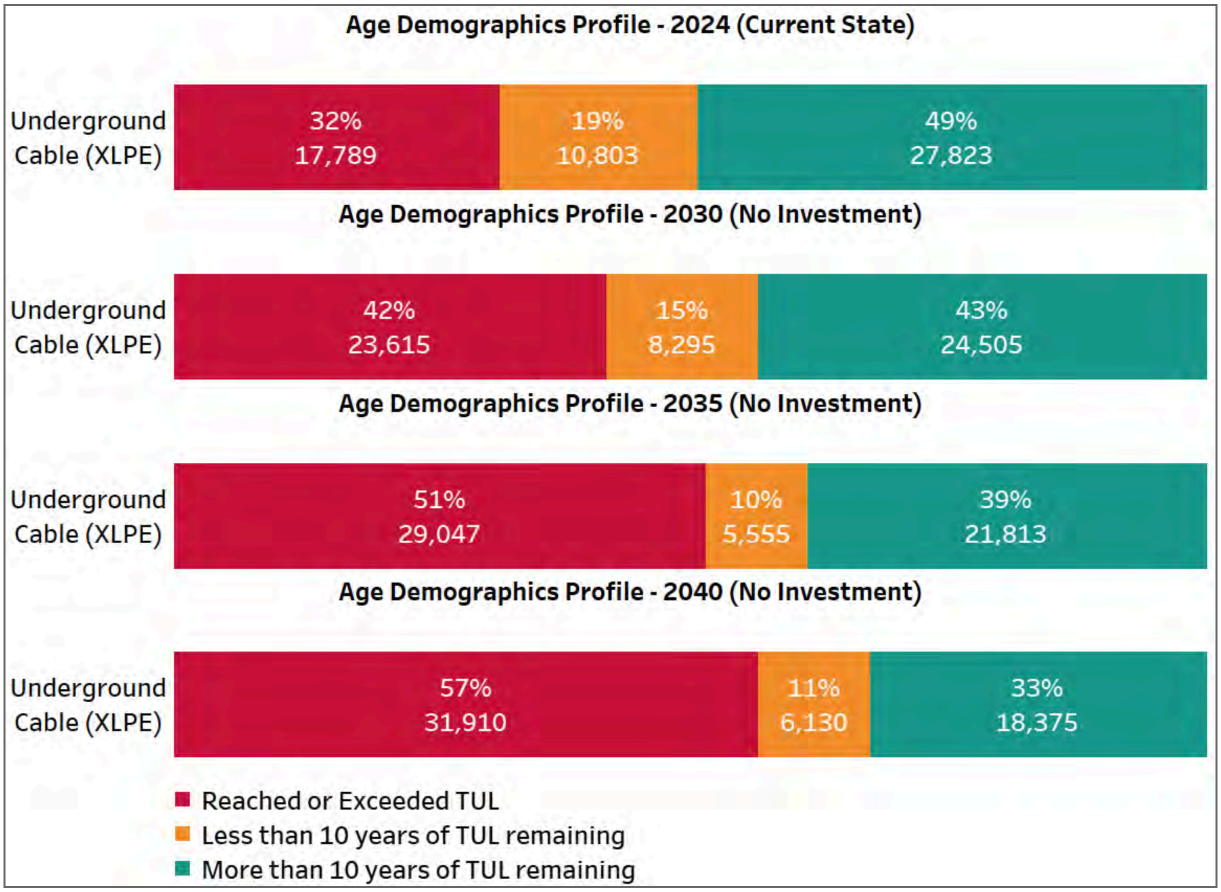
2

Figure 49 - Condition Profile of UG Transformers



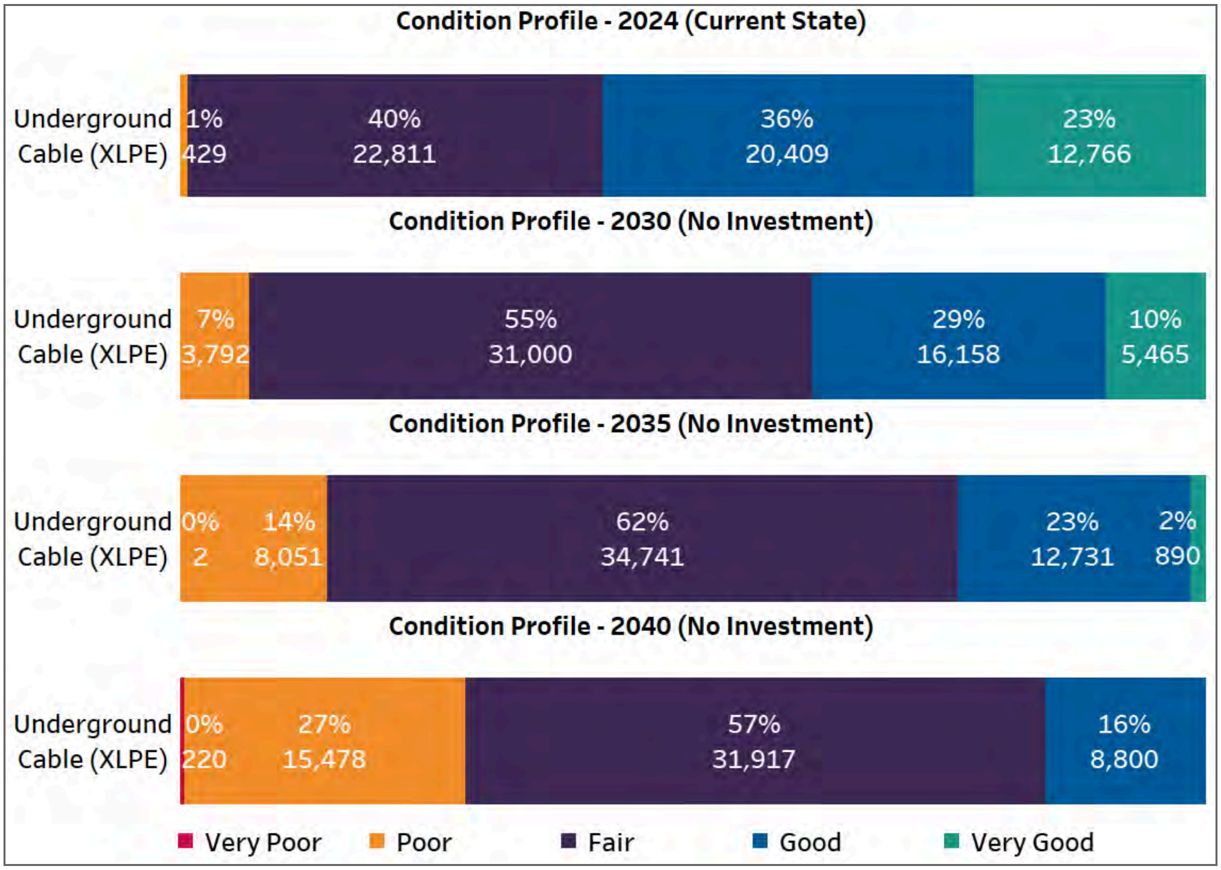
Figures 50 and 51 demonstrate that Hydro Ottawa's Cross Linked Polyethylene (XLPE) cables are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of XLPE cables that have reached their end of life will continue to grow at a rate of approximately 8% every five years. Likewise, without intervention, the percentage of XLPE cables in degraded condition (poor or very poor) will continue to grow at a rate of approximately 9% every 5 years.

1 **Figure 50 - Age Demographics Profile of UG Cables (XLPE)**



2

Figure 51 - Condition Profile of UG Cables (XLPE)



Hydro Ottawa has approximately 3,000 km of XLPE cable infrastructure with many regions having the same vintage of cables and an identical probability of failure. UG transformers and UG cables are one of the major contributors to the number of outages due to equipment failure, as outlined in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Hydro Ottawa has seen a major impact due to the number of leaking transformers discovered every year. However these transformer leak issues are localized and confined to a certain manufacturer type and region. Hydro Ottawa’s approach is to continue to tackle these issues through the Corrective Renewal program on an as-needed basis (as outlined in Section 6 - Corrective Renewal) and proactively maintain the UG transformer population through regular planned maintenance in addition to addressing any issues through the Cable Renewal program. In addition, there are ongoing conversations with the manufacturer to mitigate the potential risk of failure of in-service assets.

Figure 52 - UG Transformer Failure

Hydro Ottawa implemented inspection enhancements in 2024 to capture more UG transformer inspection data (down to the component level) and perform more advanced UG cable diagnostic tests such as VLF Tan Delta, Partial Discharge and Time Domain Reflectometry which will continue through 2026-2030 to further improve the condition assessment of UG transformers and cables for preventing unanticipated failures as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

4.3.5. Vault Equipment

Figures 53 and 54 demonstrate that Hydro Ottawa's vault transformers are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of vault transformers that have reached their end of life will continue to grow at a rate of approximately 12% every five years. Likewise, without intervention, the percentage of vault transformers in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years. Applying a similar view to vault switchgear (owned by Hydro Ottawa), the percentage of units that have reached their end of life will continue to grow at 14% every 5 years and those in degraded condition (poor or very poor) will increase by 3% every 5 years.

Figure 53 - Age Demographics Profile of Vault Transformers

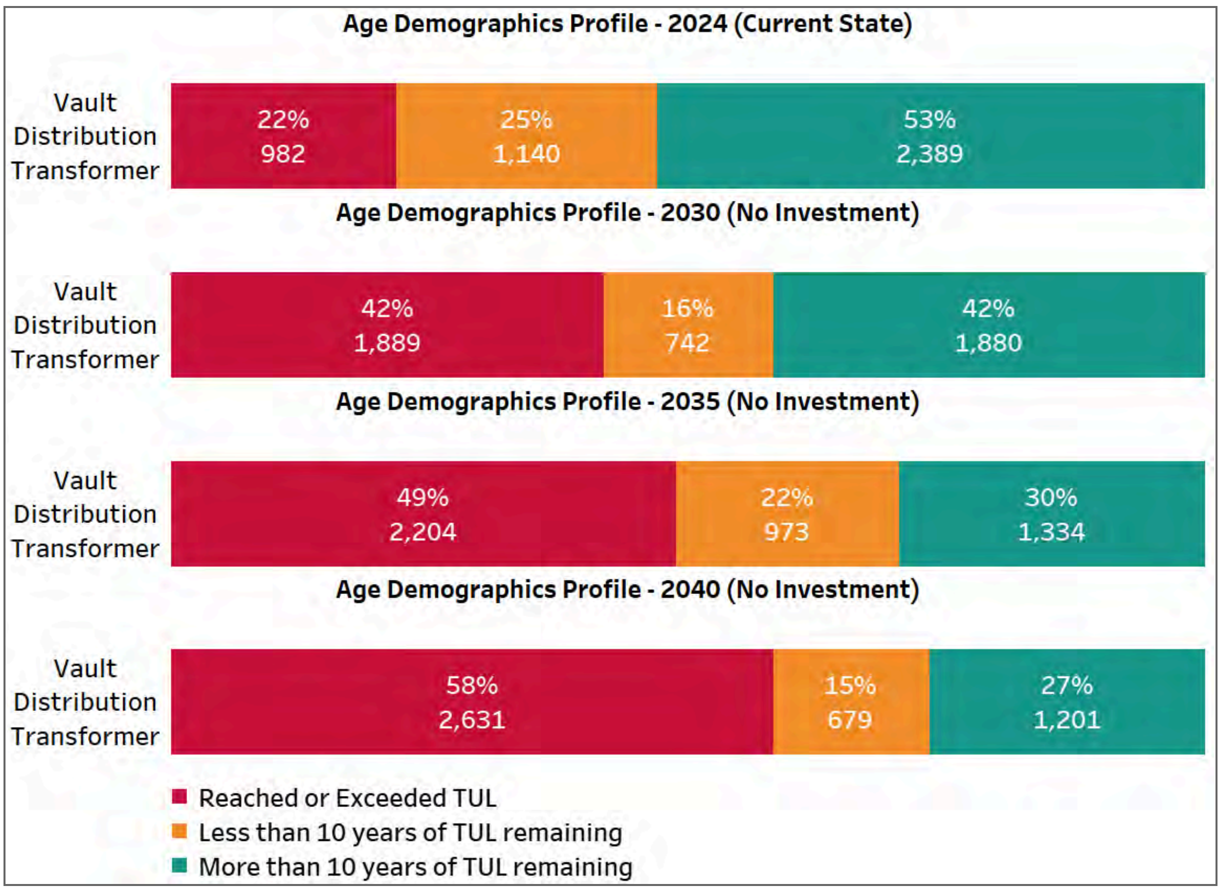


Figure 54 - Condition Profile of Vault Transformers

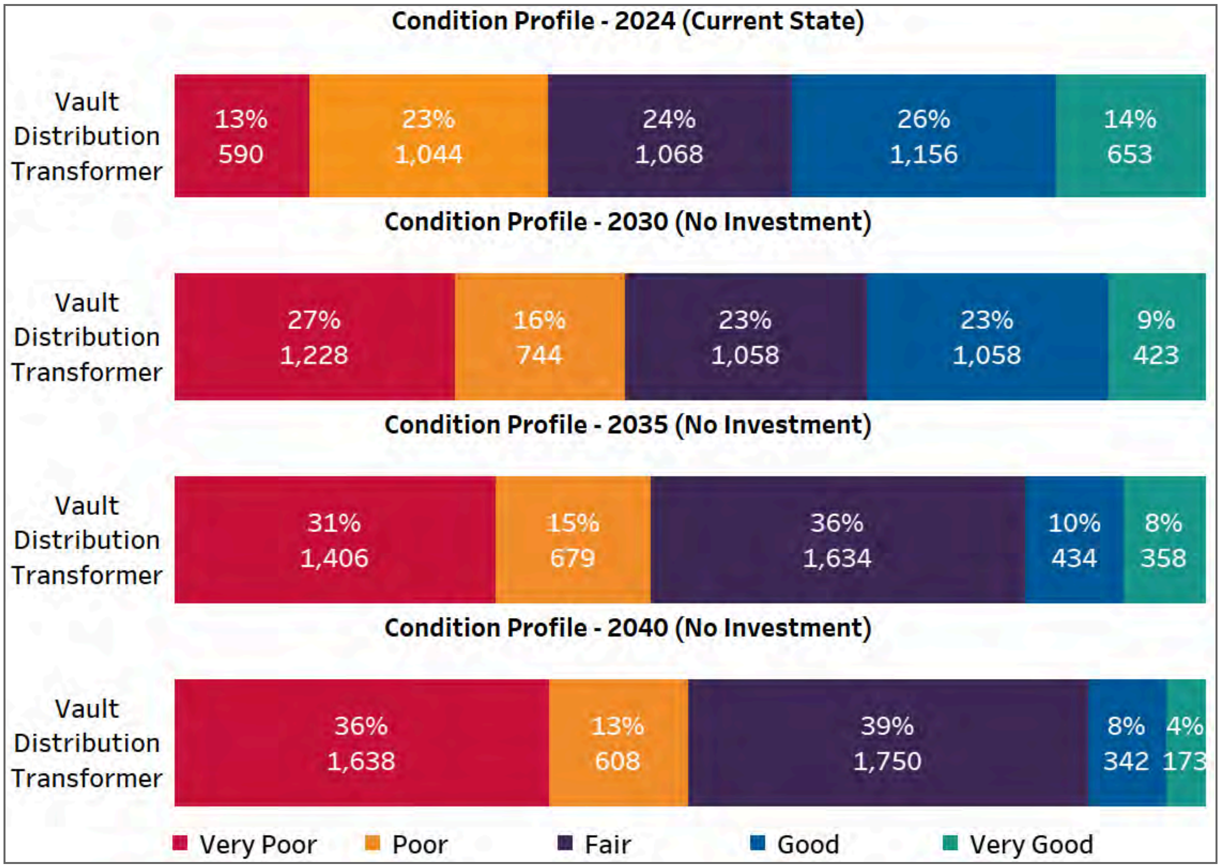


Figure 55 - Age Demographics Profile of Vault Switchgear (excl. customer-owned)

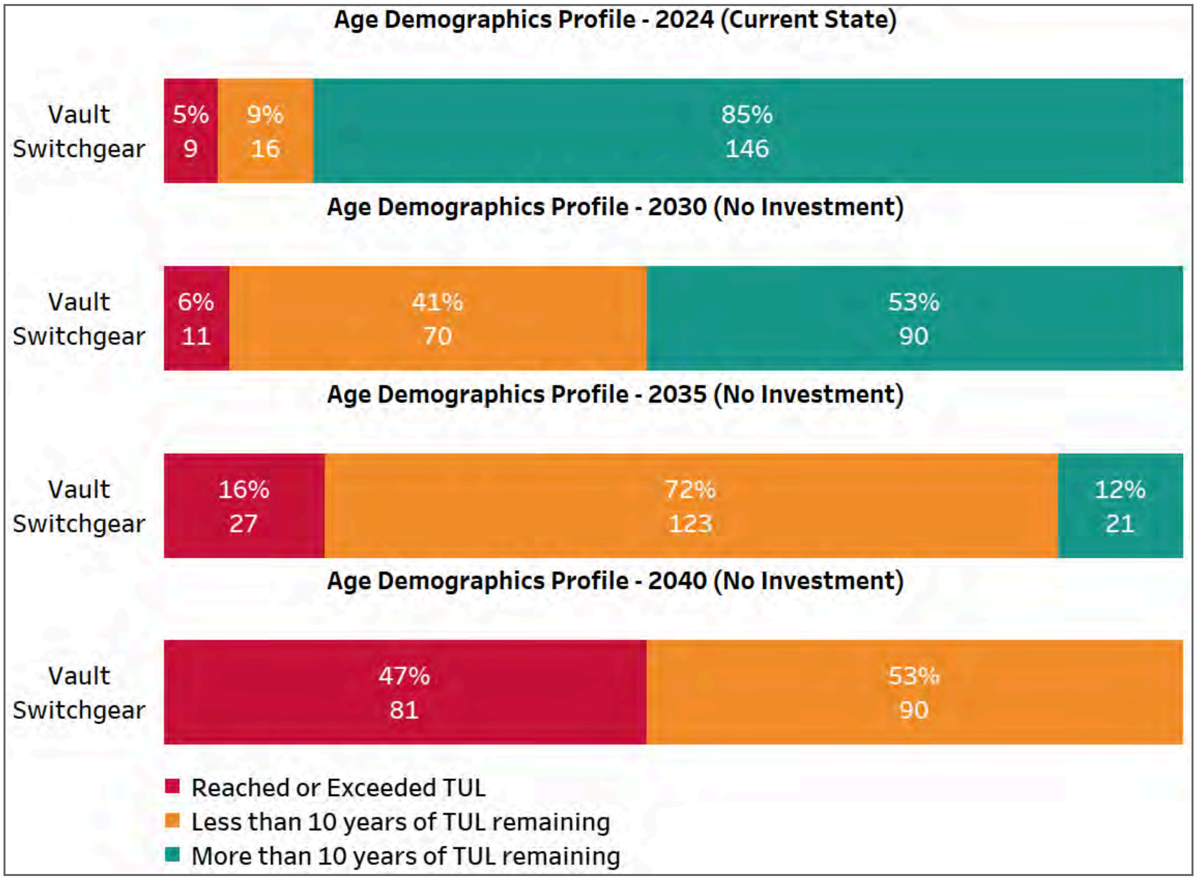


Figure 56 - Condition Profile of Vault Switchgear (excl. customer-owned)

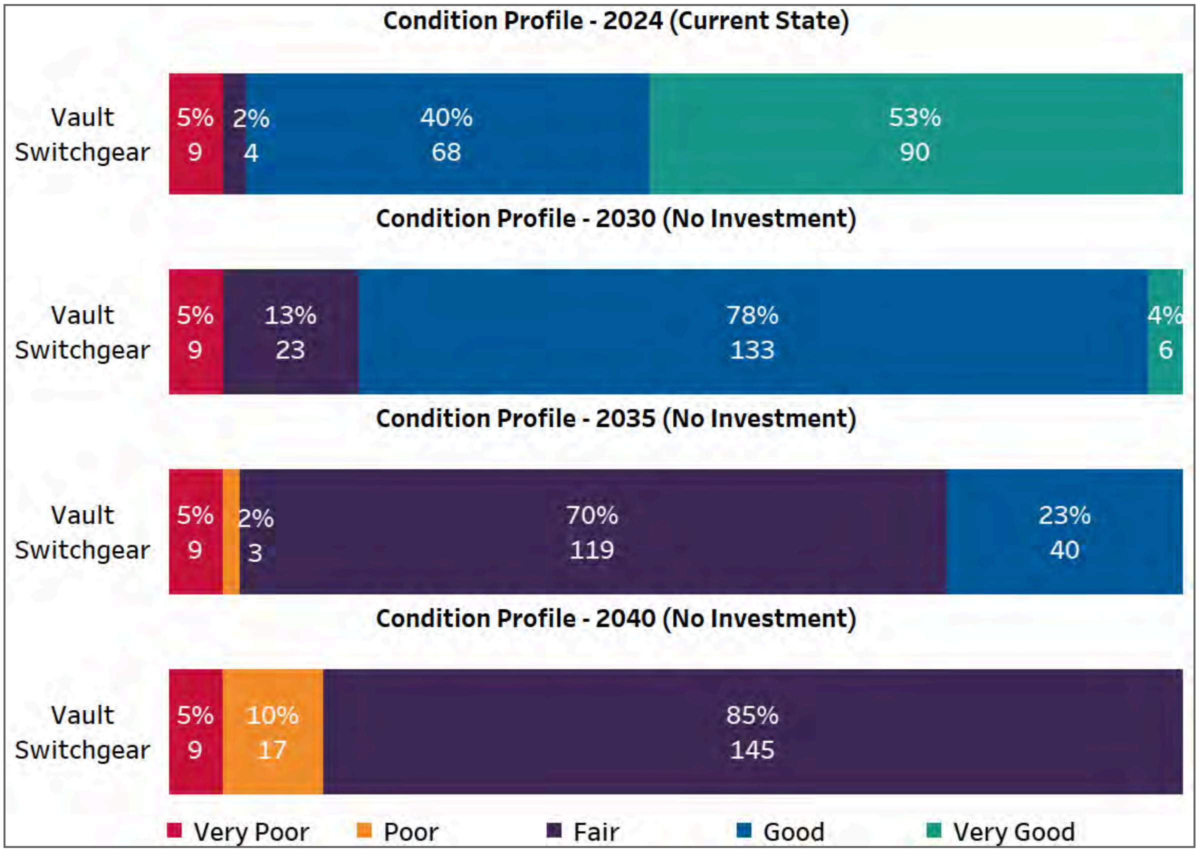


Table 14 displays age demographic projections for customer owned vault switchgear, current state and in 2030 (without investments). Currently, 3% of the vault switchgear units have reached or exceeded their TUL and 8% have less than 10 years of TUL remaining. By 2030, if no investment is made, 5% of customer-owned vault equipment would reach their TUL and 75% with less than 10 years of TUL remaining.

Table 14 - Age Demographic Projections of Customer Owned Vault Switchgear

Asset Type	Number of Units	Age Criterion	2024 Current State	2030 No Investment
Vault Switchgear Customer Owned	964	Reached or Exceeded TUL	3%	5%
		Less than 10 years of TUL remaining	8%	75%
		More than 10 years of TUL remaining	89%	20%

Hydro Ottawa has seen some recent reliability impact due to the failure of customer-owned vault switchgear, with 7 outages observed in 2022 and 2023, primarily due to age deterioration. While analyzing the factors impacting SAIDI between 2019 and 2023, the failure of customer owned equipment has caused delays in restoration due to the coordination involved with the customer and lack of maintenance from their end, as outlined in Section 5 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement.

In responding to outages due to vault equipment failure, Hydro Ottawa has also encountered increasing difficulties replacing vault equipment or accessories (e.g. bushings) due to space limitations in customer-owned vaults. These failures also had to be tackled under the Emergency Renewal budget program, as outlined in Section 6 - Corrective Renewal.

This has necessitated investments as a part of this Application period to intervene on 30 vault switchgear units (including customer-owned ones, contingent on Hydro Ottawa taking ownership of the assets). This selection would be based on customer owned assets that have a high reliability impact on other customers in the system. A more recent outage in 2023 was due to the failure of a vault switchgear unit wherein a phase bushing had completely burned out due to a flashover event, as shown in Figure 57.

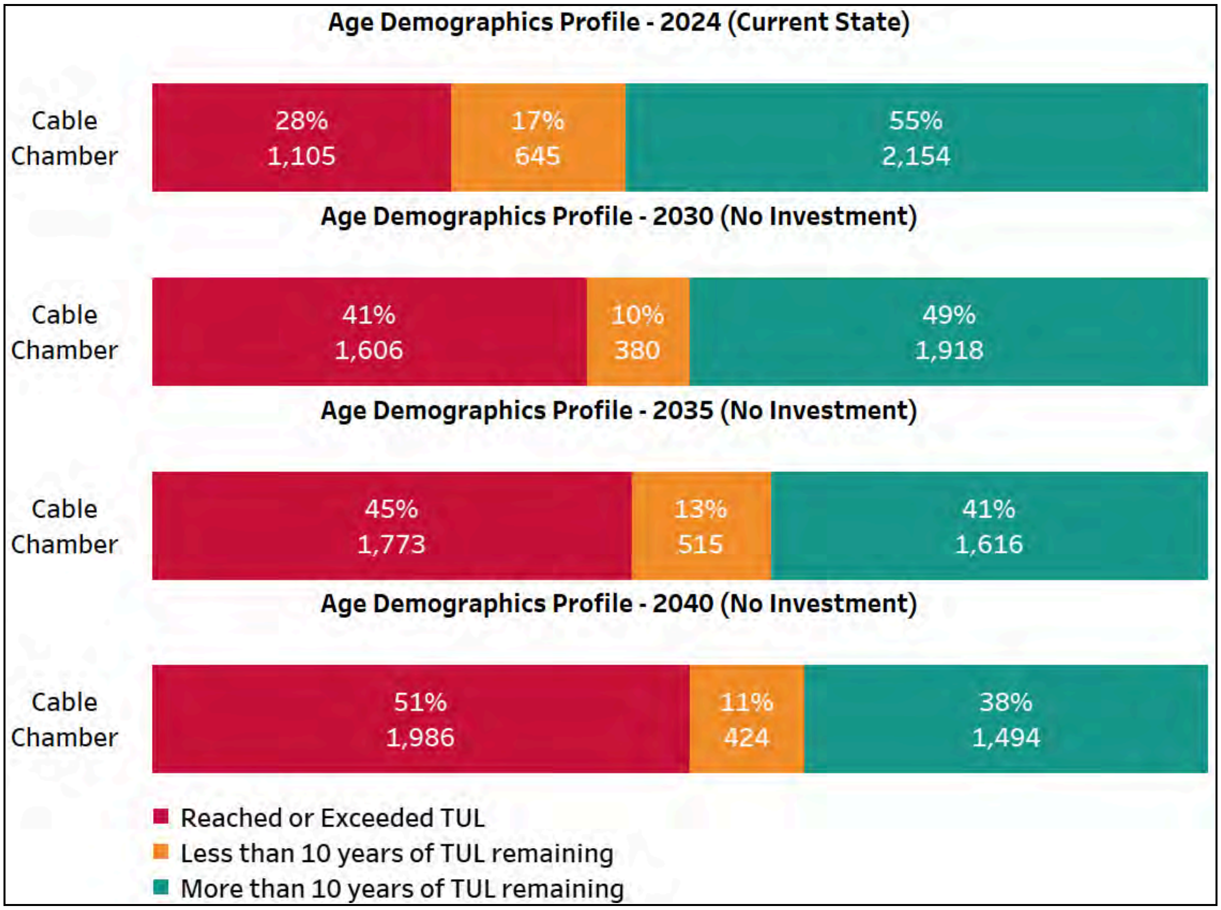
Figure 57 - Vault Switchgear Failure

Hydro Ottawa had proposed inspection enhancements in 2024 to capture inspection data related to vault equipment which will continue through 2026-2030 to further advance the condition assessment of vault equipment for preventing unanticipated failures as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. The data from the condition assessments will be used to determine which vault equipment will be addressed during annual scoping from 2026-2030.

4.3.6. Cable Chambers

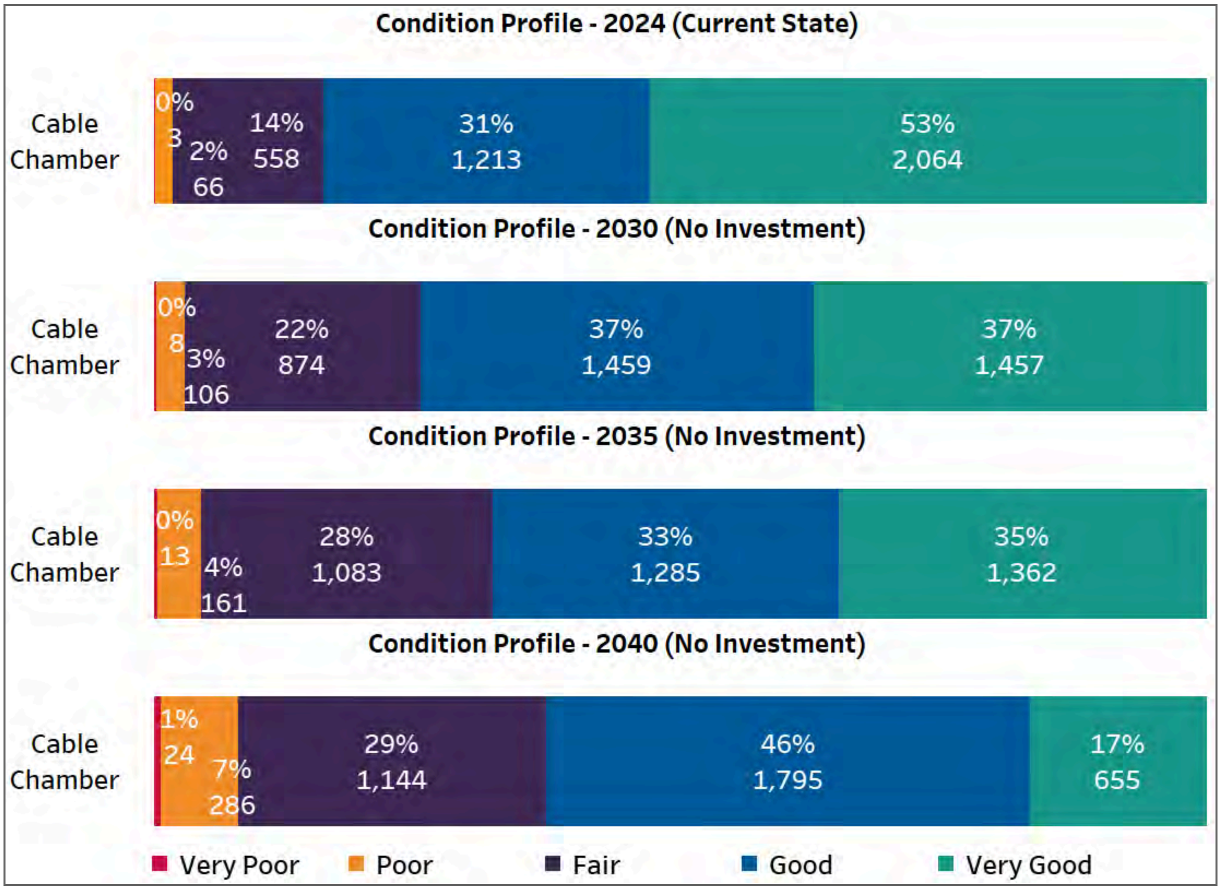
Hydro Ottawa's underground civil structure assets consist of a collection of UG cable chambers (colloquially referred to as manholes), hand holes, and duct banks forming an underground distribution system. Figures 58 and 59 demonstrate that Hydro Ottawa's cable chambers are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of cable chambers that have reached their end of life will continue to grow at a rate of approximately 8% every five years. Likewise, without intervention, the percentage of cable chambers in degraded condition (poor or very poor) will continue to grow at a rate of approximately 2% every five years.

1 **Figure 58 - Age Demographics Profile of Cable Chambers**



2

Figure 59 - Condition Profile of Cable Chambers



Failures have occurred due to concrete deterioration and rebar corrosion. Renewal activities focussing on structural components like collars, roofs, and walls are critical to improving conditions and mitigating safety risks to the public and Hydro Ottawa employees. Through its preventative maintenance program, Hydro Ottawa has observed issues such as the deterioration of concrete and corrosion of rebar among other factors impacting the structural integrity of cable chambers. To mitigate safety risks to the public and Hydro Ottawa employees, continued renewal investment in cable chambers is essential through 2026-2030, alongside exploring the use of sophisticated cameras/tools for the cable chamber inspection program.

4.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the UG distribution assets renewal program are summarized in the section below.

4.4.1. System Operation Efficiency and Cost Effectiveness

Adding remote functionality to UG switchgear will improve system observability, allowing for efficient system operations and control. Additionally, the replacement of deteriorated UG transformers as a part of the UG cable renewal program drives cost savings and efficiencies, by enabling Hydro Ottawa to replace these deteriorated assets in conjunction with UG cable replacement.

4.4.2. Customer

The UG distribution asset renewal program focuses on replacing deteriorating and failing UG distribution assets with the aim to maintain the number of outages due to equipment failures below levels experienced between 2021 to 2025. The program also includes equipment upgrades to increase capacity (specifically around UG transformers), thereby positively impacting customers and supporting load growths.

4.4.3. Safety

The replacement of deteriorated UG distribution equipment reduces the risk of in-service equipment failure and consequently, reduces the potential safety risk to employees and the public from catastrophic equipment failures.

4.4.4. Economic Development

Robust and reliable electric distribution infrastructure is essential for Ottawa's economic stability and growth. Hydro Ottawa's UG distribution asset renewal program contributes to consistent and dependable power which businesses need to thrive, supporting job retention and creation, furthermore the ability to provide stable power will continue to attract commercial investment in Ottawa.

4.4.5. Environment

Hydro Ottawa will be replacing a select population of at-risk UG oil-filled and SF_6-based distribution equipment that have reached or exceeded the TUL and are in a deteriorated condition, minimizing the risk of environmental contamination.

4.5. PROGRAM COSTS

Table 15 shows the historical and future spending by budget program, as a part of the UG distribution asset renewal program. In the 2026-2030 period Hydro Ottawa forecasts investment in this program of $103.0M, compared to $63.2M in the 2021-2025 period. There are considerations around equipment/resource availability as well as project prioritization/scheduling which results in some variability in the projected spending between 2026 and 2030.

Table 15 - Historical, Bridge and Test Year Spending per UG Distribution Assets Renewal Budget Program ($'000 000s)[6]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
UG Transformer Renewal	-	$ 0.1	$ 0.5	-	-	-	-	-	-	-
UG Switchgear Renewal	$ (0.1)[7]	$ 0.8	-	$ 0.5	$ 0.8	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.2
Cable Renewal	$ 9.7	$ 15.4	$ 10.4	$ 9.1	$ 9.8	$ 16.4	$ 16.9	$ 17.7	$ 18.2	$ 18.8
Civil Renewal	$ 0.5	$ 1.1	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.3
Vault Renewal	-	$ 0.5	-	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 1.2	$ 0.6
ANNUAL TOTAL	**$ 10.2**	**$ 17.8**	**$ 11.9**	**$ 11.2**	**$ 12.2**	**$ 19.1**	**$ 19.7**	**$ 20.6**	**$ 21.8**	**$ 21.9**
5-YEAR TOTAL					**$ 63.2**					**$ 103.0**

Table 16 shows the detailed historical and future units (either replaced or forecasted) by the underlying asset class, as a part of UG distribution asset renewal program. The UG transformer count shows the forecasted units to be replaced under the cable renewal program.

[6] Totals may not sum due to rounding
[7] Negative balance due to material return and reissue to Critical U/G Switches

Table 16 - Annual Unit Replacements per UG Distribution Assets Renewal Budget Program

Asset Class	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
UG Transformers	94	62	60	72	72	80	80	80	80	80
UG Switchgear	-	6	-	4	5	6	6	6	6	6
UG Cables (km)	19.86	20.24	6.89	13.5	13.5	12.28	12.28	12.28	12.28	12.28
Cable Chambers	1	6	4	6	6	6	6	6	6	6
Vault Transformers	-	6	-	7	5	18	18	18	18	18
Vault Switchgear	-	-	-	-	-	6	6	6	6	6

4.5.1. Cable Renewal

The Cable Renewal program's spending is forecasted to increase from $54.3M in 2021-2025 to $88.2M in 2026-2030. Hydro Ottawa's 2021-2025 cable renewal program unit rate, which was $0.3M/km, proved to be too low due to underestimating the technical complexity of the Ottawa region along with high inflationary costs associated with the civil works. Further information regarding inflationary pressures found in Section 4 of Schedule 1-2-5 - Impact of Inflationary Pressures. Actual costs from 2021-2023 averaged $0.7M/km, with some projects reaching $1M/km. To address this, the 2026-2030 budget includes a higher unit rate of $1.4M/km, accounting for inflation and increased material and contractor costs. The renewal of UG transformers do not have a distinct program budget as the cost for replacement is contemplated within the cable renewal budget.

Through 2026-2030, Hydro Ottawa will evaluate cable replacement across 12 feeders supplying areas such as Bilberry, Beaverbrook, Hiawartha Park, Orleans Village, Convent Glenn, Chapel Hill, Beaconhill South, Pineview, Emerald Meadows, Windsor Park and Blossom Park. The results from the UG cable testing program shall be used to inform the targeted high-risk sections to be renewed within the aforementioned areas.

4.5.2. UG Switchgear Renewal

The UG Switchgear Renewal program's spending is forecasted to increase from $2M in 2021-2025 to $5.4M in 2026-2030, which is due to the increase in volume considered over the 2026-2030 period. The increased investment is essential to tackle the growing trend of UG switchgear units that have reached their end of life and the higher number of air-type switchgear failures resulting in outages since 2022, given that all air-type switchgears that failed had reached or exceeded their TUL. Through 2026-2030, Hydro Ottawa plans to intervene on 30 air-type UG switchgear units, with the ability to introduce remote operability to ten of them.

4.5.3. Vault Renewal

The Vault Renewal program's spending is forecasted to increase from $1.5M in 2021-2025 to $3.5M in 2026-2030. The increased investment is essential to manage the growing number of vault equipment owned by Hydro Ottawa that have reached their end of life. Also, based on the reliability impact observed since 2022, the proposed increase in spending will allow Hydro Ottawa to manage critical customer-owned vault switchgear. Customer-owned vault equipment are integral to Hydro Ottawa's distribution system and their failures result in widespread, complex, and lengthy outages. Therefore, an intervention is necessary in the short term to minimize the related reliability impact. Through 2026-2030, Hydro Ottawa plans to replace 90 single phase vault transformers and 11 vault switchgear units (owned by Hydro Ottawa) requiring an intervention in the short term. The planned replacement of customer-owned vault switchgear causing a significant reliability impact to Hydro Ottawa, will be contingent on a final agreement with the related customers.

4.5.4. Civil Renewal

The Civil Renewal program's spending will increase from $4.9M in 2021-2025 to $5.9M in 2026-2030. The increase in the proposed spending is to address deteriorating and failing cable chambers to address key safety issues around the structural integrity of civil structures. Between 2026-2030, Hydro Ottawa plans to evaluate and potentially replace 30 cable chambers. This evaluation will be based on recommendations from the annual inspection program, focusing on factors like the need for a complete rebuild and other issues such as severe damage to the roof or walls, rusted support beams, and significant cracks near entrances, all of which pose substantial structural risks.

4.5.5. Cost Factors

Cost factors that affect UG distribution asset renewal are listed below:

- Location, condition and compatibility with existing civil support structures
- Type and coordination of replacement with other components
- Nature of renewal: like-for-like or like-for-better (e.g. air type switchgear with an air type switchgear or air type switchgear with an SF_6 type switchgear)
- Material costs

4.6. ALTERNATIVES EVALUATION

4.6.1. Alternatives Considered

In order to address the drivers and achieve the performance objectives of the program, Hydro Ottawa conducted an analysis using Copperleaf PA to optimize the number of units renewed as part of UG distribution asset renewal projects, with the goal of minimizing the number of asset failures and managing long term operational performance. As a result of the high value of mitigated reliability risk mitigated from an UG XLPE cable segment replacement and Copperleaf PA's focus on individual asset performance, the PA analysis recommended that Hydro Ottawa replace 336 km of UG XLPE cables forecasted to be in a degraded condition by 2030, over the 5-year period. To achieve this objective, Hydro Ottawa would need to invest in excess of $300M in the cable renewal program alone, far exceeding the $63.2M investment level proposed by Hydro Ottawa over the 2021-2025 period, across all UG distribution asset renewal programs. This level of investment would result in rate and resourcing impacts that do not align with the overall objectives of the DSP.

In this regard, three investment alternatives were considered, as outlined in Table 17, with varying levels of replacement rates and alignment to the Outcomes described in Table 13 and with the objective of balancing long term-cost impacts with the risks associated with assets in degraded condition.

Table 17 - Summary of Program Investments of Alternatives Considered

Program Investments	Alternative 1: Cost Containment	Alternative 2: Short Term Risk Mitigation (Preferred)	Alternative 3: Long Term Risk Mitigation
UG Cables	15km (7km/year)	61km (12km/year)	100km (20km/year)
UG Transformers	215 (43/year)	400 (80/year)	650 (130/year)
Vault Transformers	45 (9/year)	90 (18/year)	120 (24/year)
Vault Switchgear	None	30 (6/year)	45 (9/year)
UG Switchgear	15 (3/year)	30 (6/year)	65 (13/year)
Civil Rebuild	15 (3/year)	30 (6/year)	60 (12/year)
System Observability Investments	None	10 (2/ year)	20 (4/ year)
TOTAL PROGRAM COST	**$47M**	**$103M**	**$150M**

Alternative 1: Cost Containment (~$47M): This alternative will provide:

- Cost impacts are minimized during the 2026-2030 period, however replacement rates will not allow Hydro Ottawa to balance long term affordability or effectively manage risk associated with assets in degraded condition:
  - A 0.2% increase in the percent of UG transformers in degraded condition compared to 2024 levels (refer to Figure 61) and a net 12% increase in UG transformers that have reached their typical useful life by 2030 (refer to Figure 60), creating a back-log of UG transformers to be replaced in the long term.
  - No reduction in the percent of UG switchgear in degraded condition compared to 2024 levels (refer to Figure 63) and a net 8% increase in UG switchgear that have reached their typical useful life by 2030 (refer to Figure 62), creating a back-log of UG switchgear to be replaced in the long term.
  - A net 6% increase in the length of UG XLPE cables in degraded condition compared to

2024 levels (refer to Figure 65) and a net 10% increase in the length of UG XLPE cables that have reached their typical useful life by 2030 (refer to Figure 64), creating a back-log of UG XLPE cables to be replaced in the long term.
    - A net 7% increase in vault transformers in degraded condition compared to 2024 levels (refer to Figure 67) and a net 19% increase in vault transformers that have reached their typical useful life by 2030 (refer to Figure 66), creating a back-log of vault transformers to be replaced in the long term.
    - No reduction in the percent of Hydro Ottawa-owned vault switchgear in degraded condition compared to 2024 levels (refer to Figure 69) and a net 1% increase in vault switchgear that have reached their typical useful life by 2030 (refer to Figure 68), creating a back-log of vault transformers to be replaced in the long term.
    - A minor 0.7% increase in the cable chambers in degraded condition compared to 2024 levels (refer to Figure 71) and a net 13% increase in cable chambers that have reached their typical useful life by 2030 (refer to Figure 70), creating a back-log of cable chambers to be replaced in the long term.
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- No ability to increase system observability through the UG asset renewal program
- No ability to renew vault switchgear

Alternative 2: Short Term Risk Mitigation (~$103M - Preferred Alternative): This alternative will provide:

- Cost impacts are more significant and replacement rates will allow Hydro Ottawa to balance only short term risk associated with assets in degraded condition.
    - A 0.2% decrease in the percent of UG transformers in degraded condition compared to 2024 levels (refer to Figure 61) and a net 11% increase in UG transformers that have reached their typical useful life by 2030 (refer to Figure 60), moderately reducing the back-log of UG transformers to be replaced in the long term.
    - A 2% decrease in the UG switchgear in degraded condition compared to 2024 levels

(refer to Figure 63) and a net 5% increase in UG switchgear that have reached their typical useful life by 2030 (refer to Figure 62), moderately reducing the back-log of UG switchgear to be replaced in the long term.
    - A net 5% increase in the length of UG XLPE cables in degraded condition compared to 2024 levels (refer to Figure 65) and a net 9% increase in the length of UG cables that have reached their typical useful life by 2030 (refer to Figure 64), moderately reducing the back-log of UG XLPE cables to be replaced in the long term.
    - A net 6% increase in vault transformers in degraded condition compared to 2024 levels (refer to Figure 67) and a net 18% increase in vault transformers that have reached their typical useful life by 2030 (refer to Figure 66), moderately reducing the back-log of vault transformers to be replaced in the long term.
    - A 5% reduction in the number of Hydro Ottawa-owned vault switchgear in degraded condition and having reached their typical useful life by 2030 as compared to 2024 levels (refer to Figure 69 and Figure 68).
    - A minor 0.4% increase in cable chambers in degraded condition compared to 2024 levels (refer to Figure 71) and a net 12% increase in cable chambers that have reached their typical useful life by 2030 (refer to Figure 70), moderately reducing the back-log of cable chambers to be replaced in the long term.
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Moderate ability to increase system observability through the UG asset renewal program
- Moderate ability to reduce reliability impact tied to the failure risk of customer-owned vault switchgear by taking ownership and also renew aged vault switchgears owned by Hydro Ottawa

Alternative 3: Long Term Risk Mitigation (~$150M): This alternative will provide:
- Cost impacts are highest however replacement rates will allow Hydro Ottawa to most effectively balance long term affordability and risk associated with assets in degraded condition:
    - A 0.2% decrease in the percent of UG transformers in degraded condition compared to 2024 levels (refer to Figure 61) and a net 10% increase in UG transformers that have

reached their typical useful life by 2030 (refer to Figure 60), reducing the back-log of UG transformers to be replaced in the long term.

- A 2% decrease in the UG switchgear in degraded condition compared to 2024 levels (refer to Figure 63) and a net 1% decrease in UG switchgear that have reached their typical useful life by 2030 (refer to Figure 62), largely reducing the back-log of UG switchgear to be replaced in the long term.
- A net 4% increase in the length of UG XLPE cables in degraded condition compared to 2024 levels (refer to Figure 65) and a net 8% increase in the length of UG cables that have reached their typical useful life by 2030 (refer to Figure 64), reducing the back-log of UG cables to be replaced in the long term.
- A net 5% increase in vault transformers in degraded condition compared to 2024 levels (refer to Figure 67) and a net 17% increase in vault transformers that have reached their typical useful life by 2030 (refer to Figure 66), reducing the back-log of vault transformers to be replaced in the long term.
- A 5% reduction in the number of Hydro Ottawa-owned vault switchgear in degraded condition and having reached their typical useful life by 2030 as compared to 2024 levels (refer to Figure 69 and Figure 68), reducing the back-log of vault switchgear units to be replaced in the long run.
- A 0.4% decrease in cable chambers in degraded condition compared to 2024 levels (refer to Figure 71) and a net 12% increase in cable chambers that have reached their typical useful life by 2030 (refer to Figure 70), reducing the back-log of cable chambers to be replaced in the long term.

- Ability to manage resourcing levels and to procure long-lead items at the rate required
- High ability to increase system observability through the UG asset renewal program
- High ability to reduce reliability impact tied to the failure risk of vault switchgear and renew aged vault switchgears

Figures 60 to 71 show the proportion of UG distribution assets that will reach the TUL and deteriorating condition by 2030, based on current state and a consideration of the different intervention strategies around managing the UG distribution asset population.

Figure 60 - Number of UG Distribution Transformers Projected to Reach Typical Useful Life by 2030

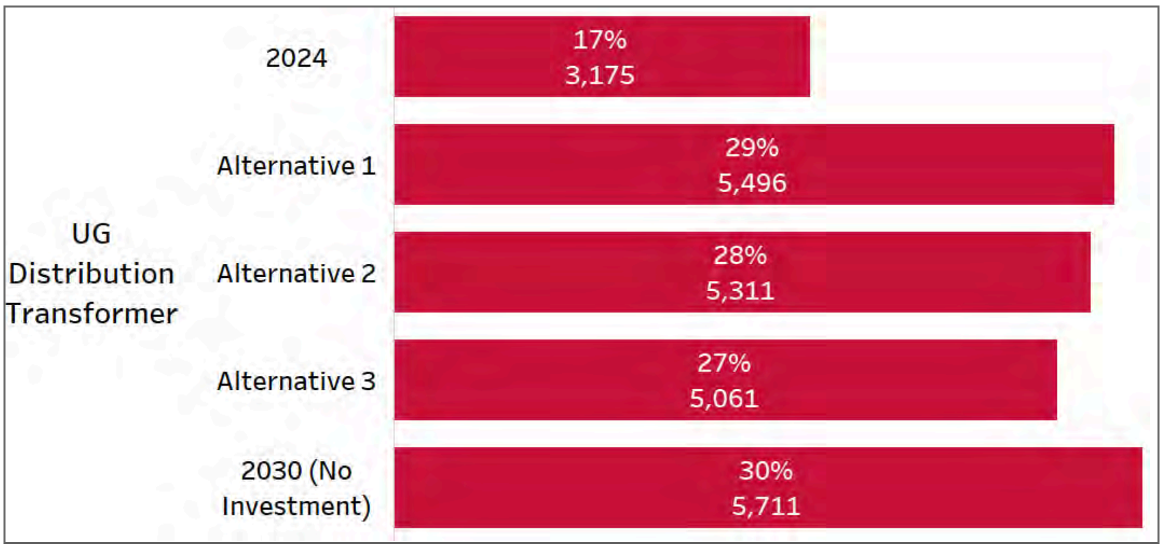


Figure 61 - Number of UG Distribution Transformers Projected to Reach a Deteriorated Condition by 2030

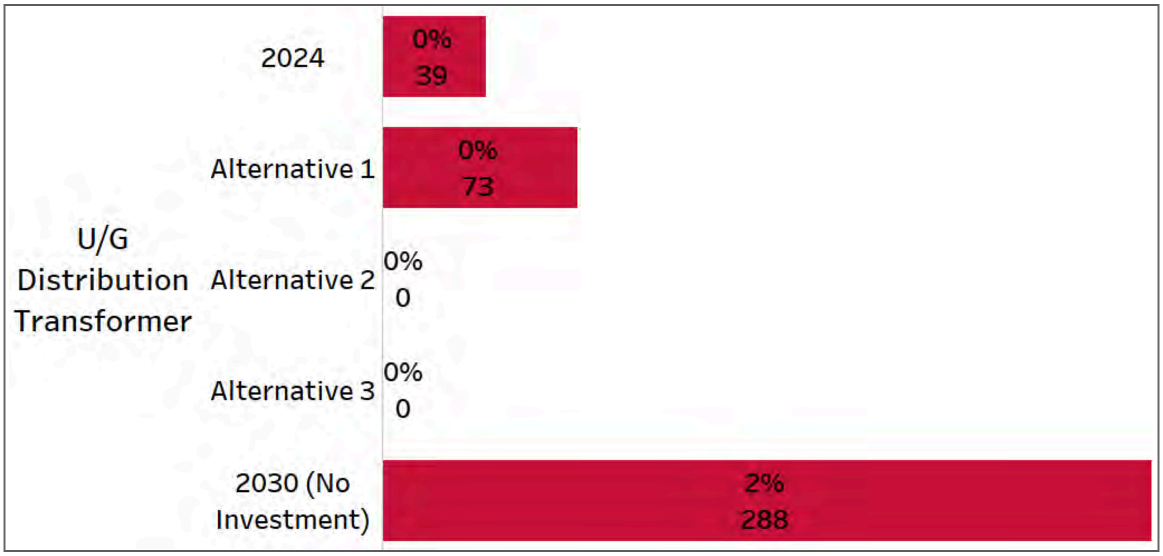


Figure 62 - Number of UG Switchgear Projected to Reach Typical Useful Life by 2030

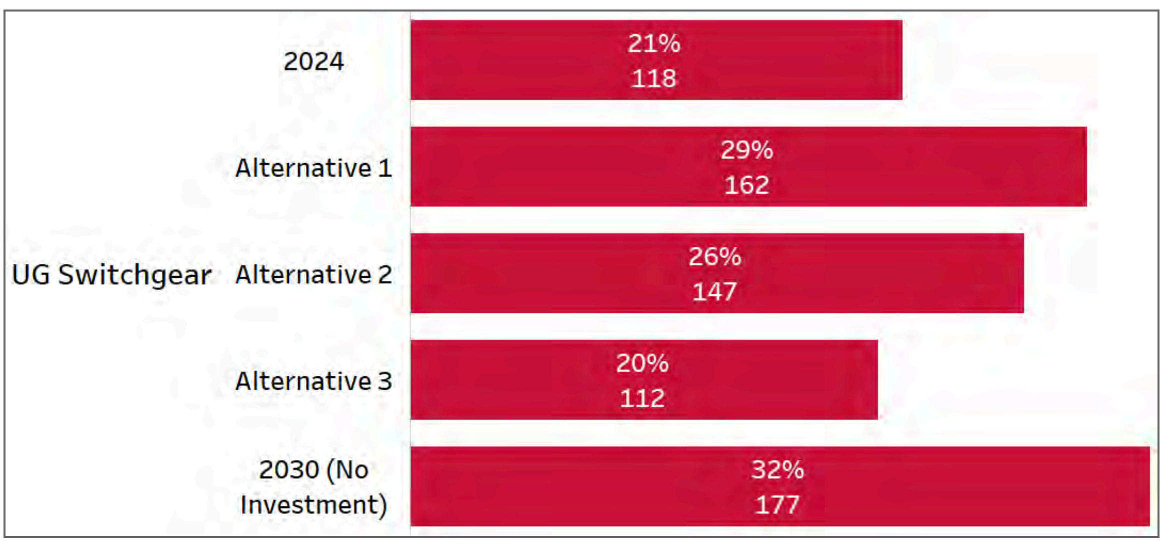


Figure 63 - Number of UG Switchgear Projected to Reach a Deteriorated Condition by 2030

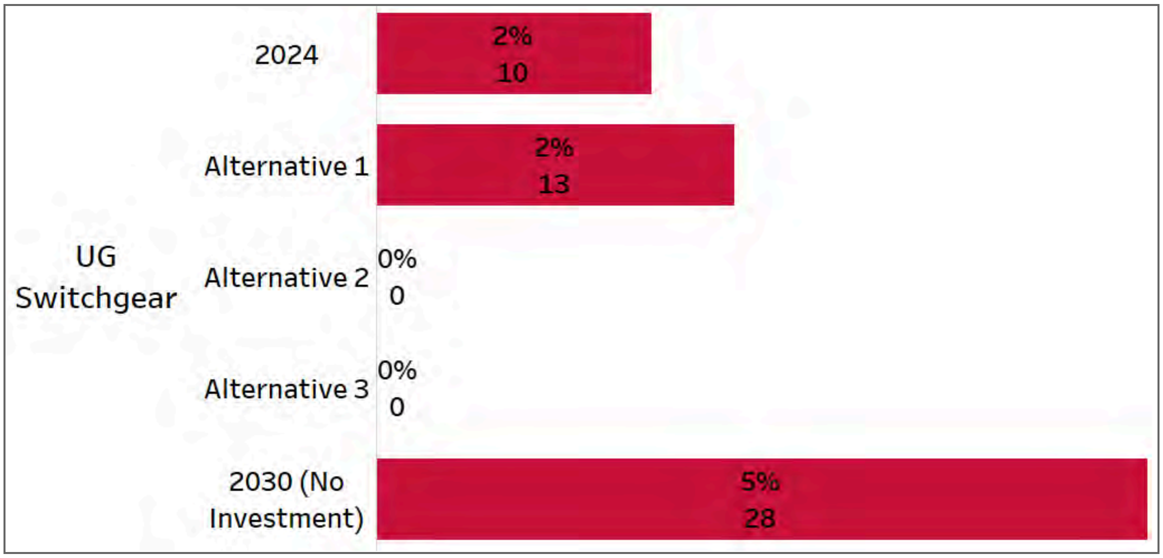


Figure 64 - Length (in km) of UG XLPE Cables Projected to Reach Typical Useful Life by 2030

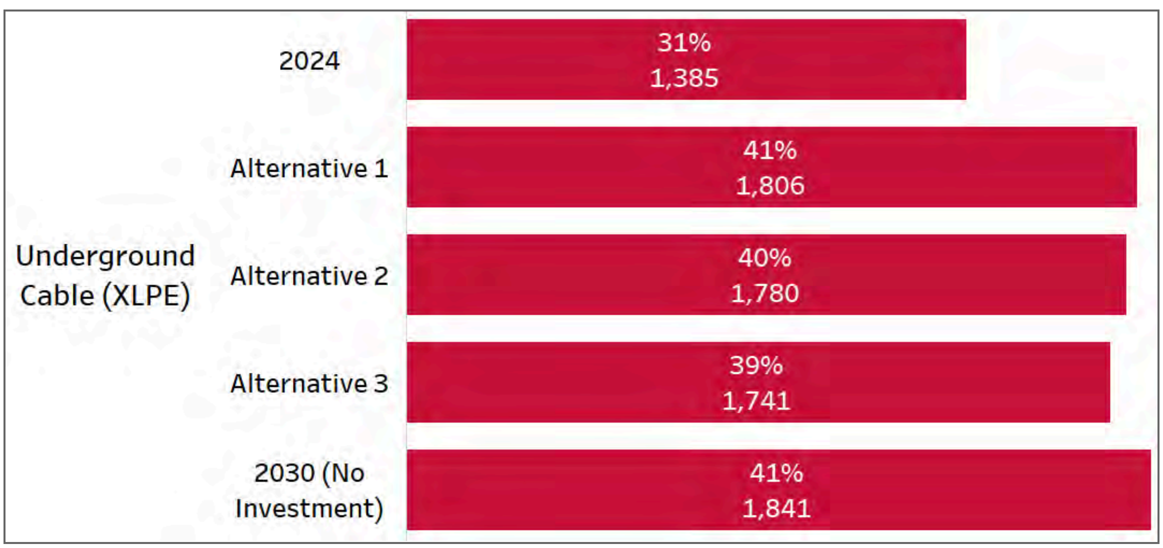


Figure 65 - Length (in km) of UG XLPE Cables Projected to Reach a Deteriorated Condition by 2030

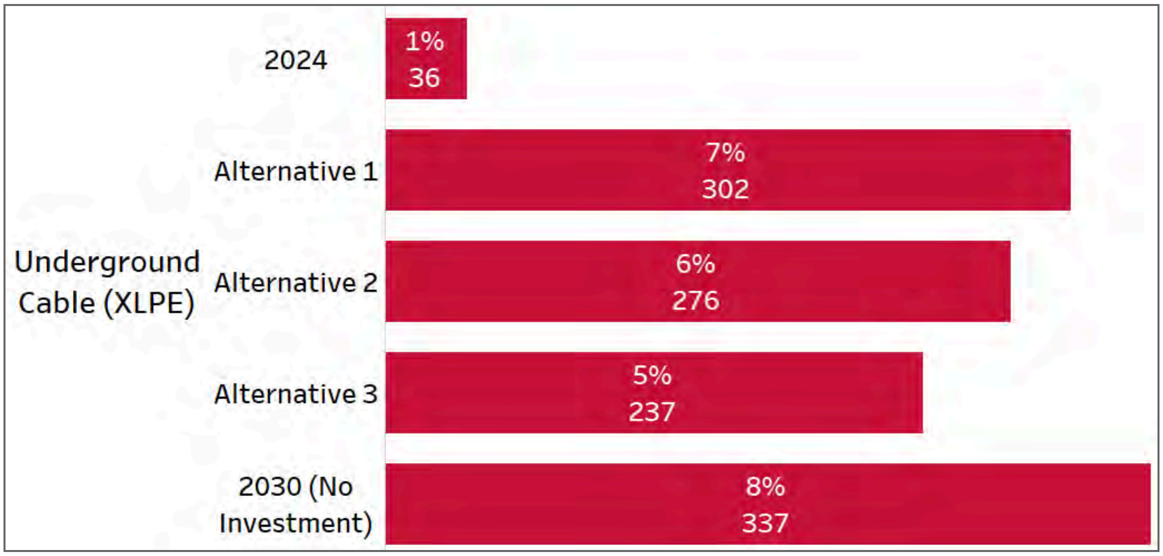


Figure 66 - Number of Vault Distribution Transformers Projected to Reach Typical Useful Life by 2030

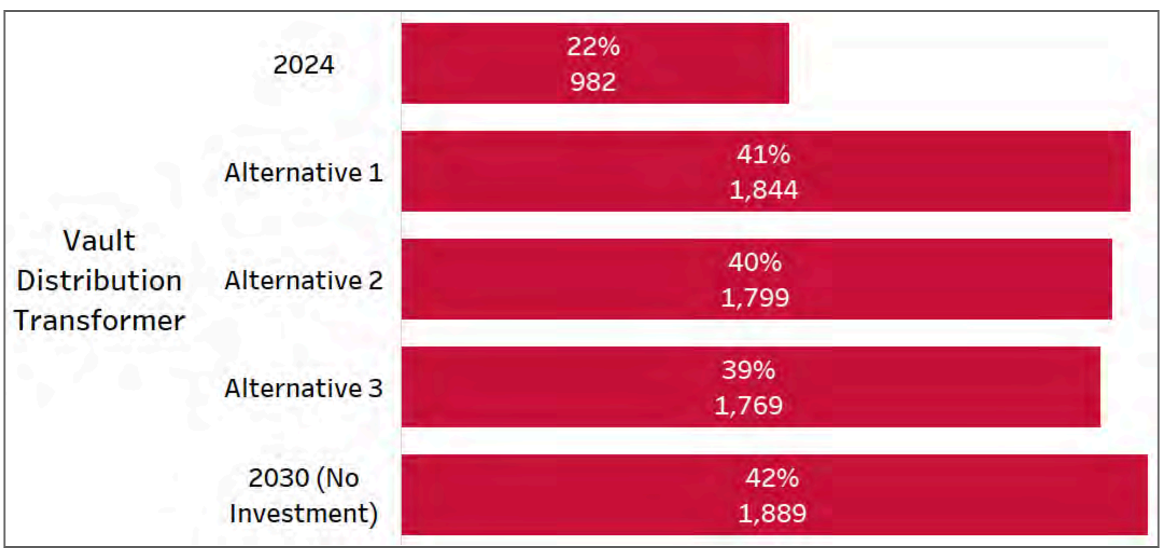


Figure 67 - Number of Vault Distribution Transformers Projected to Reach a Deteriorated Condition by 2030

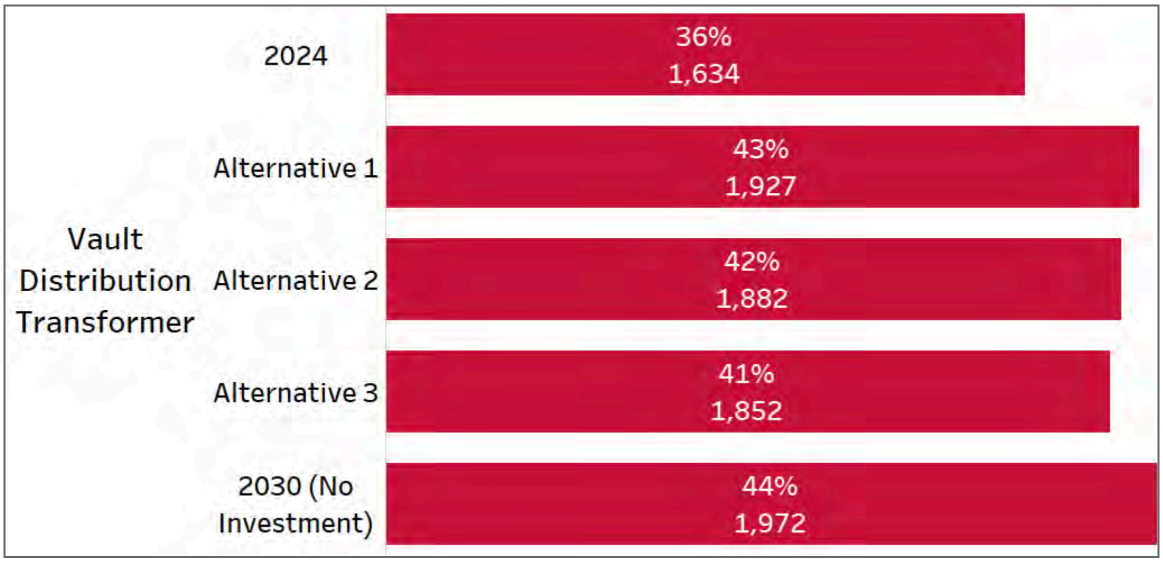


Figure 68 - Number of Vault Switchgear (excl. Customer-Owned) Projected to Reach Typical Useful Life by 2030

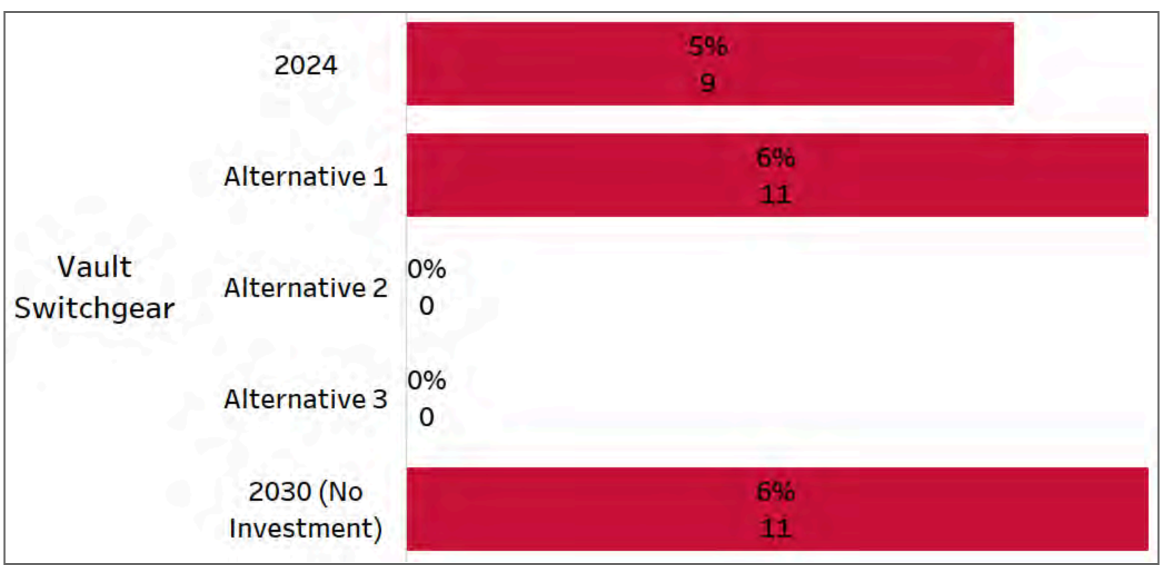


Figure 69 - Number of Vault Switchgear (excl. Customer-Owned) Projected to Reach a Deteriorated Condition by 2030

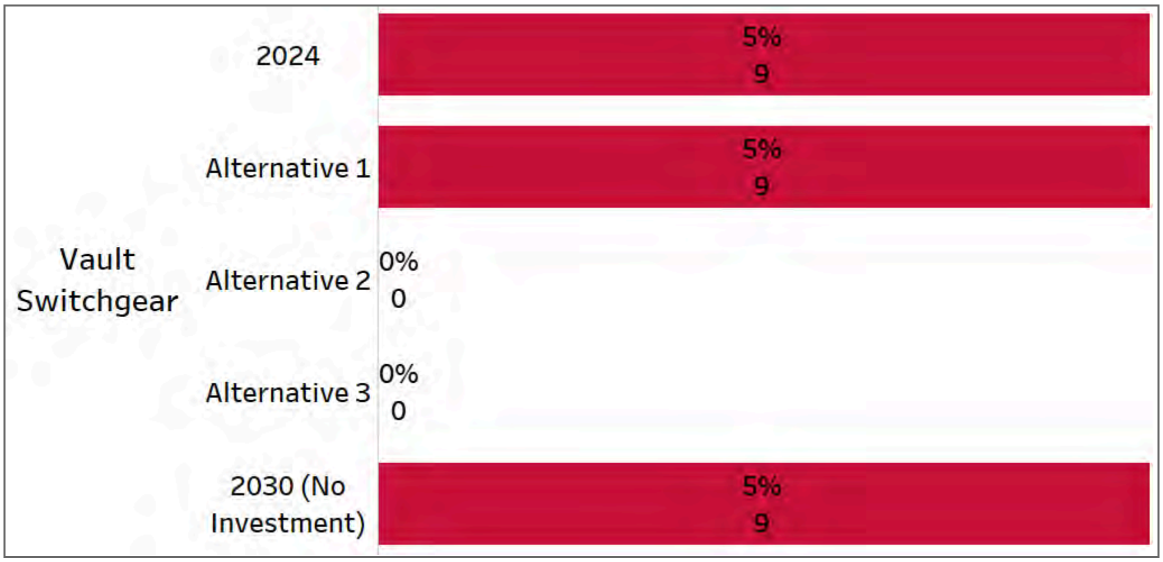


Figure 70 - Number of Cable Chambers Projected to Reach Typical Useful Life by 2030

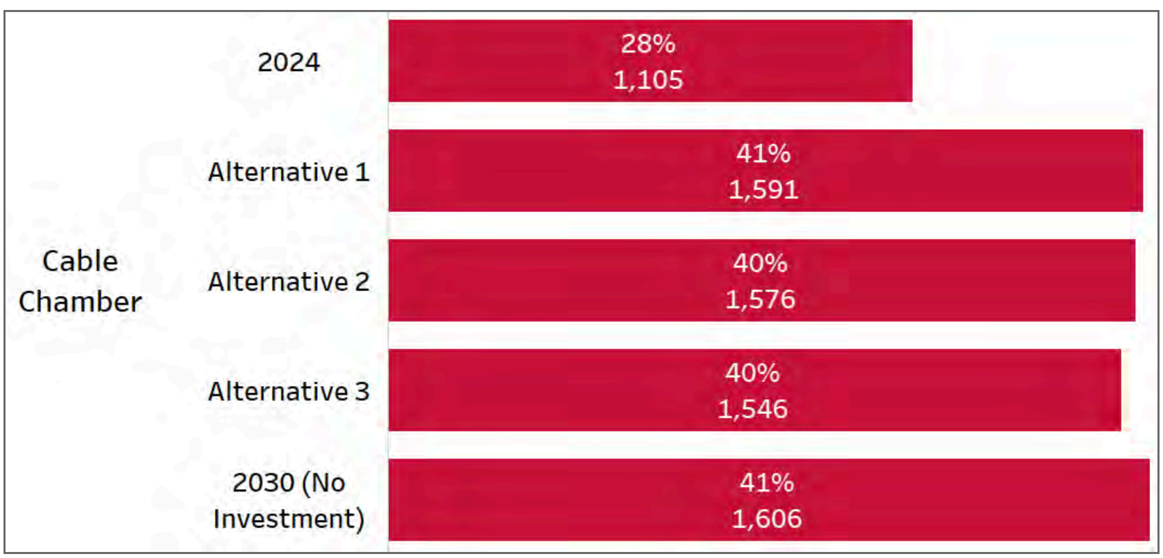
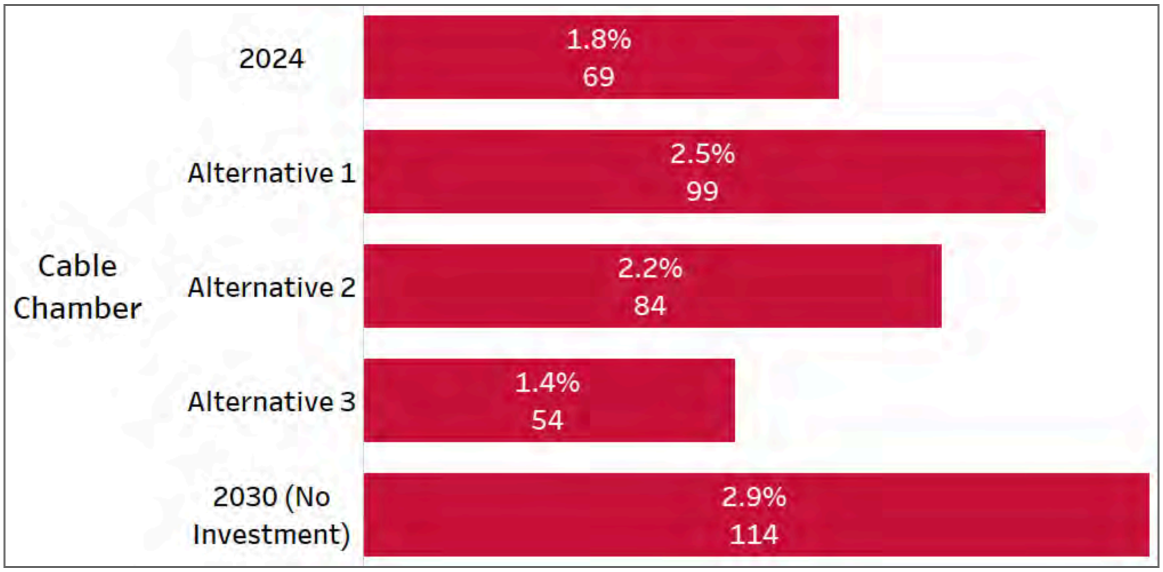


Figure 71 - Number of Cable Chambers Projected to Reach a Deteriorated Condition by 2030



4.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. The increased potential of failure posed by deteriorating UG assets will impact Hydro Ottawa's ability to protect workers and public safety. The selected alternative must maintain or improve the safety of Hydro Ottawa's employees and the public.

Reliability

The increased potential of failure posed by deteriorating UG distribution assets will impact Hydro Ottawa's ability to deliver reliable power. The selected alternative shall help manage asset performance by reducing the reliability risk posed by UG distribution assets and mitigate the risk of failure.

Financial

This criterion assesses the ability to manage long-term financial needs for UG distribution assets. This helps to avoid large spikes in asset renewal spending and the associated rate impacts on customers. The selected alternative should ensure a levelized spending profile, manage long-term asset performance, and prevent significant service disruptions due to deteriorating UG distribution asset failures.

System Observability

The preferred alternative shall also increase the overall system observability and control (through the introduction of remote operability with UG switchgear), in line with Hydro Ottawa's grid modernization initiatives/efforts.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

4.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 4.6.1 - Alternatives Considered under the evaluation criteria of Section 4.6.2 - Evaluation Criteria.

The recommended approach, Alternative Two, involves replacing 61km of UG XLPE cables, 400 UG transformers, 90 vault transformers, 30 vault switchgear, 30 UG switchgear and 30 civil rebuilds. This alternative also includes a strategic approach to improve system observability by considering the replacement of 10 UG switchgears with remote controllable capability.

As shown in Figures 45 and 46, Hydro Ottawa will face a substantial rise in UG switchgear requiring attention by 2030, with 59 additional UG switchgear units reaching their TUL and 18 units in a deteriorated (very poor or poor) condition. The replacement rate of 30 UG switchgears under Alternative Two strategically balances the imperative need to address the short term risks posed by deteriorating UG switchgear units and mitigating the reliability impact of failing air-type switchgears. Alternative Two also results in a moderate increase in UG distribution asset visibility by 2030 compared to the current level, through introducing remote operability in 10 UG switchgear units considered for replacement.

UG transformers and UG XLPE cables are reaching end of life and degrading rapidly with projected increases in excess of 8% every five years. The recommendation from Copperleaf PA was to intervene on all UG XLPE cables in a degraded condition by 2030, requiring a significant capital investment. UG transformers and cables are also major contributors to the number of outages due to the related failures.

In 2022, Hydro Ottawa saw a significant overspend of $7M, following the resumption of the cable renewal program, post COVID-19. This substantial increase was attributed to the significant increases in material costs and higher civil contractor prices, driving up the actual cost per km to $0.7M/km from the budgeted $0.3M/km. Given the major cost increase, Hydro Ottawa has budgeted the replacement of 61 km down from 74 km replaced in 2021-2025 and not replace widespread, to manage the short-term failure risk of major UG cable sections. Therefore, Alternative Two allows for a strategic balance between the urgent need to address short term risks due to deteriorating UG transformers and cables and the necessity of reducing the associated reliability impact.

Hydro Ottawa had also implemented enhancements to inspection programs in 2024, to gather better condition information for accurate assessments and planning interventions. Hydro Ottawa intends to continue the proposed inspection program enhancements through 2026-2030 as further explained in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

Hydro Ottawa-owned vault equipment (both transformers and switchgear) are reaching end of life, with major projected increases for vault transformers, in particular. Customer-owned vault switchgears are also aging, with a significant increase in units nearing end of life by 2030. Hydro

Ottawa had advanced the vault equipment inspection program in 2024 (to capture component level information) and there is a continued focus on investing in the proposed inspection enhancements through 2026-2030, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. Customer-owned vault switchgear failures have caused outages and there are replacement challenges due to space limitations within vaults. The vault renewal program is resource intensive and costly, as described in Section 3.1.2.2 of Attachment 4-1-3(C) - Workforce Growth. To this end, Alternative Two is optimized to account for resource management considerations that can handle the increase in the number of vault equipment slated for replacement. It is also in alignment with Hydro Ottawa's workforce growth strategy for 2026-2030, to execute on the vault renewal program. Therefore, Alternative Two strikes a strategic balance between the urgent need to address short term risks due to aging vault equipment and the need to reduce the associated impact on reliability.

Cable chambers are reaching end of life and degrading (from a condition perspective) at a rate of 8% and 2% every five years, respectively. The failure of cable chambers introduces safety risks to the public and Hydro Ottawa personnel. Alternative Two allows Hydro Ottawa to moderately reduce the back log of cable chamber replacements required in the long run and relatively maintains the proportion of cable chambers in a deteriorated condition by 2030, as compared to 2024 (limiting the increase to only 0.4%).

The condition information of certain UG distribution assets such as vault transformers and vault switchgear are evolving based on the inspection enhancements introduced in 2024. Hydro Ottawa intends to continue to implement these enhancements through 2026-2030, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. In this background, Hydro Ottawa's need in renewing UG distribution asset infrastructure is two-fold:

- Without intervention, the percentage of Hydro Ottawa's UG assets that have reached their end of life will continue to grow at a rate of approximately 9% every five years resulting in a back-log of replacements required in the long run.

- High number of outages due to UG equipment failures between 2019-2023 (specifically UG cables, UG transformers and more recently vault equipment and UG switchgear) as outlined in Section 4.5.6.1 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement, requiring an intervention to mitigate the short term failure risk

Therefore, Alternative Two allows for the best use of capital by moderately decreasing the back-log of underground distribution assets that have reached their TUL or deteriorated condition while primarily mitigating the short term risk of failure. The data from ongoing condition assessments based on the enhancements introduced in 2024 and continued through 2026-2030 will be used to determine which equipment will be addressed during annual scoping from 2026-2030. As Hydro Ottawa's maintenance programs advance further, that would support more enhanced condition assessments down to the component level and further support future renewal decisions.

4.7. PROGRAM EXECUTION AND RISK MITIGATIONS

4.7.1. Implementation Plan

Planned UG distribution replacements are prioritized based on the related equipment's condition and level of risk posed to Hydro Ottawa. Using the recommended rate of planned renewal, a program of planned renewal will begin in 2026 addressing UG equipment whose condition poses an increased risk compared to the others. If any UG distribution assets are found in a deteriorated condition, through the planned programs of inspection or through the day-to-day activities of internal resources, that warrants replacement, these will be performed reactively on an as-needed basis, or the planned renewal program adjusted accordingly.

4.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its UG distribution asset renewal program, Table 18 outlines the key risks and corresponding mitigation strategies.

1 **Table 18 - Key Risks of UG Distribution Asset Renewal Program and Mitigation Strategies**

Category	Risk	Mitigation
Distribution System Upgrades	System reconfigurations, upgrades, or expansions may be required, posing a risk to project delivery schedule and scope.	Develop long-term infrastructure plans and allocate resources efficiently to manage the costs and timing of necessary system modifications, minimizing financial impacts on customers.
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

5. METERING RENEWAL

5.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $11.8M

2026-2030: $86.4M

Budget Programs: Metering Upgrades

Main Driver: Functional Obsolescence

Secondary Driver: Mandated Service Obligation, Failure Risk, Observability

Outcomes: Customer Focus, Public Policy Responsiveness, Operational Effectiveness

Hydro Ottawa's metering fleet is a critical component of the distribution system, essential for accurate customer billing, settlement with the Independent Electricity System Operator (IESO), and effective grid operations. Continued reliable and accurate metering is fundamental to ensuring accurate billing, regulatory compliance, and the ability to manage the distribution grid effectively. Hydro Ottawa's first large-scale deployment of smart meters began as a result of Ontario Bill 21 - Energy Conservation Responsibility Act in 2006. This deployment saw the complete replacement of over 277,000 electro-mechanical meters to electronic smart meters, with the major portion completed by 2011.

Today, as a result of this aging metering fleet, Hydro Ottawa is proactively addressing the challenges presented by functional obsolescence in this metering infrastructure. A significant portion of the existing metering assets are nearing the end of their typical useful life, driven by the increasing challenges of supporting aging metering technologies. The Metering Renewal Program is essential to maintain the accuracy and reliability of meters, which is critical for revenue collection, regulatory compliance, supporting evolving customer needs and Hydro Ottawa's grid modernization strategy.

To this end, Hydro Ottawa has proposed to invest $86.4M in the Metering Renewal Program over this Application period. This will include the replacement of 161,000 meters, which is approximately 43% of the total fleet. The replacement of the remaining meters will be carried out in the subsequent rate period, thereby distributing the deployment and associated costs across multiple rate periods, minimizing the financial impact to ratepayers. As part of the phased replacement strategy, the age of meters in service will be the primary criterion for prioritizing replacements.

This Metering Renewal Program addresses the metering fleet needs under the following budget programs over the 2026-2030 period:

- **Revenue Meter Compliance:** This program focuses on initiatives impacting all of Hydro Ottawa's customers, including:
    - Planned replacement of residential and small commercial meters with next-generation Advanced Metering Infrastructure (AMI) 2.0 meters.
    - Upgrading supporting metering infrastructure.
- **Metering Element Conversion Initiatives:** This program focuses on upgrading or replacing end-of-life meters for 3-phase customers and legacy single element customers, while ensuring compliance with Measurement Canada standards:
    - **2.5 Element to 3.0 Element Upgrades (Measurement Canada Policy E-24):**
        - Existing 2.5 Element Metering: Measures current and voltage using two elements and calculates power factor using a third element.
        - Conversion to 3.0 Element Metering: Directly measures current and voltage for each phase of the electricity supply using three elements.
    - **1.0 Element to 1.5 Element Upgrades:**
        - Existing 1.0 Element Metering: Measures a single electrical quantity, the current flowing through the meter.
        - Conversion to 1.5 Element Metering: Measures two electrical quantities, both current and voltage.

5.2. PERFORMANCE OUTCOMES

Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. With the implementation of the Metering Renewal Program, improvements are expected in the outcomes shown in Table 19 below.

Table 19 - Metering Renewal Program Performance Outcomes

OEB Performance Outcome	Target
Customer Focus	Ensures continuous and reliable metering service by mitigating the risk of functional obsolescence, thereby minimizing billing interruptions and enhancing customer satisfaction. Maintain Meter Billing Accuracy Target of 98%.
Operational Effectiveness	Hydro Ottawa's system reliability objectives are supported by replacing the aging metering fleet with meters that have near-real-time grid observability features
Public Policy Responsiveness	Contributes to maintaining Hydro Ottawa's compliance objectives by conforming with Measurement Canada's Electricity and Gas Inspection Act and Regulations, the Weights and Measures Act, and the IESO's Market Rules, ensuring accurate and timely meter reading, billing, and market settlements

5.3. PROGRAM DRIVERS AND NEED

5.3.1. Main and Secondary Drivers

Primary Driver - Functional Obsolescence is the primary driver for the Metering Renewal Program. As a result of Ontario Bill 21 - Energy Conservation Responsibility Act in 2006, Hydro Ottawa quickly replaced its entire electromechanical fleet of meters over 4 years. This technology is now approaching end-of-life and requires upgrades to keep pace with customer expectations, maintain functionality and compliance. The aging metering fleet poses a risk to Hydro Ottawa's ability to ensure customer service, accurate billing, and regulatory compliance. This impacts regulatory requirements for various customer rate classes, as accurate metering is crucial for ensuring fair and transparent billing practices.

Furthermore, aging meters may fail in the field, leading to a loss of automated billing capability, forcing estimations, which negatively impacts customer service.

Secondary Drivers - Customer Focus, Operational Effectiveness, and Public Policy Responsiveness: The Metering Renewal Program is primarily driven by functional obsolescence, which poses significant risks to secondary drivers, including customer focus, public policy responsiveness, and operational effectiveness. Associated with this is cyber security which ensures the security of customer data.

This program contributes to enhanced operational effectiveness and grid observability. For example, the introduction of AMI 2.0 technology improves grid observability by providing customer outage data from the meter. This enhancement supports Hydro Ottawa's Grid Modernization Strategy, as outlined in Section 3.4.2 of Schedule 2-5-4 - Asset Management Process.

From a customer focus perspective, replacing the aging metering fleet minimizes the occurrence of non-communicating meters, thereby reducing estimated bills, customer disputes, and enhancing overall customer satisfaction. AMI 2.0 technology also enables greater customer visibility and control of energy consumption. These improvements contribute to a more reliable, efficient, and customer-centric electricity grid.

Cyber security considerations are also important to consider as it pertains to customer satisfaction. Robust cyber security measures are important to protect sensitive customer data, as functional obsolescence progresses, associated cyber security vulnerabilities are likely to increase.

5.3.2. Current Issues

Aging Metering Assets

The primary focus of the Metering Renewal program is to mitigate the impact of functional obsolescence and continued deterioration of the existing metering fleet (installed as early as 2006), which pose a growing risk to customer focus, operational effectiveness, and public policy responsiveness. Revenue meters are one of the largest Hydro Ottawa asset classes, both in terms of installed quantity and overall cost. Figure 72 shows the current meter fleet demographics as of

2024, Figure 73 demonstrates the forecasted age demographics in 2030 for residential and small commercial revenue meters, should no action be taken. Figure 74 demonstrates the summary of the current and forecasted demographics of the metering fleet if no replacement occurs.

Figure 72 - Current Age Demographics Profile of Residential and Small Commercial Meters (as of 2024)

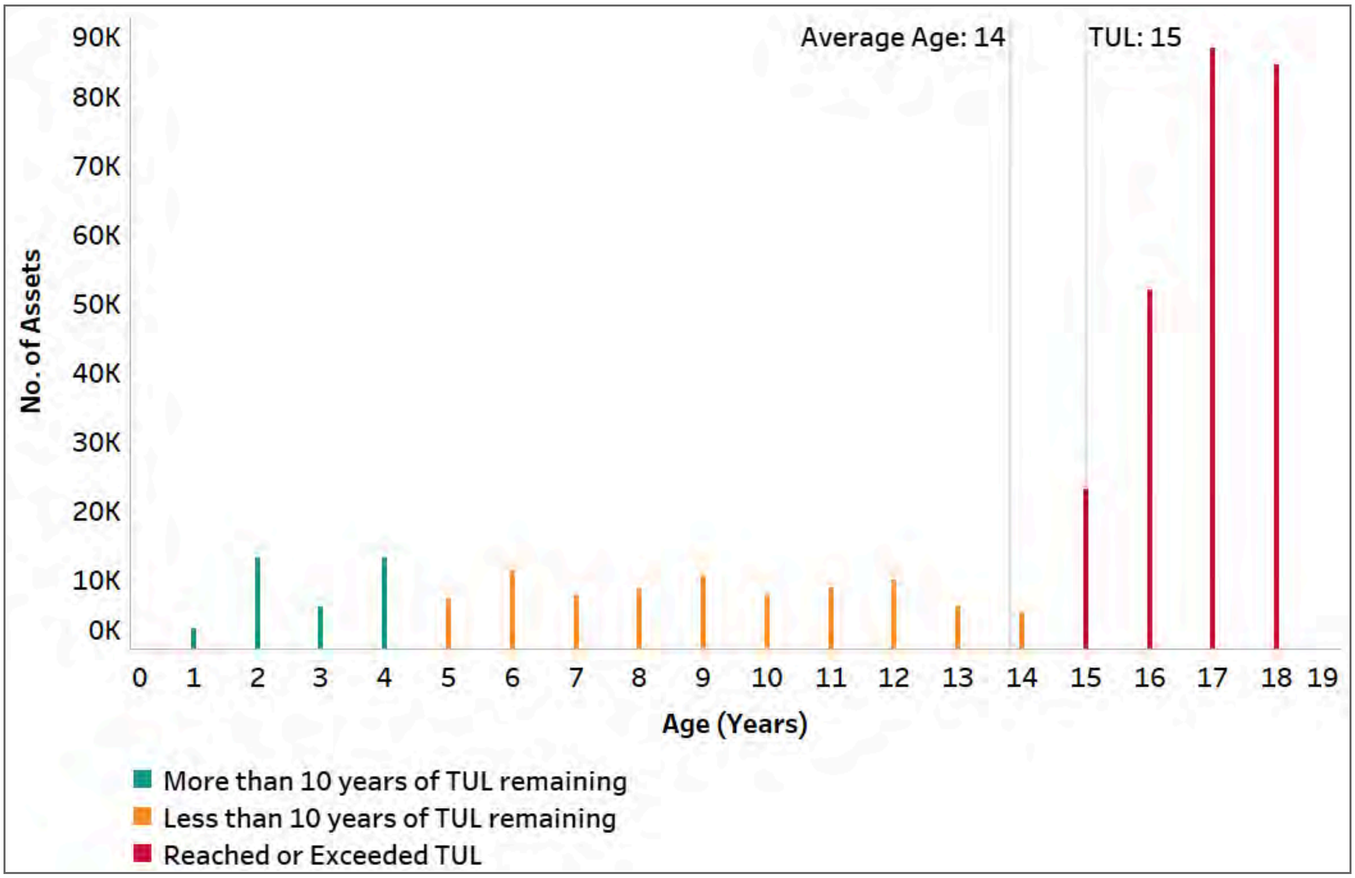


Figure 73 - 2030 Forecast Age Demographics Profile of Residential and Small Commercial Meters (No Replacement Action)

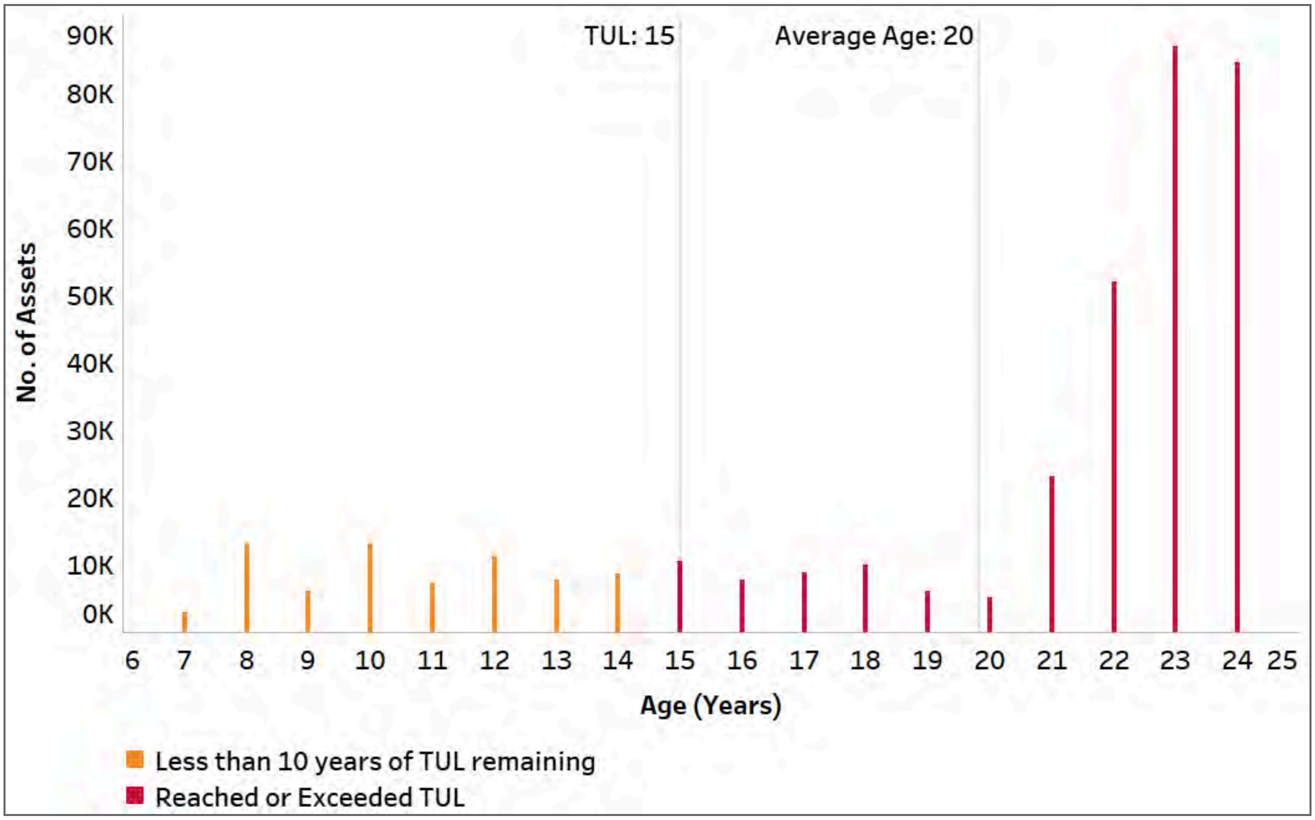
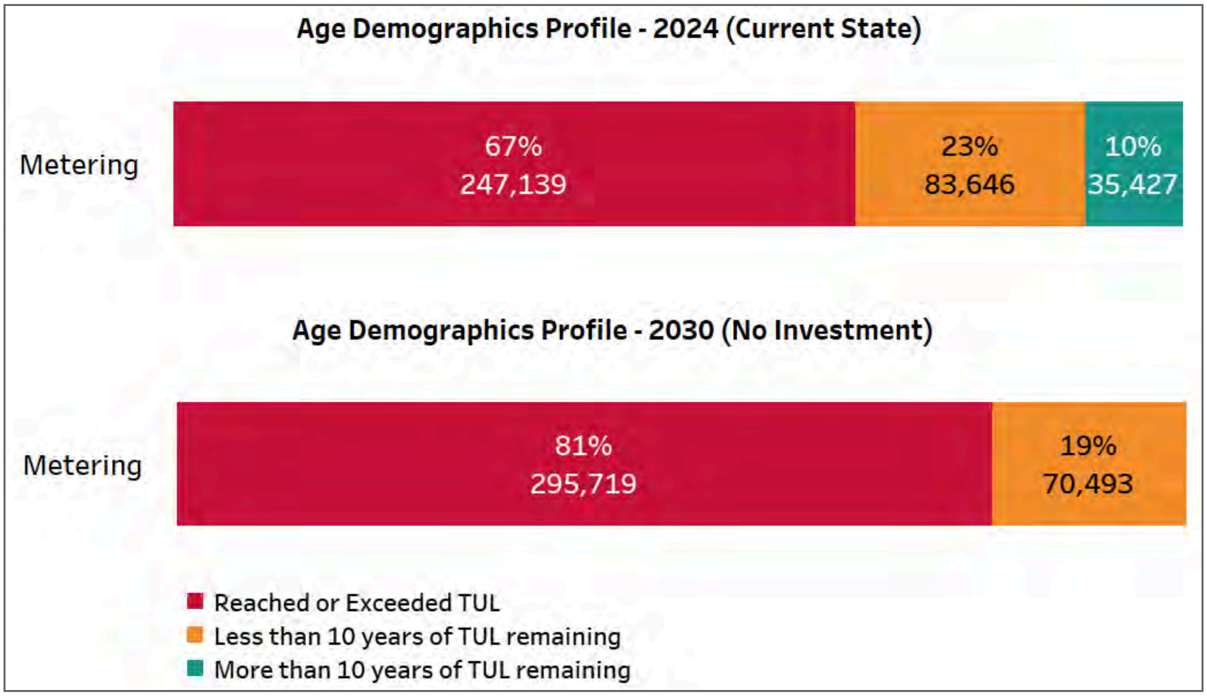


Figure 74 - Age Demographics Profile of Residential and Small Commercial Meters Summary



Approximately 81% of the revenue meters will reach the end of their typical useful life by 2030 if no replacement action is taken. Deteriorating meters are increasingly prone to in-field failure, leading to inaccurate or missing meter reads. This can result in estimated bills, billing disputes, and customer dissatisfaction.

Hydro Ottawa has experienced increasing meter failures in the field such as from accidental physical damage, internal meter circuit board failures, meter communication failures, and meter memory (EEPROM) failures. Table 20 shows the field activities issued and completed based on suspected failure type for meter installations through 2021-2024.

Table 20 - Completed Revenue Meter Field Activity by Failure Type (2021-2024)

Revenue Meter Field Activity by Failure Type	Count (2021-2024)
Collector Check	274
Emergency Meter Check	6
Interval Meter - Communication Check	187
Interval Meter - Gatekeeper Check	256
Interval Meter - Gatekeeper Check (with nodes)	37
Meter Check Communication	2,080
Meter Check/Repair	1,024
Meter Voltage Check	259
Orphan Meter	231
Smart Meter Chip Error Change	798
Residential Smart Meter Change	2,420

- **Meter Communication Issues/Checks:** Since 2021, Hydro Ottawa has responded to 2,080 events related to meter communication issues, highlighting the need for reliable communication infrastructure to ensure accurate and timely data transmission.
- **Residential Smart Meter Changes:** Hydro Ottawa has performed a significant number of residential smart meter changes, including installations, replacements, and repairs, to maintain accurate metering and customer satisfaction.
- **Smart Meter Chip Error Issues:** The utility has addressed smart meter chip errors through repairs and replacements to ensure accurate meter readings and prevent billing discrepancies.
- **Meter Delivery Issues:** Hydro Ottawa has experienced challenges with meter delivery, which can impact project timelines and the timely replacement of aging assets.
- **Operational Issues with Router Communications Module:** Critical failures encountered during shop testing of a specific router communications module required prompt resolution to prevent potential communication disruptions.
- **Performance Issues with Daily Read Schedules:** Issues with daily read schedules limited data collection to register readings, impacting billing processes and delaying revenue collection.

Hydro Ottawa's aging meters and communication structure is functionally configured to read billable data once per day. This legacy metering infrastructure cannot provide the necessary high-resolution data at the intervals necessary for grid modernization efforts, impedes the integration of DERs, and compromises Hydro Ottawa's ability to optimize grid operations and deliver innovative customer-centric solutions. Addressing these challenges requires a strategic investment in a modernized metering infrastructure that prioritizes reliability, accuracy, and future-proofing capabilities.

3-Phase Metering Element Compliance

Driven by Measurement Canada Policy E-24 Policy on Approval and Use of 2.5 Element Metering, Hydro Ottawa proposes to upgrade its remaining 3-phase 2.5 Element (2.5 EL) metering population from a 2.5 Element to a 3 Element (3.0 EL) service. As well, Hydro Ottawa will also upgrade self-contained 1.0 Element services to 1.5 Element. The elimination of these nonstandard 1.0 element meter installations from Hydro Ottawa's system will reduce inventory overhead costs.

5.4. PROGRAM BENEFITS

The Metering Renewal Program will result in benefits across several key areas:

5.4.1. System Operation Efficiency and Cost Effectiveness

The proposed leveled-pace replacement of Hydro Ottawa's aging metering technology with AMI 2.0-capable equipment enhances operational efficiency by enabling remote meter management, grid feedback, and data collection, thereby reducing meter communication errors, as demonstrated in Table 20, and additional operational field activities.

Proactive meter replacement also minimizes the risk of billing estimation and customer disputes, further contributing to cost savings.

AMI 2.0 infrastructure, with enhanced data analytics, enables grid observability, enabling quicker identification and resolution of grid issues. This investment supports the data integration requirements necessary to effectively manage DERs, unlocking efficiencies such as demand response programs for peak load and asset stress management.

5.4.2. Customer

The replacement of Hydro Ottawa's aging metering technology with AMI 2.0-capable equipment directly benefits customers through enhanced service reliability and power quality. The advanced technology of AMI 2.0 enables faster and more precise outage detection, leading to shorter outage durations and quicker restoration times; meaning fewer disruptions to customers' daily lives and businesses. The proposed phased replacement pace benefits the customer by distributing the required investment across multiple rate periods. This strategy also avoids recurring end-of-life whole-fleet replacement burdens such as the original 2006 implementation.

Hydro Ottawa considered the results from the customer engagement survey, where there was strong support for Hydro Ottawa's proposed investments towards ensuring a reliable and modern electrical distribution system.

5.4.3. Safety

The Metering Renewal Program enhances safety by addressing potential hazards associated with less advanced metering equipment such as:

Enhanced Detection of Tampering and Fraud: Aging meters replaced with AMI 2.0 systems provide improved capabilities for detecting meter tampering and electricity theft. Tampering can create dangerous conditions, such as exposed wiring or bypassed safety mechanisms. By facilitating the identification and correction of tampering, the program contributes to a safer environment for both customers and the general public.

Support for Emergency Response: AMI 2.0 infrastructure can provide more timely and accurate information during power outages and emergencies. This information can help Hydro Ottawa and emergency responders to better assess situations, prioritize responses, and ensure the safety of both the public and field personnel.

5.4.4. Cyber Security and Privacy

The replacement of Hydro Ottawa's aging metering technology with AMI 2.0-capable equipment has cyber security and data privacy as core principles. The advanced AMI 2.0 system is designed with next-generation security measures to safeguard customer data and protect the grid infrastructure from cyber threats:

- **Encryption Protocols:** Data communication between meters and the central system is encrypted, making it unreadable to unauthorized parties in case of interception.
- **Secure Authentication:** Authentication protocols ensure only authorized devices and personnel can access the AMI network, preventing unauthorized access and data manipulation.
- **Vulnerability Management:** The system is continuously monitored and updated with the latest security patches to address potential vulnerabilities and mitigate cyber risks.

By implementing these robust security measures, Hydro Ottawa strengthens its commitment to data privacy and ensures customer information remains secure within the metering replacement program.

5.4.5. Coordination and Interoperability

Hydro Ottawa's AMI 2.0 Metering Renewal Project prioritizes the seamless integration and coordination of the advanced metering infrastructure with existing grid operations. The AMI 2.0 system will adhere to open standards and protocols, fostering interoperability with other utility systems such as the Outage Management System (OMS), Advanced Distribution Management System (ADMS) - refer to Section 5 of Schedule 2-5-8 - System Service Investments. This integration enables real-time data exchange, streamlined communication, and enhanced operational efficiency across all aspects of grid management.

Furthermore, the AMI 2.0 system's interoperability supports the integration of DERs like solar panels and battery storage. By seamlessly communicating with these DERs, Hydro Ottawa can monitor and optimize their performance, enabling a more dynamic and flexible grid that can adapt to changing energy demands and supply conditions. This integration is key to supporting decarbonization by facilitating the adoption of renewable energy sources and enabling greater customer participation in energy programs.

The enhanced coordination between AMI 2.0 and other grid systems leads to improved outage management and faster restoration times. With real-time data on outage locations and power status, crews can be dispatched more efficiently, minimizing disruptions to customers. Additionally, the AMI 2.0 system can remotely detect meter tampering and theft, enhancing grid security and protecting revenue.

By leveraging the coordinated and interoperable nature of the AMI 2.0 system, Hydro Ottawa gains valuable insights into grid performance, load patterns, and customer behavior. This data-driven approach enables better decision-making, more effective resource allocation, and the development of innovative programs and services that benefit both the utility and its customers. Ultimately, the improved coordination and interoperability fostered by the AMI 2.0 Metering Renewal Project will contribute to a more reliable, efficient, and resilient grid, well-equipped to meet the evolving needs of the community and support a sustainable energy future.

5.4.6. Economic Development

The multi-period implementation of the aging meter replacement program represents a prudent investment for Hydro Ottawa and its ratepayers. The technological advancements embedded in AMI 2.0 have the potential to yield long-term cost savings through increased operational efficiency, reduced meter reading expenses, and improved outage management.

Furthermore, AMI 2.0's advanced capabilities, such as detailed energy usage data, can empower customers to make informed decisions about their energy consumption patterns. This increased awareness and control may lead to behavioral changes that result in lower energy bills for consumers.

Additionally, the integration of AMI 2.0 with DERs can create a more dynamic and flexible grid, potentially reducing the need for costly infrastructure upgrades and further mitigating upward pressure on rates. The ability to manage and optimize DERs can lead to improved voltage regulation, reduced peak demand, and the potential for new customer programs and services, all of which contribute to a more efficient and cost-effective energy system that benefits both the utility and its ratepayers.

5.4.7. Environment

The AMI 2.0 Metering Renewal Project contributes to environmental benefits by facilitating a more efficient and sustainable energy system. Replacement of the aging meter fleet with AMI 2.0 capable meters, optimizing grid operations, enabling better integration of renewable energy sources, and empowering customers to manage their energy use. Additionally, the replacement of end-of-life meters reduces maintenance truck rolls, leading to a decrease in vehicle emissions, promoting a cleaner environment.

5.5. PROGRAM COSTS

Table 21 shows the historical and future spending by the underlying budget programs, as a part of the Metering Renewal program including capital expenditures, operations, management and administration (OM&A) and derecognition costs. The 2026-2030 period will see an increase in spending, reaching $86.4M, compared to $11.8M in the 2021-2025 period. Considerations around equipment/resource availability as well as project prioritization/scheduling resulted in some variability in the projected spending between 2026 and 2030.

Table 21 - Historical, Bridge and Test Year Expenditures for the Metering Renewal Program ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Metering Upgrades	$ 1.5	$ 0.3	$ 1.3	$ 4.6	$ 4.1	$ 15.4	$ 14.6	$ 16.2	$ 19.3	$ 20.9
5-YEAR SUBTOTAL					**$ 11.8**					**$ 86.4**
OM&A	-	-	-	-	-	$ 0.7	$ 1.0	$ 1.2	$ 1.6	$ 2.0
Derecognition costs	-	-	-	-	-	$ 0.4	$ 0.8	$ 0.8	$ 0.8	$ 0.8
ANNUAL TOTAL	**$ 1.5**	**$ 0.3**	**$ 1.3**	**$ 4.6**	**$ 4.1**	**$ 16.4**	**$ 16.4**	**$ 18.2**	**$ 21.6**	**$ 23.7**
5-YEAR TOTAL					**$ 11.8**					**$ 96.4**

Table 22 shows the historical and preferred alternative future units to be replaced as a part of the metering renewal program.

Table 22 - Preferred Alternative Metering Unit Replacements Overview

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Metering Replacements	408	1,488	3,764	2,912	1,377	11,000	29,300	32,950	40,250	47,500

5.5.1. Metering Replacements

81% of the metering fleet have currently reached or will exceed the TUL by 2030. The Metering Renewal program's spending is forecasted to increase significantly, from $11.8M in 2021-2025 to $86.4M in 2026-2030. This increase in spending is essential to address the growing challenge of functional obsolescence within Hydro Ottawa's metering infrastructure. The increased spending will enable Hydro Ottawa to replace a substantial portion of end-of-life metering infrastructure, invest in AMI 2.0 technology, and enhance grid observability to support grid modernization efforts. This investment represents a strategic initiative by Hydro Ottawa to mitigate these risks, ensure the long-term performance and reliability of the metering system, and support evolving customer needs.

5.5.2. Cost Factors

Cost factors that affect the Metering Renewal program are listed below:

- Physical location and configuration of the meter on customer's premise
- Communication type and system integration complexity
- Project delays and unit lead times
- Skilled labour availability
- Material & equipment cost

5.6. ALTERNATIVES EVALUATION

5.6.1. Alternatives Considered

To address the drivers and achieve the performance objectives of the program, Hydro Ottawa undertook an analysis to determine the optimal number of metering units to replace, focusing on minimizing functional failures, enhancing overall system performance, and balancing the financial impact on ratepayers. This analysis considered several key factors, including regulatory compliance, assessment of the current metering infrastructure (prioritizing replacement of units nearing or past their end-of-life), financial impact, and the ability to support advanced grid functionalities through observability.

Three alternatives were considered for this program. These alternatives were designed to achieve a balance between rate impact and service quality performance, both in the near and longer term, while readying the grid with prudent investments to serve the evolving needs of its customers.

Alternative 1 - Run to Failure:

This alternative takes a reactive approach to meter replacement, addressing meters only upon failure, enduring functional obsolescence of the meters for several future rate periods. While this alternative appears to minimize immediate capital outlay, it poses significant challenges to Hydro Ottawa's system integrity, grid modernization objectives, and long-term efficiency. Replacing meters solely upon failure increases the risk of billing estimations and reactive operational costs, while hindering grid observability objectives. This approach also eliminates cost savings associated with purchasing meters in bulk, prevents a competitive procurement process, and presents significant technical risk to success due to a need to integrate with obsolete technology. This alternative poses risks to regulatory compliance, operational efficiency, system reliability, and effective grid modernization. The metering element upgrade programs driven by Measurement Canada Policy E-24 are included in this alternative.

- AMI 2.0 deployment replacement upon unit failure
- 2.5 Element to 3.0 Element Upgrade - 50 units upgraded per year
- 1.0 Element to 1.5 Element Upgrade - $50k per year

Alternative 2 - Phased Metering Renewal:

This alternative takes a customer-centric approach to meter renewal by upgrading Hydro Ottawa's metering infrastructure over two rate periods (10 years). While the entire metering fleet would not be replaced within this timeframe, and some meters may reach their typical useful life, this phased implementation prioritizes overall meter TUL for replacement. This strategy allows for the progressive introduction of advanced metering technologies and grid observability. By spreading the investment, Hydro Ottawa seeks to mitigate the immediate impact on customer rates and prevent the cyclical major investment patterns caused by mandated smart metering initiatives.

There is no proposed change to the element upgrade programs driven by Measurement Canada Policy E-24 in this alternative.

- AMI 2.0 deployment at a moderate pace to reduce the ratepayer burden through a 10-year implementation plan (161,000 Meters by 2030)
- 2.5 Element to 3.0 Element Upgrade - 50 units upgraded per year
- 1.0 Element to 1.5 Element Upgrade - $50k per year

Alternative 3 - Aggressive Metering Renewal:

This alternative proposes an accelerated renewal of Hydro Ottawa's metering infrastructure, with the replacement of all meters occurring within a single rate period (5 years). This approach offers the benefit of a rapid transition to advanced metering technologies, potentially maximizing the speed of realizing associated grid modernization benefits. However, it also presents significant challenges, particularly concerning cost impacts on ratepayers and the creation of a cyclical investment pattern.

There is no proposed change to the element upgrade programs driven by Measurement Canada Policy E-24 in this alternative.

- AMI 2.0 deployment at an aggressive pace based on a 5-year implementation plan (366,000 Meters by 2030)
- 2.5 Element to 3.0 Element Upgrade - 50 units upgraded per year
- 1.0 Element to 1.5 Element Upgrade - $50k per year

Table 23 - Comparison of Metering Renewal Alternatives

Alternative	Age Demographics Impact Asset Condition Impact Reliability Risk Reduction	Outcome/Customer Impact
Run to Failure	Deterioration	Low investment level. Functional obsolescence. Increased risk of meter failures leading to billing estimations. negatively impacting customer trust. Higher operational costs, increased reactive maintenance. Delays in outage restoration and issue resolution due to reduced system observability. Limited ability to offer customers new services or programs that rely on advanced metering data.
Phased Metering Renewal	Moderate Improvement	Moderate investment level. Phased replacement. Mitigate failure risk of aging metering assets and ensure continued quality of service to customers. Progressive realization of benefits from advanced metering technologies. Balances affordability and system modernization.
Aggressive Metering Renewal	High Improvement (Complete Replacement)	High investment level, near-term rate impacts on customers. Ability to mitigate failure risk of most metering assets and enable realization of advanced metering benefits. Risk of creating future cyclical investment needs.

5.6.2. Evaluation Criteria

Compliance

Hydro Ottawa prioritizes compliance with all applicable regulatory requirements and industry standards governing metering. The selected alternative must ensure adherence to the Electricity and Gas Inspection Act, the Weights and Measures Act (Measurement Canada), and the IESO Market Rules, while also meeting OEB requirements for accurate billing and data provision.

Safety

Hydro Ottawa places the safety of its employees and the public at the forefront of its decision-making process. The selected alternative must maintain or improve the safety of Hydro Ottawa's employees and the public.

Reliability and Observability

The selected alternative shall reduce the risk posed by aging metering assets and mitigate the impact of in field failure. The preferred alternative shall promote the grid modernization strategy through improved grid observability.

Cyber Security

Data security and privacy are paramount concerns. The selected solution shall adhere to the highest industry standards for cyber security, including encryption protocols, secure authentication, and vulnerability management, to protect customer data and safeguard the grid from potential cyber threats.

Resources

The chosen alternative shall optimize resource utilization across the project lifecycle. It shall demonstrate efficient deployment strategies, streamline integration with existing systems, and minimize the need for manual interventions and troubleshooting. Additionally, the solution shall reduce the number of reactive metering projects.

Financial

The preferred alternative shall reduce emergency or reactive renewal costs through the execution of planned metering asset renewal work, while ensuring customer affordability.

Environmental

The solution shall aim to minimize its environmental footprint throughout its lifecycle. This includes considering the energy efficiency of the meters and communication devices, the use of recyclable shipping materials, and responsible disposal of replaced equipment. The solution shall also reduce the impact of unnecessary maintenance field activity, reducing Hydro Ottawa's carbon footprint.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

5.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 5.6.1 under the evaluation criteria of Section 5.6.2.

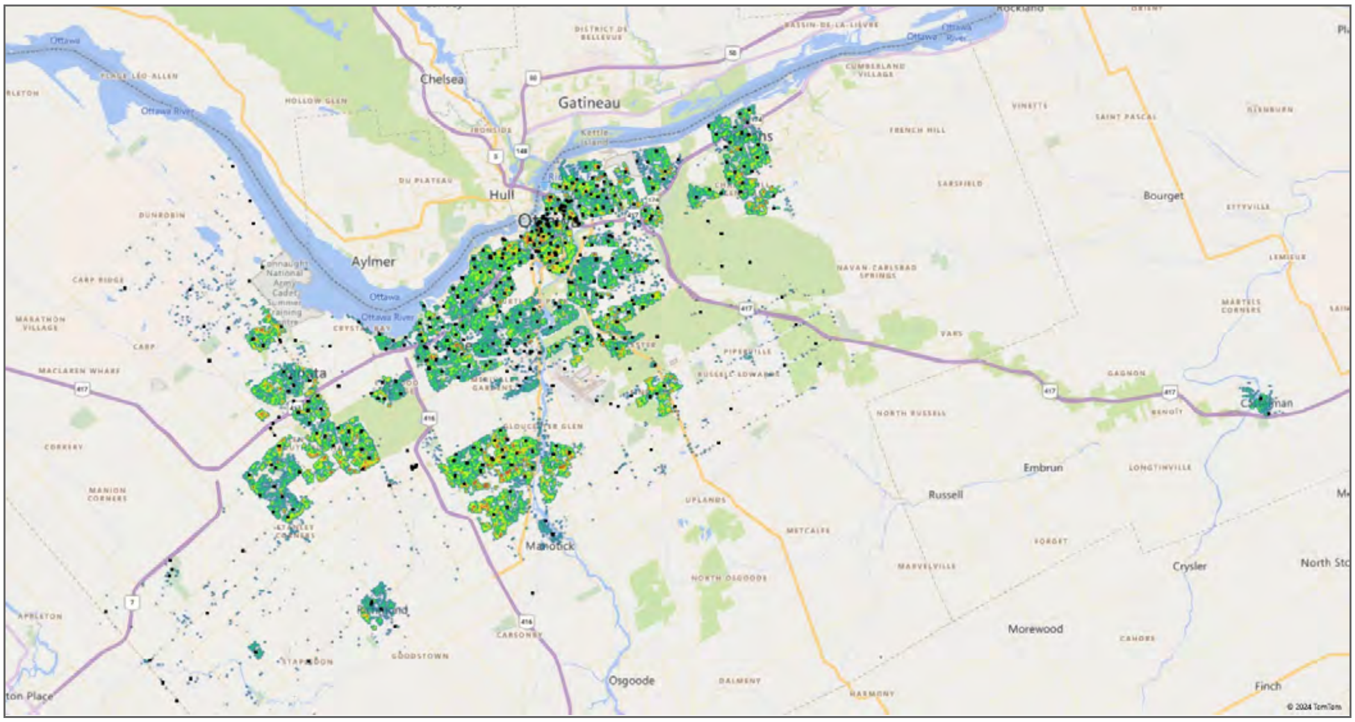
The recommended approach, Alternative 2, addresses Hydro Ottawa's aging metering fleet through a phased renewal of metering infrastructure, balancing the need for replacement with customer affordability and preventing future cyclical investment patterns. This approach creates a pathway for the progressive deployment of advanced metering technologies, empowering enhanced grid management and improved customer services. By strategically addressing aging infrastructure and investing in new capabilities, Hydro Ottawa can optimize its metering operations and better serve its customers.

This strategy also positions Hydro Ottawa to respond to grid modernization requirements, such as integrating new technologies and adapting to the evolving energy landscape. Ultimately, this investment translates to a more affordable, reliable, and efficient metering system, supporting enhanced grid functionality and enabling new opportunities for customer engagement and energy management.

5.7. PROGRAM EXECUTION AND RISK MITIGATION

5.7.1. Implementation Plan

Figure 75 - Existing Hydro Ottawa Metering Fleet Locations



Based on the preferred alternative 2, the AMI 2.0 Metering Renewal Project will be implemented through a phased, 10-year deployment to manage costs effectively. Meter replacement prioritization will be based on a multi-faceted approach, considering factors such as:

- **Meter Age:** Meters exceeding or approaching their useful life**.**
- **Meter Seal Date:** Meters approaching or exceeding their Measurement Canada-approved lifespans will be prioritized for replacement to ensure regulatory compliance instead of resealing.

- **Geographical Location:** Areas experiencing frequent outages, voltage fluctuations, or other reliability issues.
- **Critical Infrastructure:** Meters serving critical infrastructure or essential services may be prioritized to maintain uninterrupted power supply.
- **Grid Modernization Initiatives:** Areas with planned or ongoing DER integration or distribution automation projects will be considered for early deployment to leverage AMI 2.0 capabilities.
- **Customer Density:** Regions with high customer density or anticipated load growth will be targeted to ensure grid capacity and support future energy needs.

The phased AMI 2.0 deployment will be optimized for maximum benefit, balancing modernization with cost and minimizing customer disruption. Hydro Ottawa will use a strategic, data-driven prioritization approach combined with efficient implementation. This includes leveraging internal expertise for project management and commissioning supplemented by external partnerships for installation and system integration. To maximize efficiency and minimize disruptions, meter replacements will be prioritized and coordinated, including bundling work geographically to reduce truck rolls and customer interruptions. Resource allocation, progress tracking, delay management and costs, will be monitored using key performance indicators, with regular reporting to stakeholders and a post-implementation review to identify improvements.

5.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Meter Renewal Program. Table 24 outlines the key risks and corresponding mitigation strategies.

1 **Table 24 - Key Risks of Metering Renewal Program and Mitigation Strategies**

Category	Risk	Mitigation
Systems Integration	Issues with integration with existing IT and OT infrastructure, including legacy systems poses a risk to program delivery schedule, scope, and cost.	Implement thorough planning and testing to mitigate compatibility issues and data migration challenges
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather	Create and where required implement contingency plans to account for

Category	Risk	Mitigation
	events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

6. CORRECTIVE RENEWAL

6.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $82.6M

2026-2030: $66.9M

Budget Programs: Critical Renewal, Emergency Renewal, Damage to Plant

Main Driver: Failure

Secondary Driver: Failure Risk

Outcomes: Operational Effectiveness and Customer Focus

The Corrective Renewal Program consists of three Budget Programs: Emergency Renewal, Critical Renewal, and Damage to Plant. The Emergency Renewal Program includes replacement of assets that have failed and must be replaced immediately. The Critical Asset Replacement Program involves replacement of assets that have degraded to a point of functional failure, and pose an imminent failure risk, but are able to be repaired or replaced in a planned fashion. The Damage to Plant Budget Program also falls under the Corrective Renewal Program to cover the unplanned replacement of damaged assets caused by a third party.

Hydro Ottawa's distribution system consists of a variety of asset classes. The corrective renewal program categorizes work into emergency and critical within the following asset types: Overhead Switches, Underground Switches, Overhead Transformers, Underground Transformers, Polymer Cable, Paper Insulated Lead Cable (PILC), Overhead Primary Conductor and Insulators, Underground Secondary Service, Overhead Secondary Service, Underground Civil, Poles, Station Transformer, Station Switchgear, Station DC System, and Station P&C.

The asset classes above are covered by one of Hydro Ottawa's Renewal Programs (refer to Stations, Overhead and Underground System Renewal sections) with exception to the Overhead and Underground Secondary Services which are "run to failure".

This Corrective Renewal Program addresses the needs under the following Budget Programs over the 2026-2030 period:

Emergency Renewal: This budget program is related to immediately replacing assets that have failed and resulted in an outage or have been found to pose a definite and immediate safety or environmental risk. Some of the criteria to qualify under Emergency Renewal for the various asset classes is shown in Table 25.

1 **Table 25 - Emergency Renewal Criteria**

Asset Class	Emergency Renewal Criteria (Immediate Risk)
Station Transformers	Internal fault
	Bushing failure
	Tank rupture (loss of oil)
	Major issue found during maintenance
	Health index of 0%
Station Switchgear	Damaged beyond repair
	Inoperable
	Extreme corona discharge
	Time/travel tests above operable limits
	Health index of 0%
Station Batteries	Battery charger failure
	Multiple battery cells fail testing
	Leaking batteries
Station P&C Equipment	Relay failed
	Power supply failed
	Software error
	Input/Output board failed
Poles	Pole on the ground
	Detached pole (non-securable)
	Detached or Broken cross arm
	Health index of 0%
	Corroded conductor
OH Switches	Damaged Beyond Repair
	Inoperable
	Extreme Corona Detected
	Health index of 0%
OH Transformers	Damaged beyond repair
	Leaking oil
	Overheating (identified through IR scan)
	Popped pressure indicator
	Health index of 0%
UG Transformers	Damaged beyond repair
	Inoperable

Asset Class	Emergency Renewal Criteria (Immediate Risk)
	Exposure of live components to public
	Significant loss of oil
	Health index of 0%
UG Switchgear	Damaged beyond repair
	Inoperable
	Exposure of live components to public
	Extreme corona detected
	Health index of 0%
UG Cables (PILC)	Cracked Pothead
	Dielectric Breakdown (Fault)
UG Cables - Cross Linked Polyethylene (XLPE/TRXLPE)	Unacceptable Cable Testing Value
	Failed Hi-Pot Test
	Dielectric Breakdown (Fault)
UG Cables - Ethylene Propylene Rubber (EPR)	Dielectric Breakdown (Fault)
	Failed Hi-Pot Test
Vault Transformers	Damaged beyond repair
	Significant loss of oil
	Extreme corona detected
	Failed IR scan (overheating)
	Operated (popped) pressure flag
UG Civil Structures	Collapsed member (wall, roof, collar)
	Crack / gap permitting access to energized component
	Health index of 0%

Critical Renewal: This budget program is related to replacing assets that have functionally failed, requiring urgent intervention in the short-term. Some of the criteria to qualify under Critical Renewal for the various asset classes is shown in Table 26.

Table 26 - Critical Renewal Criteria

Asset Class	Critical Renewal Criteria (Imminent Risk)
Station Transformers	Tap-changer failure
	Heavy gassing
	Overheated bushing (found with IR scan)
	High furan level
	Significant issues found in testing
	Insufficient health index (very poor / < 30%)
Station Switchgear	Dielectric breakdown
	Irreplaceable component
	Loss of pressure (vacuum or SF6)
	Contact resistance test failed
	Insufficient health index (very poor / < 30%)
Station Batteries	Battery charger overheating
	Single cell fails testing
	Irreplaceable component fails
Station P&C Equipment	SCADA communications failed
Poles	Rotten butt
	Detached pole (engineered securable)
	Excessive lean (> 15 degrees)
	Insufficient health index (very poor / < 30%) including damage from woodpeckers
	Cracked insulator
OH Switches	Loss of Dielectric / Dielectric Breakdown
	Irreplaceable Component(s)
	Insufficient health index (very poor / < 30%)
OH Transformers	Cracked / broken bushing
	Insufficient health index (very poor / < 30%)
UG Transformers	Minor oil leak cannot be repaired
	Irreplaceable component
	Insufficient health index (very poor / < 30%)
UG Switchgear	Dielectric breakdown / loss of dielectric

Asset Class	Critical Renewal Criteria (Imminent Risk)
	Irreplaceable component
	Insufficient health index (very poor / < 30%)
UG Cables (PILC)	Leaking Splice
	Swollen / Flat Sleeve
	Leaking Pothead
	Multiple Failures (Faults) in Same segment (AM Decision)
UG Cables (XLPE/TRXLPE)	Overheating
	Multiple Failures (Faults) in Same segment (AM Decision)
	Corroded Concentric Neutral
UG Cables (EPR)	Overheating
	Multiple Failures (Faults) in Same Length (AM Decision)
	Corroded Concentric Neutral
Vault Transformers	Cracked bushing
	Minor oil leak cannot be repaired
	Irreplaceable component
UG Civil Structures	Imminent collapse
	Sunken base impeding access/affecting asset management objectives
	Insufficient health index (very poor / < 30%)

Damage to Plant: This budget program is related to replacing assets that have failed due to damage caused by third parties. The damage must be severe enough to cause the asset to functionally fail. In some cases, the party responsible for the damage is unknown.

6.2. PERFORMANCE OUTCOMES

The objective of the Corrective Renewal program is to reactively repair, refurbish, or replace assets in critical or emergency condition. Since this program involves employing immediate or near-term action, the proposed budget must be sufficient to cover all Emergency and Critical replacements that occur throughout the year. Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. With the implementation of the corrective renewal program, improvements are expected in the outcomes shown in Table 27 below due to the replacement of assets that pose an immediate/imminent risk.

Table 27 - Corrective Renewal Program Performance Outcomes

OEB Performance Outcome	Target
Operational Effectiveness	Contributes to the improvement of reliability metrics (SAIDI and SAIFI) by reducing the percentage of distribution assets in poor and very poor condition and/or operating beyond their typical useful life (varies by asset type), posing an immediate/imminent risk
	● Contributes to Hydro Ottawa's Environmental metrics by reducing the Environmental risk measured by the number of oil leaking distribution equipment per year ● Contributes to Hydro Ottawa's Environmental metrics by reducing the Environmental risk measured by the number of gas leaking distribution switchgear per year
Customer Focus	Contributes to Customer Satisfaction by maintaining system reliability

6.3. PROGRAM DRIVERS AND NEED

6.3.1. Main and Secondary Drivers

Primary Driver: Failure. The primary driver for corrective renewal is that the replacement of assets under Emergency Renewal is crucial as the assets are in a failed state.

Secondary Driver: Failure Risk. The secondary driver for corrective renewal is that the replacement of assets replaced under Critical Renewal is crucial as the assets are in a state of high failure risk.

6.3.2. Current Issues

The following sub-sections summarize some of the challenges highlighting the need for the underlying budget programs.

6.3.3. Critical and Emergency Renewal

Asset age and condition primarily impact the overall health and largely result in failures. End-of-life and deteriorated assets (those in Poor/Very Poor condition) dictate the need for emergency/critical replacements. Hydro Ottawa requires a corrective renewal program outside of the planned renewal program as there is a need to replace/manage electrical assets which pose an immediate or imminent risk to Hydro Ottawa's asset management objectives. Such equipment (in Poor/Very Poor condition) are identified through yearly inspections by completing a comprehensive asset condition assessment, to be managed in the short term.

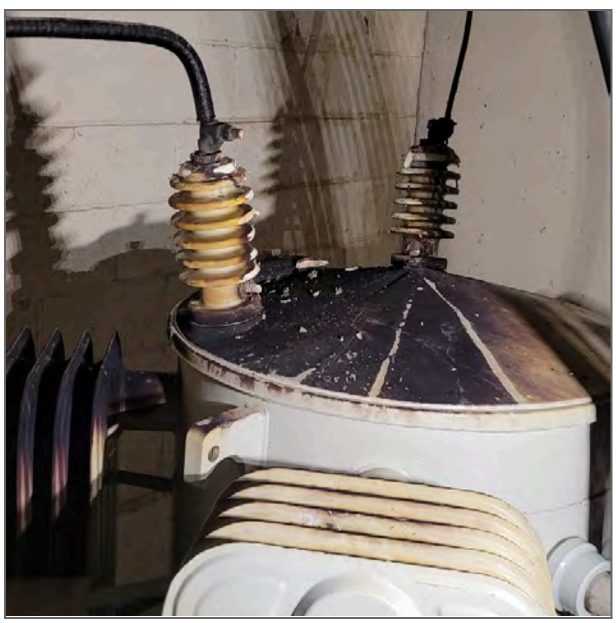
Table 28 shows the existing proportion of distribution assets in a deteriorated condition, requiring some form of intervention in the short term. In line with the proportion of assets in a bad condition, Hydro Ottawa has faced issues with metalclad station switchgear (air and SF_6), OH distribution apparatus (primarily poles), UG cables (XLPE), leaking UG transformers, air type switchgear and vault equipment.

Table 28 - Overview of Distribution Assets in a Deteriorated Condition[8]

Distribution Asset Category	Number of Assets in Poor/Very Poor Condition	Proportion
Stations	164	13%
Overhead	7,385	12%
Underground	2,222	3%
Overall	9,771	6%

Electrical asset failures on Hydro Ottawa's distribution system result in reliability risks, which further cause outages and impact customers. There are other key considerations such as environmental impacts (due to oil/SF_6 leaks) and safety risks due to arc flash conditions/fires. The timely replacement of such failed equipment is crucial to ensure that the system is not left in an abnormal state. Figure 76 shows the example of a vault transformer failure event.

Figure 76 - Vault Transformer Failure



[8] As of December 2023.

The Emergency renewal budget is also used to support the reactive emergency replacement of meters. Some of the issues resulting in the emergency replacement of meters (inclusive of smart meters, suite meters, interval and primary meters) include blown instrument transformer fuses, communication loss, functional defects etc. Being unable to replace failed meters can lead to inaccurate/delayed customer billing.

Hydro Ottawa experiences impacts and degradation to its distribution asset infrastructure due to various factors such as foreign interference, equipment failure and weather (e.g. major storms). Hydro Ottawa's service territory has been impacted by adverse weather events in recent years as described in Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Hydro Ottawa faced increased spending under the Emergency Renewal budget program, due to the Derecho storm event. Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report is the report published by Hydro Ottawa around the scale of damages and the asset replacements required, as a result of the 2022 Derecho event.

Hydro Ottawa's deteriorating OH asset population has also been negatively affected by extreme weather. Some assets, such as wood poles, haven't completely failed due to adverse weather, but certain components (e.g. pole top, OH switchgear, OH conductor etc.) are degrading faster than expected, which could result in power outages if not proactively managed, as outlined in Section 3.3.3 - Poles and OH Distribution Transformers. To this end, Hydro Ottawa has proposed additional investments to leverage drones to capture more accurate condition information on OH distribution assets as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs, so they can be managed proactively.

6.3.4. Damage to Plant

Electrical distribution assets owned by Hydro Ottawa that are damaged due to third parties are replaced immediately after the area is made safe, under the Damage to Plant budget program. Historically, this has been due to motor vehicle accidents or construction equipment.

Figure 77 shows a damaged pole due to a vehicular accident (foreign interference).

Figure 77 - Pole Damaged Due to Motor Vehicle Accident

6.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the corrective renewal program are summarized in the section below.

6.4.1. System Operation Efficiency and Cost Effectiveness

Reactively attending to assets in need of Emergency Renewal eliminates the damaging effect of failed assets in the system. The distribution system is then able to operate properly when newer, better rated, or more suitable assets are installed in a way which increases the efficiency of the system. It is more cost effective to repair emergency assets immediately to avoid increasing the risk, danger, and cost due to leaving assets in a failed state.

6.4.2. Customer

Replacing failed equipment restores system back-up capability, or enables power restoration directly affecting customer reliability. When an asset is replaced, system enhancement is often considered which benefits both system reliability and reduces customer disruption.

6.4.3. Safety

Acting upon failed assets ultimately facilitates safety with regards to the system, employees, and the public. Eliminating safety risks associated with failed assets also improves reliability metrics and Key Performance Indicators (KPIs).

6.4.4. Economic Development

Maintaining a reliable and stable power supply encourages industries to begin, creates more job opportunities, and more taxes to the Government overall.

6.4.5. Environment

The environment is benefitted by replacing failed assets which could otherwise cause an environmental impact (due to oil/SF_6 gas leaks).

6.5. PROGRAM COSTS

Table 29 shows the detailed historical and future spending by the underlying budget programs, as a part of Corrective Renewal. The budget allocated for Corrective Renewal projects in the 2026-2030 period is based on historical expenditures, normalized for the impact of the 2022 Derecho storm. As such, the forecasted expenditures for the 2026-2030 period are lower than the expenditures in the current 2021-2025 period.

Table 29 - Corrective Renewal Historical, Bridge and Future Spending Overview ($000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Critical Renewal	$ 4.1	$ 3.5	$ 3.2	$ 4.6	$ 4.7	$ 4.0	$ 4.1	$ 4.3	$ 4.5	$ 4.6
Emergency Renewal	$ 8.6	$ 21.9	$ 8.5	$ 9.2	$ 9.3	$ 7.5	$ 7.6	$ 8.0	$ 8.2	$ 8.4
Damage to Plant	$ 0.6	$ 1.1	$ 1.0	$ 1.1	$ 1.2	$ 1.0	$ 1.1	$ 1.1	$ 1.2	$ 1.2
ANNUAL TOTAL	**$ 13.3**	**$ 26.5**	**$ 12.7**	**$ 14.9**	**$ 15.2**	**$ 12.5**	**$ 12.8**	**$ 13.4**	**$ 13.9**	**$ 14.2**
5-YEAR TOTAL					**$ 82.6**					**$ 66.9**

6.5.1. Critical Renewal

The Critical Renewal program's spending will slightly increase from $20.1M in 2021-2025 to $21.5M in 2026-2030, to mainly account for inflation. Hydro Ottawa's asset renewal strategy is not to replace all aged or deteriorated assets. Rather, it aims to mitigate and manage asset failure risks by strategically replacing deteriorating infrastructure. To this end, Hydro Ottawa has largely maintained the critical renewal spending observed through 2021-2025. Hydro Ottawa aims to ensure asset performance through increased spending in planned renewal programs (while considering rate impact to customers) and more focused spending in OM&A.   .

6.5.2. Emergency Renewal

The Emergency Renewal program's spending will decrease from $57.5M in 2021-2025 to $39.7M in 2026-2030. Unforeseen impacts like high material cost increases and material delays due to COVID-19 and major storms affected the 2021-2025 actuals, which have not been considered in the 2026-2030 budget. However, there is still a high failure risk associated with the deteriorating asset infrastructure combined with specific issues around certain asset types such as leaking UG transformers, UG switchgear, station equipment etc.

6.5.3. Damage to Plant

The Damage to Plant program's spending will slightly increase from $5M in 2021-2025 to $ 5.6M in 2026-2030. Hydro Ottawa must maintain the proposed spending in this program to address damage to its asset infrastructure caused by third parties.

6.5.4. Cost Factors

Additional cost factors that need to be considered are potential physical barriers that cause access issues, or unforeseen circumstances such as aged equipment failing while the work is being done. Cost may also be altered if the area of work overlaps with a separate planned capital project. The occurrence of high impact low frequency events such as the 2022 Derecho storm will impose a huge burden and impact on Hydro Ottawa's electrical infrastructure.

6.6. ALTERNATIVES EVALUATION

6.6.1. Alternatives Considered

There are two alternatives considered for this program:

Alternative 1: Do Nothing

"Do nothing" is not feasible because the asset has already failed and the operation of the distribution system is dependent on the functionality of the asset. As a result this option reflects no allocated budget for Emergency or Critical Renewal projects. At the point of asset failure, immediate work would still need to be done to repair, refurbish, or replace the failed asset. This would impact the overall spending and timing of Hydro Ottawa's planned capital projects. Option 1 results in several consequences: resources may be limited due to unplanned replacements, capital projects would need to be deferred in order to accommodate unexpected spending on assets in need of Emergency or Critical Renewal. This ongoing deferral of planned work would be ineffective and in-efficient.

Alternative 2: Allocate Budget Based on Historical Spending and Planned Renewal Program Needs ($ 66.9M - Preferred Alternative)

This option allocates the budget where future yearly spending has been determined from historical average spending, for the major part, except for poles and UG transformers. The critical renewal budget considers the replacement of 75 poles each year and 10 UG transformers, while the emergency renewal budget accounts for the replacement of 25 poles and 40 UG transformers. This approach allocates resources to address deteriorated/failed assets without deferring planned work, supporting overall more efficient program delivery. The Emergency Renewal budgeting doesn't account for once in 50 years storms such as the 2022 Derecho event.

6.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. The preferred alternative must mitigate any risks to Hydro Ottawa's employees and public safety.

Reliability

The increased potential of failure or actual failure of distribution assets will impact Hydro Ottawa's ability to deliver reliable power. The selected alternative shall help manage asset performance by mitigating the risk of failure of assets in a critical condition and promptly responding to unanticipated failures.

Financial

The selected alternative should manage short-term financial needs, manage long-term asset performance, and prevent significant service disruptions to customers due to deteriorating or failed distribution equipment.

Resources

Resources are reserved in order to act reactively towards failed assets in need of emergency replacement. The future reliability of the system, safety of employees and the public, the environment, and the utility's economics are considered when using internal or external resources. The alternative which is a prudent use of resources will be selected.

6.6.3. Preferred Alternative

Alternative 2, the preferred alternative, allocates the Corrective Renewal budget based on historical spending, with the exception of poles and UG transformers. This strategy ensures that all critical deteriorated or failed distribution assets are covered by either the Emergency or Critical budget. As a result, this alternative effectively addresses failed assets that have caused outages or other risks that could harm the system if not promptly replaced. By having a budget allocated for unplanned failures, Hydro Ottawa will be able to maintain asset performance. With resources available through this reserved budget, Hydro Ottawa can react quickly to address failed assets, ensuring system reliability and the safety of both employees and the public.

6.7. PROGRAM EXECUTION AND RISK MITIGATIONS

6.7.1. Implementation Plan

The first step of implementation is determining whether the asset belongs in the Corrective Renewal Program. If the asset has functionally failed and falls into one of the categories, then the project is classified as either in the Emergency Renewal Program or the Critical Renewal Program. If the project falls into the Emergency Asset Replacement category, action must be taken as soon as possible. At this stage, a decision is made towards repairing, refurbishing, or replacing the failed asset. Factors such as the age, maintenance history, new standards, and immediate availability of spare parts are used to make the decision. The method of replacement is evaluated for opportunities to increase system efficiency. This may involve replacing assets in proximity in conjunction, coordinating this project with another project covering the same assets, accommodating future growth and demand, and possibly decommissioning the asset.

6.7.2. Risks to Completion and Mitigation Strategies

Hydro Ottawa faces several risks in managing its corrective renewal program, Table 30 outlines the key risks and corresponding mitigation strategies:

Table 30 - Key Risks of the Corrective Renewal Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

SYSTEM SERVICE INVESTMENTS

1. SUMMARY

Hydro Ottawa's planned System Service net capital investments for 2026-2030 total $469.1M, focusing on six key programs designed to increase capacity of the distribution system to meet forecasted demand, improve system reliability and resilience, and increase grid modernization in the distribution system.

System Service Capital Programs:

Section 2. Capacity Upgrades ($342.6M - CAPEX, $13.3M - OM&A, $10.0M - Costs included in Other Income and Deductions):

The capacity upgrades program addresses system capacity needs through station capacity, distribution capacity and non-wire capacity upgrades. Station capacity upgrades, designed to meet forecasted demand, focus on expanding existing Hydro Ottawa substations or building new ones. To fully utilize the increased capacity provided by the station projects, the distribution capacity upgrades program will enhance the electrical distribution network through feeder expansion and upgrades. The Non-Wires Capacity Upgrade program is a new initiative which aims to improve grid capacity and reliability by implementing alternatives to traditional infrastructure upgrades, such as utility owned battery energy storage solutions and Non-Wires Customer Solutions.

Section 3. Distribution Enhancements ($92.8M):

The Distribution Enhancement program modernizes the grid and addresses climate change risks through four key programs: Reliability, Enhancements, Resilience and Observability. The Reliability program improves efficiency and reliability through feeder reconfiguration and phase balancing. The Enhancements program supports DER integration through infrastructure upgrades and pilot projects, leveraging federal funding for innovation. The Resilience program strengthens weather resilience with strategic undergrounding, storm hardening, and line relocation, aligning with the OEB's VASH initiative. The Observability program enhances grid management through real-time data, remote switching, and advanced technologies like the Advanced Distribution Management System (ADMS), improving reliability and flexibility.

Section 4. Station Enhancements ($3.0M):

This program will improve distribution system observability and operability through cyber security investments and station modifications, including enhanced monitoring. Specifically, online transformer monitoring will proactively identify faults, improving asset observability and reliability by reducing unexpected failures. Addressing vulnerabilities, the program will also deploy OT Cyber Security sensors at all IP connected substations to bolster cyber security at vulnerable substations, improving threat detection and response to prevent disruptions and maintain reliable power delivery.

Section 5. Grid Technologies ($6.4M):

This program modernizes grid management by enhancing observability and controllability through data acquisition, monitoring, and control capabilities. Focusing on ADMS, it enhances grid troubleshooting and asset monitoring, supporting data-driven decisions for preventative and predictive maintenance, and integrating with other systems. Driven by system efficiency, it addresses integration complexities, optimizes data handling, enhances reliability and security, and improves performance through a unified platform, seamless data exchange, and simplified maintenance. This upgrade reduces single points of failure, strengthens cyber security, and enables advanced analytics for better grid management.

Section 6. Field Area Network ($20.8M):

The Field Area Network (FAN) program is essential for Hydro Ottawa's digital and grid modernization, providing the communication backbone for grid devices and central systems.

Four key initiatives—OTN Fiber Network Resilience, Wireless Communication (PLTE pilot), Intelligent Electronic Device Management, and OTN Cyber Security—enhance reliability, security, and efficiency. Driven by system efficiency, the FAN enables real-time data access for grid modernization and DER integration, strengthens cyber security, and improves outage response by providing grid visibility and control.

Section 7. Control and Optimization ($3.6M):

This program focuses on Distributed Energy Resources Management Systems (DERMS) implementation to manage the growing complexity of DERs, improving grid stability, reliability, efficiency, and resilience. This program aims to improve operational effectiveness by increasing DER visibility and control, accommodating higher DER penetration, and improving grid efficiency. It also supports customer focus by facilitating DER adoption and improving grid flexibility, and public policy responsiveness by enabling electrification. These upgrades and enhancements support grid flexibility, enabling more efficient use of existing grid capacity.

These investments are designed to address critical challenges, including evolving capacity requirements, the integration of advanced grid technologies and distributed energy resources, and the enhancement of grid resilience against the increasing frequency and severity of weather-related disruptions. Hydro Ottawa is committed to providing safe, reliable, and sustainable electricity service to the residents and businesses of Ottawa, and these investments are crucial to fulfilling that commitment.

These investments will deliver tangible benefits to Hydro Ottawa's customers:

- **Support for Growing Demand:** Increased grid capacity to accommodate the growing electricity needs of residential and commercial customers.
- **Facilitation of Renewable Energy Integration:** Enhanced grid infrastructure to support the integration of distributed energy resources, enabling customers to participate in a cleaner energy future.
- **Enhanced Grid Observability and Control:** Advanced technologies and monitoring systems will allow for more proactive management of the grid, leading to faster response times during outages and improved overall system performance.
- **Increased Resilience to Climate Change:** Investments in grid hardening and resilience measures will better protect customers from the impacts of extreme weather events.
- **More Efficient and Secure Grid:** Upgraded technologies and cyber security measures will ensure a more efficient and secure electricity supply.

Hydro Ottawa recognizes the complex undertaking involved in executing these System Service investments, encompassing the modernization of deteriorating infrastructure to bolster reliability, the fortification of the network against increasing climate volatility, and the strategic deployment of advanced technologies to optimize grid performance. This document details how these investments will address these challenges to deliver safe, reliable, and sustainable electricity service to the Ottawa community.

2. CAPACITY UPGRADE

2.1. PROGRAM SUMMARY

Investment Category: System Service

Program Costs:

2021-2025: $108.2M

2026-2030: $342.6 Net Capex, $13.3M (OM&A) $10.0M (Costs included in Other Income and Deductions)

Budget Program: Station Capacity Upgrades, Distribution Capacity Upgrades, Non-Wire Upgrades

Main Driver: Capacity Constraint

Secondary Driver: Reliability

Outcomes: Customer Focus, Operation Effectiveness, Public Policy Responsiveness

The Capacity Upgrade program allocates spending to address the need for increased capacity resulting from growth and electrification to keep pace with the electricity demand in the growing community. The program encompasses projects that utilize existing capacity through infrastructure enhancements and system reconfiguration, as well as the addition of new stations. Additionally, Non-Wire Upgrades are utilized for peak load management in capacity-constrained areas, thereby supporting grid reliability and the integration of renewable energy resources. System capacity needs and required upgrades are determined through the System Capacity Assessment as outlined in Section 9 of Schedule 2-5-4 - Asset Management Process and Integrated Regional Resource Planning, as detailed in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

The Capacity Upgrade Program addresses capacity needs of the system under the following budget programs over the 2026-2030 period:

Station Capacity Upgrade

This program focuses on increasing capacity at existing Hydro Ottawa stations or building new stations to address immediate needs in areas with committed load requirements and capacity constraints. These investments are also strategically aligned with long-term needs for system accessibility and reliable power supply to ensure efficient capital deployment. They include planned enhancements to adapt the grid for increased demand driven by electrification. For more details refer to Section 9 of Schedule 2-5-4 - Asset Management Process.

As a result of the committed loads and existing capacity constraints, Hydro Ottawa plans to energize four new stations and upgrade three existing stations. This involves upgrading transformers, switchgear, and other substation equipment. The new and upgraded stations proposed in the 2026-2030 period are:

- **Riverdale TS:** continued from previous rate period with energization in 2027
- **Piperville MTS:** continued from previous rate period with energization in 2026
- **Mer Bleue MTS:** continued from previous rate period with energization in 2028
- **Kanata North MTS:** new station to support the West 28 kV (North) System with energization in 2028
- **Greenbank MTS:** new station to support the South 28 kV and Nepean and Barrhaven 8 kV Systems with energization in 2028
- **Cyrville MTS upgrade:** station upgrade to support the East 28 kV System with energization in 2028
- **Bronson DS upgrade:** voltage conversion from 4 kV to 13 kV to support the Core and West 13 kV Systems with energization planned beyond this rate period

In addition to upgrades to Hydro Ottawa stations and assets, upgrades to Hydro One Networks Inc. (Hydro One) equipment in stations jointly owned by Hydro One and Hydro Ottawa will help increase capacity in the distribution system primarily in Downtown Ottawa and suburban regions where growth is driven by intensification, transit development and large infrastructure projects such as the new Ottawa Hospital campus. Investments in jointly owned stations in the 2026-2030 period will be proposed under the Connection Cost Recovery Agreement program as per Section 7 of Schedule 2-5-9 - General Plant Investments, these investments are:

- Secondary cable upgrades at Carling TS, Lisgar TS and King Edward TS
- Transformer upgrades at Russell TS, Albion TS and South March TS

Distribution Capacity Upgrade

Distribution capacity upgrades are required to enhance the capacity of the electrical distribution system. This includes upgrading or installing new power lines, distribution transformers, and other distribution equipment. Distribution capacity upgrades are proposed to leverage the capacity from new and existing stations through feeder integration, reduce demand on existing feeders to below planning ratings; enable forecasted growth with reduced system expansion requirements for customers; and defer more expensive alternatives, such as new station builds.

The major investments proposed under this program includes:

- Feeder integration for all the new station builds to leverage capacity- Piperville MTS, Mer Bleue MTS, Kanata North MTS, Greenbank MTS and Cyrville MTS upgrade.
- The feeder integration will also support reduction of load on some of the highly loaded stations such as Kanata MTS, Marchwood MTS and Lietrim DS
- Introduction of 28kV in the capacity constrained Nepean 8kV system
- Enable 4kV conversions to 13kV in a phased manner for energization of the Bronson 13kV station in 2032

Non-Wires Capacity Upgrade

This program involves implementing alternative solutions to traditional infrastructure upgrades to increase capacity and improve grid reliability. These solutions include utility-owned battery energy storage systems (BESS) and Non-Wires Customer Solutions, as discussed in more detail in Section 9.2 of Schedule 2-5-4 - Asset Management Process.

- **Utility-Owned Battery Energy Storage Solutions (BESS)**
    - 2.5MW BESS in the West 28 kV system
    - 7MW BESS in the Bells Corners/Bayshore 8 kV system
    - 5MW BESS at Casselman DS
    - 10MW BESS in the Core 13 kV/West 13kV system

- **Non-Wires Customer Solutions:** Hydro Ottawa will offer a portfolio of energy efficiency, generation, and demand response programs that can also leverage customer DERs, to be deployed as its Non-Wires Customer Solutions Program to help address system needs in both the short and long term. These programs will be launched and operated in:
    - Kanata North region
    - West and Core 13kV region

In total, Hydro Ottawa plans to invest an estimated $342.6M in capacity upgrades in the 2026-2030 rate period compared to a historical spending of $108.2M in the 2021-2025 period. Hydro Ottawa expects to add over 577MVA[1] in station capacity to Hydro Ottawa's distribution system as a result of these projects, as compared to 160MVA over the previous period. This would allow Hydro Ottawa to manage capacity constraints and meet immediate needs of large load customers to maintain its service obligations as well as provide reliable power supply.

[1] Piperville MTS—120MVA, Mer Bleue MTS—120MVA, Kanata North MTS—120MVA, Greenbank MTS—120MVA, Cyrville MTS—70MVA, Beckwith BESS—2.8MVA, Casselman BESS—5.6MVA, Bells Corners/Bayshore BESS—7.8MVA, Core 13 kV BESS—11MVA

2.2. PERFORMANCE OUTCOMES

Table 1 outlines the expected performance outcomes associated with the system capacity upgrade programs. It details how these programs are expected to impact operational effectiveness, customer focus, and public policy responsiveness.

Table 1 - Performance Outcomes for Capacity Upgrade Program

OEB Performance Outcomes	Outcome Description
Customer Focus	Hydro Ottawa's Customer Focus objectives are supported by: ● Increasing system capacity by 577MVA through new station construction and upgrades and associated new distribution circuits, upgrades to limiting station cables, and BESS unit installations. ● Improving DER Hosting Capacity by installing substation transformers that have been designed to accommodate injection of renewable energy into the grid. ● Increasing system flexibility by investing in NWSs such as BESS and Non-Wires Customer Solutions.
Operational Effectiveness	Hydro Ottawa's Reliability objectives are supported by: ● Contributing to the improvement of reliability metrics by increasing capacity, especially in capacity-constrained regions that provide alternate supply options during N-1 contingencies and improve station load index.
Public Policy Responsiveness	Hydro Ottawa's Public Policy Responsiveness objectives by: ● Supporting government initiatives for sustainable energy solutions. ● Enabling electrification by investing in additional capacity and operational flexibility. ● Supporting the economic development of the community.

2.3. PROGRAM DRIVERS AND NEED

2.3.1. Main and Secondary Drivers

Primary Driver: Capacity constraints;

This program is structured to address Hydro Ottawa's most capacity-constrained areas. The program targets constraints at both the feeder and station level by:

1. Building new stations to add capacity and upgrading capacity at existing stations;

2. Extending existing or new feeders to:
    a. transfer load between stations, alleviating both feeder and station limitations,
    b. add new capacity into an area with committed growth, or
    c. add back-up capacity to allow additional growth on existing feeders;
3. Implementing NWSs to support peak load management through both utility-owned technologies and customer-owned resources.

Secondary Driver: Reliability;

Lack of sufficient capacity has a direct impact on system reliability. Maintaining feeders and stations at or below planning ratings reduces system constraints and provides additional options to System Operators when isolating outages and restoring load. Furthermore, lack of capacity in nominal conditions as well as contingency scenarios will have a negative impact on reliability.

2.3.2. Current Issues

2.3.2.1 Station Capacity Needs

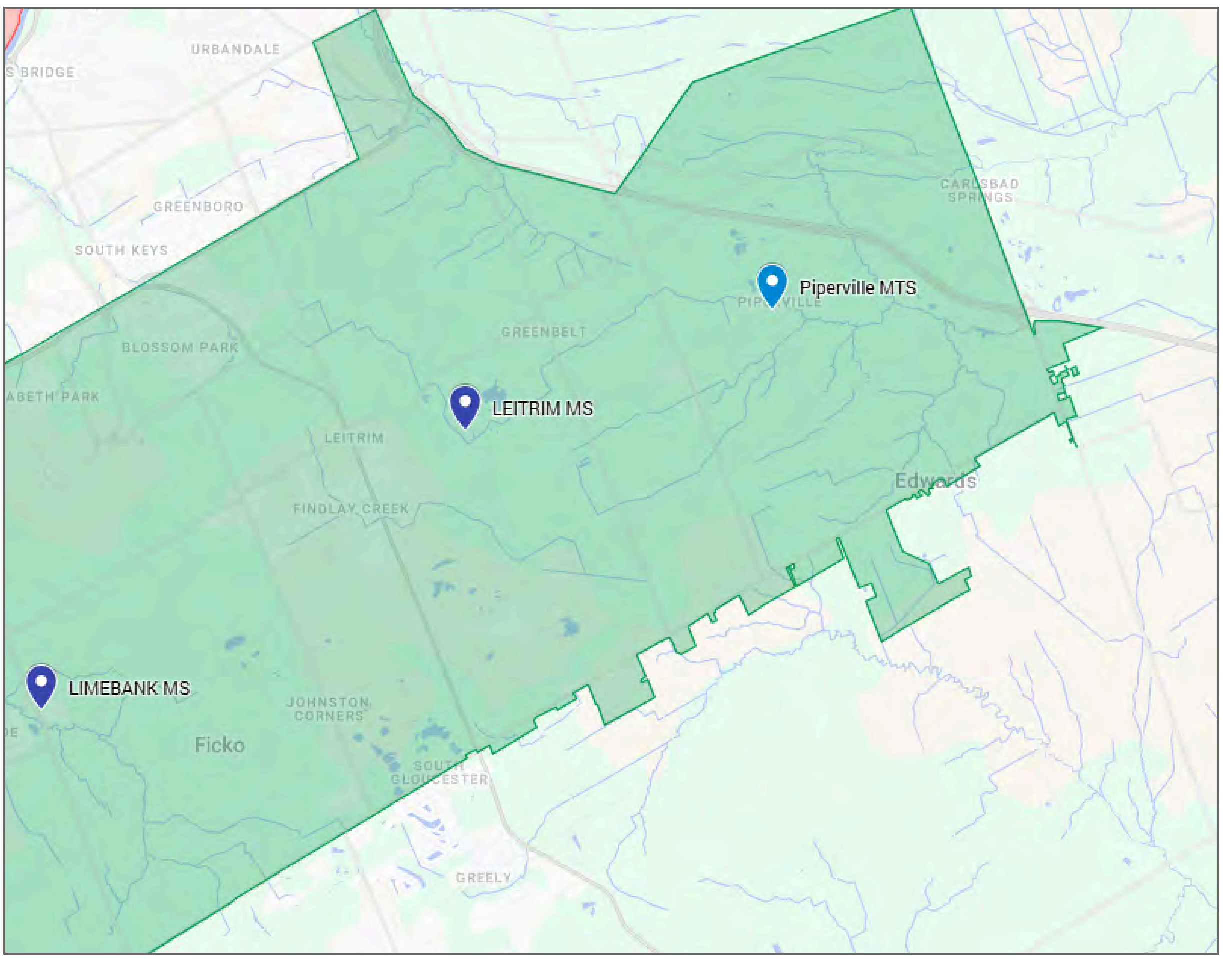
For identifying station capacity needs Hydro Ottawa prioritized investments in areas with existing capacity constraints and immediate, confirmed, and committed load requirements. Given the four- to six-year lead time required for station upgrades and even longer lead times for transmission upgrades, focus on the medium to long-term outlook beyond 2030 (informed through the IRRP forecast) was used to validate that capacity investments for immediate needs (informed through Hydro Ottawa's planning forecast) strategically align with indications of long-term needs, ensuring efficient capital deployment and optimizing asset utilization. Hydro Ottawa will continuously monitor the impact of electrification to minimize disruptions and ensure the ability to connect new customers.

The need and justification for each of Hydro Ottawa's station capacity upgrade investments are detailed below. It is important to note that all capacity upgrade investments align with the preliminary recommendations identified by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Piperville MTS

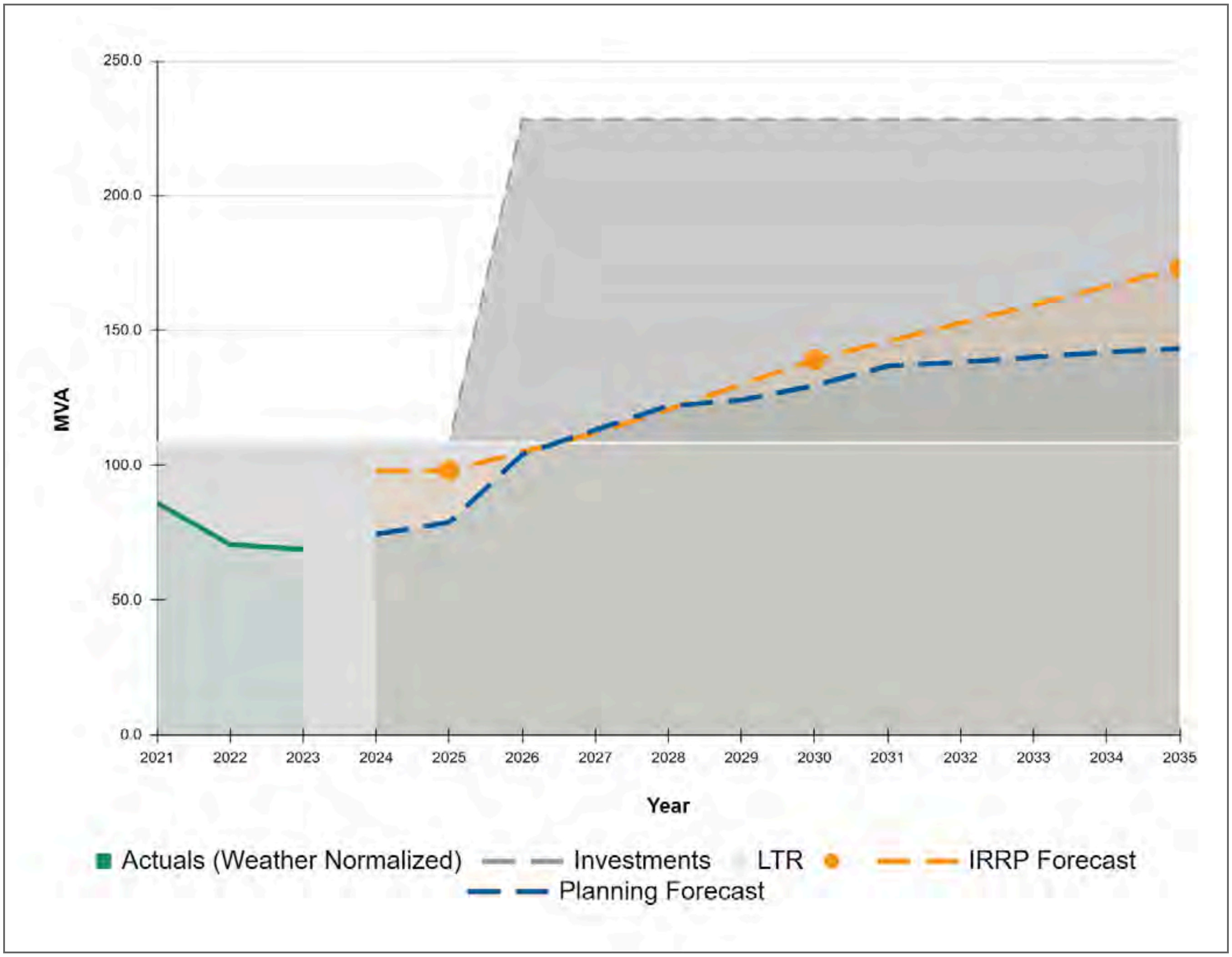
To accommodate the growing load forecast in the South-East region, shown in Figure 1 below, the new Piperville MTS is under construction, with planned energization in 2026. This project, approved as part of the 2021-2025 Rate Application, will be a 230 kV-connected station with two 100 MVA transformers and capacity for eight new feeders.

Figure 1 - South-East 28 kV Region with Under-Construction Piperville MTS



1 Figure 2 presents the load forecast against planned capacity, factoring the energization of Piperville MTS in 2026, which will increase the region's LTR to 230 MVA. The figure compares the IRRP Forecast and Planning Forecast of the region supported by Limebank MTS, Leitrim DS and Piperville MTS.

Figure 2 - South-East 28 kV Forecast



The issues that this new station helps address are elaborated below.

- Piperville MTS will alleviate capacity constraints by supporting Leitrim DS which is already operating above its planning capacity. It will also facilitate residential and commercial growth in this region.
- In addition to capacity needs, reliability in the Leitrim supply area is also of concern. The distribution feeders extending towards the eastern boundary of Hydro Ottawa's service territory cover a large area which was previously mostly rural with minimal load on these feeders. In recent years, this area has seen an uptake of new commercial and industrial customers driving further expansion of suburban development in former rural areas. The addition of these new loads decrease the tie transfer capacity of the system during contingency scenarios. Piperville MTS will support during contingency scenarios through inter-station ties.
- In addition, Leitrim DS is fed from a single 44 kV supply and must rely on adjacent stations to resupply in case of a loss of station supply. However, loads east of Leitrim DS cannot be fully restored with ties from Limebank MTS due to the distance between the loads and the station breakers. The lack of an alternate source, more local to the load pocket, leads to longer lasting outages. The new Piperville MTS will help mitigate these reliability issues.
- Piperville MTS, served by a 230kV transmission supply with redundant backup, exhibits superior reliability compared to Leitrim DS, which relies on a single 44 kV sub-transmission feed. This redundancy contributes to improved transmission-level reliability across the region.

As per the forecasted demand shown in Figure 2, construction of Piperville MTS will ease capacity constraints and improve reliability of the south east region of Ottawa.

Mer Bleue MTS

The proposed station is a 230 kV-connected 28 kV station with 100 MVA capacity and will supply up to eight new feeders in the East 28 kV region. The proposed location of the new station is shown in Figure 3. With the decommissioning of Bilberry TS, this new station will introduce a Hydro Ottawa owned 28 kV station in the eastern boundary of the 28 kV system.

Figure 3 - East 28 kV Region with under-construction Mer Bleue MTS

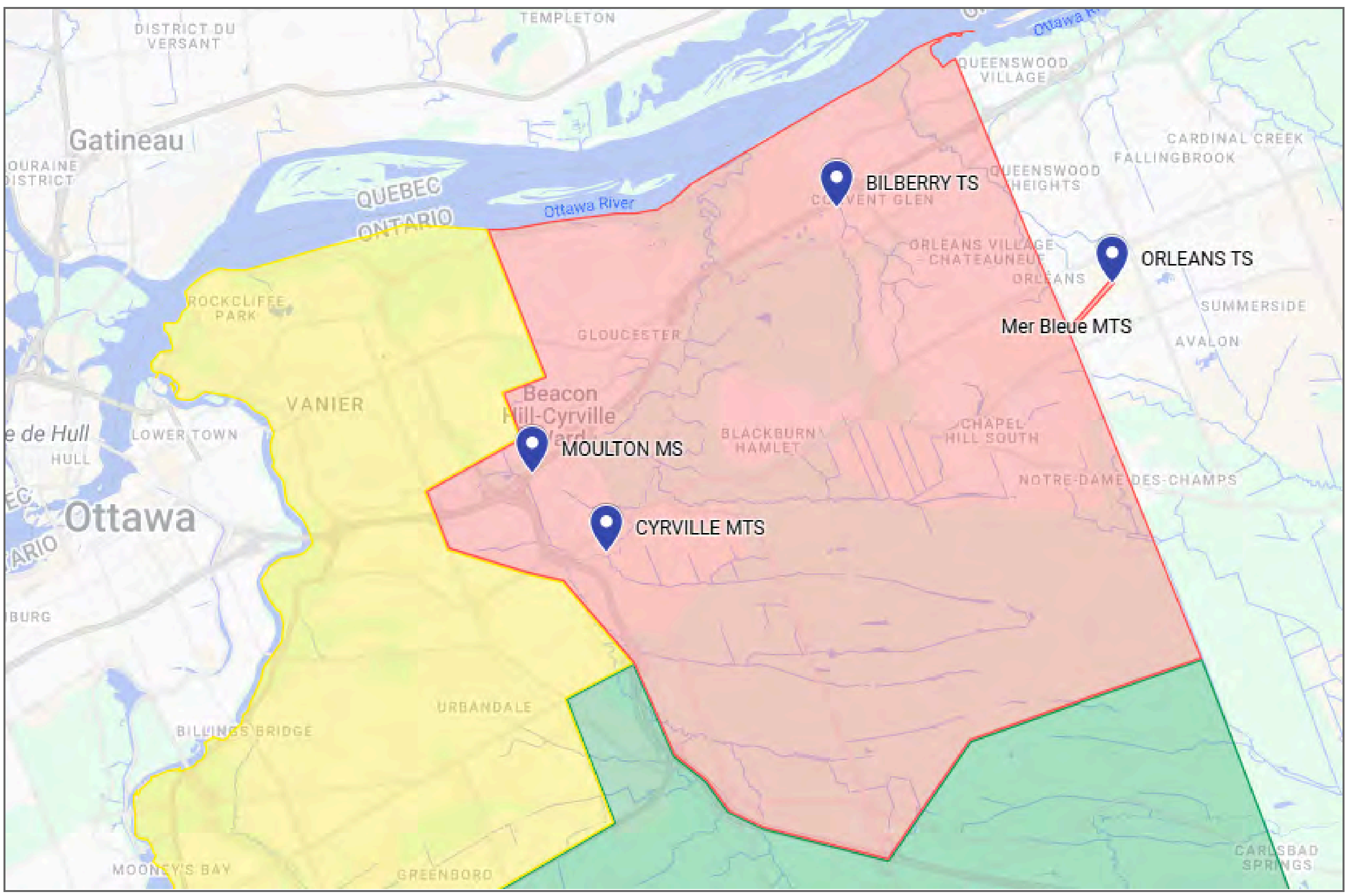
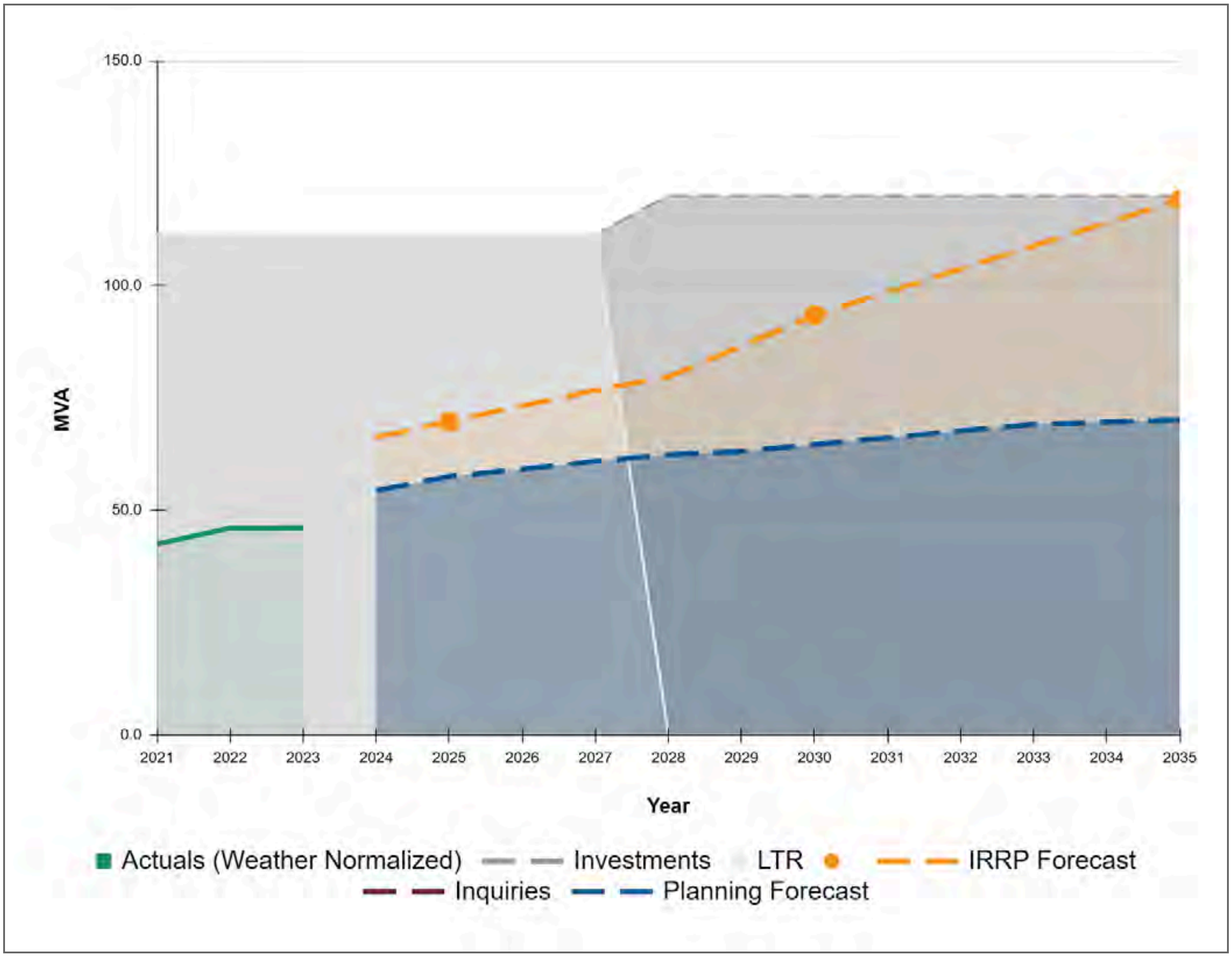


Figure 4 below presents the load forecast against planned capacity, factoring the energization of Mer Bleue MTS in 2028, which doesn't add additional capacity to the overall system (negligible addition due to Mer Bleue LTRs), due to the decommissioning of Bilberry TS, but transfers load from the constrained 115 kV to the 230 kV transmission system. The figure compares the IRRP Forecast, Planning Forecast for Bilberry TS, Orleans TS and Mer Bleue MTS.

Figure 4 - East 28 kV Forecast (Eastern region)



The issues to be resolved by this new station, namely the end of life Bilberry TS and 115 kV capacity constraints, are elaborated below.

- The previous cycle of the regional planning process led by IESO and the regional infrastructure plan report led by Hydro One in 2022 identified the need to refurbish the Bilberry TS which supplied by the 115 kV transmission system and approaching its end-of-life and to expand the station to accommodate two additional breaker positions to supply Hydro Ottawa customers.
  - This solution was based on the 2018/2019 forecast that did not include impacts due to the more recent large load requests such as the Ottawa Hospital's New Campus[2], OC Transpo's Zero Emission Buses[3], Department of National Defence Dwyer Hill Training Center Upgrade[4], new laboratory facilities for the Regulatory and Security Science Main Project[5], located at the existing Canadian Food Inspection Agency's Ottawa Laboratory, and the TerraCanada National Capital Area project located at the National Research Council of Canada facilities[6].
  - The inclusion of these load requests on top of the updated forecast led to the determination that the regional 115 kV system is constrained. All stations in the Ottawa Downtown and some suburban stations are supplied by the 115 kV system. To ease the capacity constraints on the 115 kV system, and avoid expensive transmission upgrades to introduce 230 kV into Downtown Ottawa, it was imperative that some suburban stations be transferred to a 230 kV supply.
  - The 115 kV constraints led the IRRP working group to re-evaluate the proposed Bilberry TS refurbishment along with other alternatives to meet both the end-of-life needs at

[2] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/

[3] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/news/article/oc-explained-zero-emission-bus-project/

[4] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/

[5] Government of Canada, "Government of Canada invests in laboratories to support science in Canada." https://www.canada.ca/en/public-services-procurement/news/2024/03/

[6] Government of Canada,"Government of Canada announces milestones for new science facilities in National Capital Area" https://www.canada.ca/en/public-services-procurement/news/2024/07/government-of-canada-announces-milestones-for-new-science-facilities-in-national-capital-area.html

Bilberry Creek TS as well as addressing broader supply capacity needs on the Ottawa 115 kV System.

Construction of the Mer Bleue MTS was found to be the most optimal solution. This would result in the decommissioning of the end of life 115 kV connected Bilberry TS and transfer the loads to the new 230 kV connected Mer Bleue MTS, thus aiding with offloading the constrained 115 kV system. More details in Section 4.2 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

New Kanata North MTS

The proposed station is a new 230 kV-connected 28 kV station with 100 MVA capacity and will supply up to eight new feeders to support the West 28 kV (North) system currently supplied by Kanata MTS and Marchwood MTS as shown in Figure 5.

Figure 5 - West 28 kV (North) Region with proposed Kanata North MTS

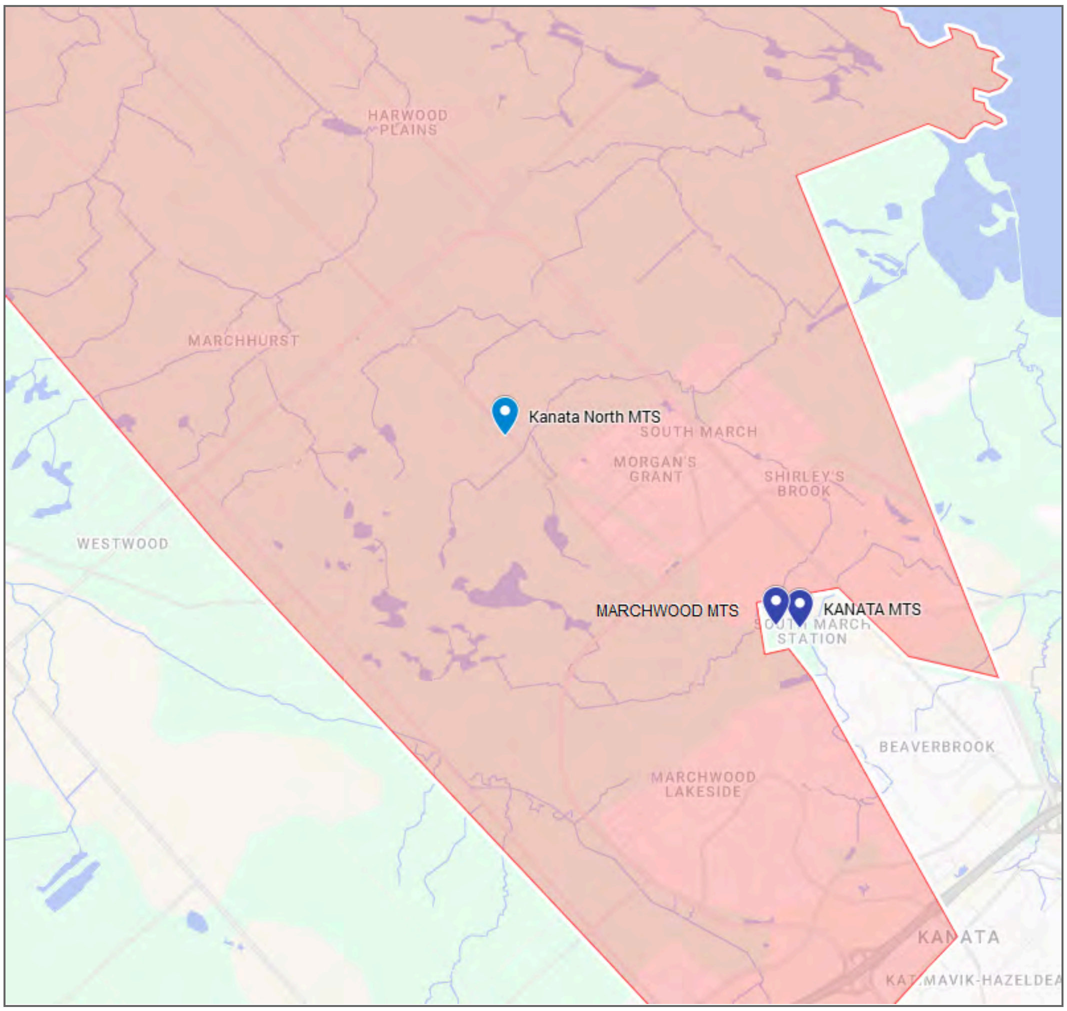


Figure 6 presents the load forecast against planned capacity (LTR), factoring the energization of Kanata North MTS in 2028, which will increase the region's capacity to 207 MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages in the West 28 kV (North) system.

Figure 6 - West 28 kV (North) Forecast with Kanata North MTS upgrade

The issues that this new station helps address are elaborated below.

- Rapid growth in Kanata North[7], particularly in the technology sector, has strained existing West 28 kV (North) stations, pushing them to their operational limits. Also, there has been a surge in large load requests in this region and data center connection inquiries.
- To facilitate the decommissioning of the end-of-life 12 kV stations and distribution infrastructure, this region will see added load due to voltage conversion from 12 kV to 28 kV.
- The new station will improve reliability by introducing new inter-station ties to balance load with Kanata MTS (currently operating at 95% of planning capacity) and Marchwood MTS (currently operating at 140% above planning capacity).

As per the forecasted demand shown in Figure 6, the need for a new station in this region is urgent and the proposed solution will ease capacity constraints and improve reliability of the West 28 kV (North) region.

Non-Wires Customer Solutions, as further detailed in Section 9.2 of Schedule 2-5-4 - Asset Management Process, are being evaluated to manage current peak capacity constraints while the new station is constructed and will continue to provide support to this region in the long term considering the IRRP forecast.

[7] Growth in Kanata North- https://ottawa.ca/en/city-hall/city-news/newsroom/kanata-north-shimmering-jewel-ottawas-business-crown

Greenbank MTS

The proposed station to be located in the Greenbank/Hunt Club area is a 230 kV-connected 28 kV station with 100 MVA capacity and will supply up to eight new feeders in support of introducing the 28 kV system in the Nepean and Barrhaven communities. Figure 7 shows the the location of the new Greenbank MTS, the Nepean 8 kV system (highlighted in green), the Barrhaven 8 kV system along with the 28 kV Fallowfield MTS and Longfield DS supply region (highlighted in yellow) and the 28 kV Cambrian supply area (highlighted in purple)

Figure 7 - South 28kV and Nepean 8kV Regions

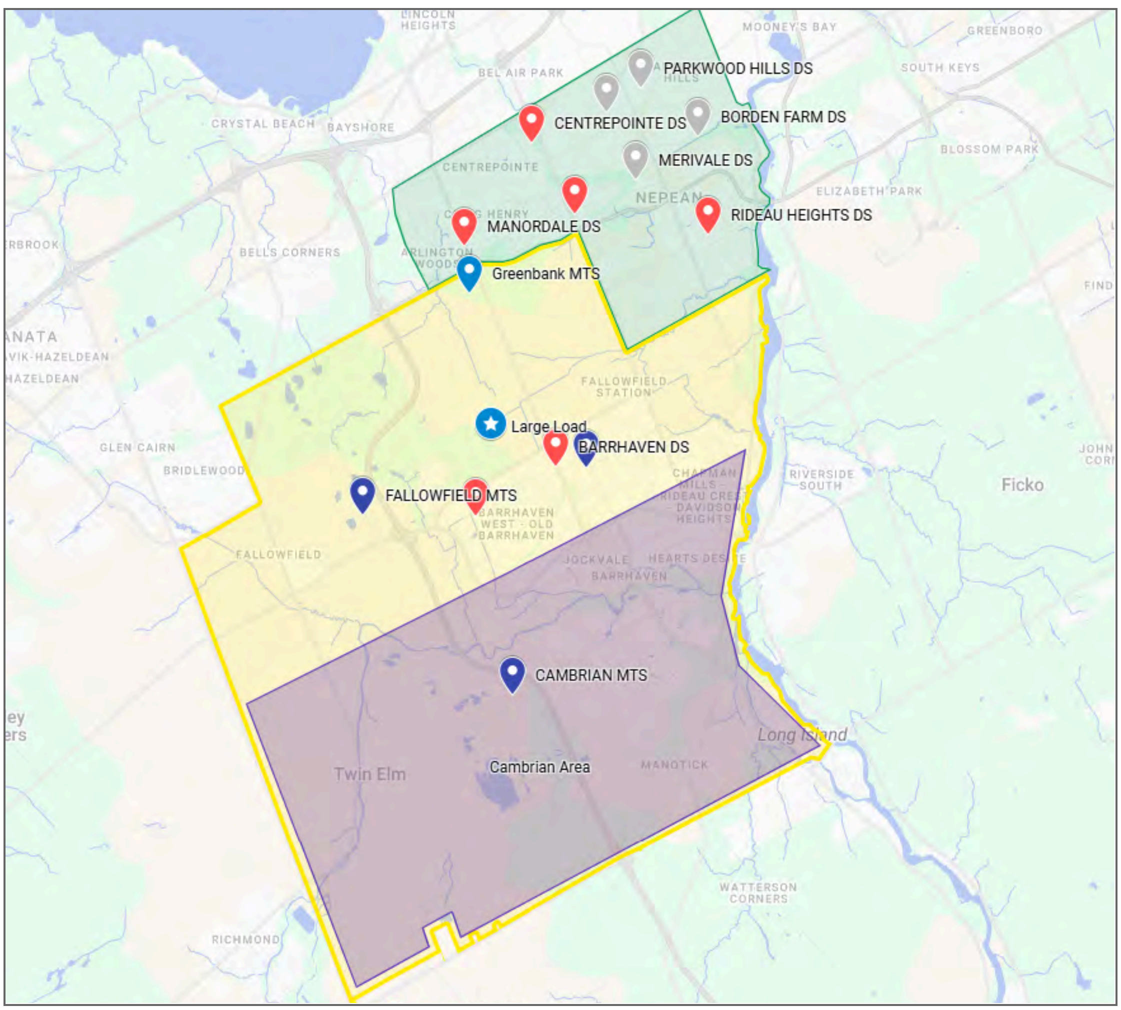
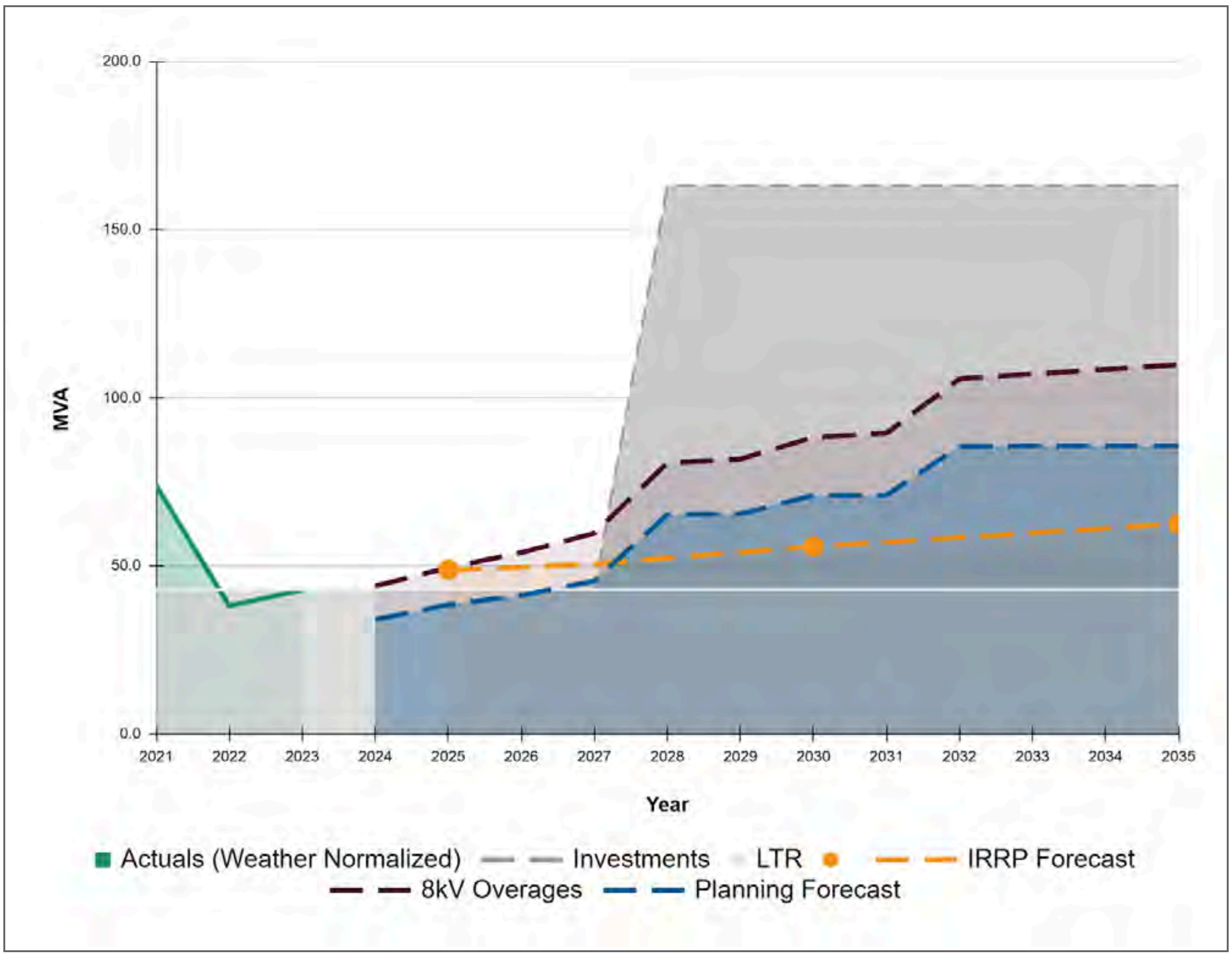


Figure 8 presents the load forecast against planned capacity, factoring the energization of Greenbank MTS in 2028, which will increase the region's LTR to 160MVA. The figure compares the IRRP Forecast, the 28 kV region Planning Forecast, and the new loads to be transferred from 8 kV overloaded stations, which represent the 28 kV Planning Forecast plus the additional capacity needed to address the overloaded 8 kV system.

Figure 8 - South 28 kV Forecast with Greenbank MTS upgrade



The current issues that the new Greenbank MTS will resolve are elaborated below:

8 kV System Limitations

- The Nepean and Barrhaven communities, as shown in Figure 7, are currently supplied by the Nepean and Barrhaven 8 kV systems. The 8 kV system presents several challenges:
  - Compared to 28 kV, 8 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 28 kV remains effective up to 15km.
  - The maximum capacity of an 8 kV feeder is 3.6MVA, versus 16.4MVA for a 28 kV feeder, significantly limiting the ability to accommodate the large load requests.
  - Heavy loading on the 8 kV stations in the Nepean and Barrhaven regions is hindering new customer connections. Seven out of the ten stations are operating above 85% of their planning capacity, with Manordale MTS and Centerpointe MTS exceeding their planning capacity.

28 kV System Limitations

- The region's 28 kV supply is strained, with Fallowfield MTS operating at 114% and Longfields DS operating at 80% of their planning capacity. This loading level limits the ability to connect new large load customers and offload the constrained 8 kV system.
- A committed large load[8], for the Regulatory and Security Science Main (RSS Main) Project's new laboratory facilities, cannot be serviced from Fallowfield MTS/Longfields DS (or the existing 8 kV system). While Cambrian MTS is the only other 28 kV station in the South 28 kV region, it cannot supply the new large load. In 2015, the IRRP identified Cambrian's necessity to address capacity deficiencies south of Strandherd Drive (highlighted in purple on Figure 7). Energized in 2022, Cambrian also enhances the reliability through feeder ties with Fallowfield MTS,

[8] Government of Canada, "Government of Canada invests in laboratories to support science in Canada." https://www.canada.ca/en/public-services-procurement/news/2024/03/

Longfields DS, and Limebank MTS. Connecting the new large load to Cambrian would create two problems:

- First, connecting the large load would require extensive feeder extensions due to the distance to site.
- Second, it would immediately necessitate the addition of a new station in South Nepean due to capacity limitations. Since this triggers the need for additional capacity, the proposed location of Greenbank MTS also provides the additional benefit of being locationally positioned to support the constrained 8 kV system and allowing Cambrian to supply further south.

Therefore, the optimal solution to address both the constrained Nepean and Barrhaven 8 kV systems and the new large load is the construction of Greenbank MTS. This station will alleviate capacity deficiencies and is strategically located to serve both the 8 kV system and the large load. As shown in Figure 7, including the 28 kV planning forecast and 8 kV overages, the addition of capacity enabled by Greenbank MTS is required to support the growth in the regions.

Cyrville MTS Upgrade

The proposed solution will upgrade the two existing Cyrville MTS transformers from 50MVA to 100MVA capacity. Figure 9 shows the East 28 kV system along with a committed large load request in this region.

Figure 9 - East 28kV Regions

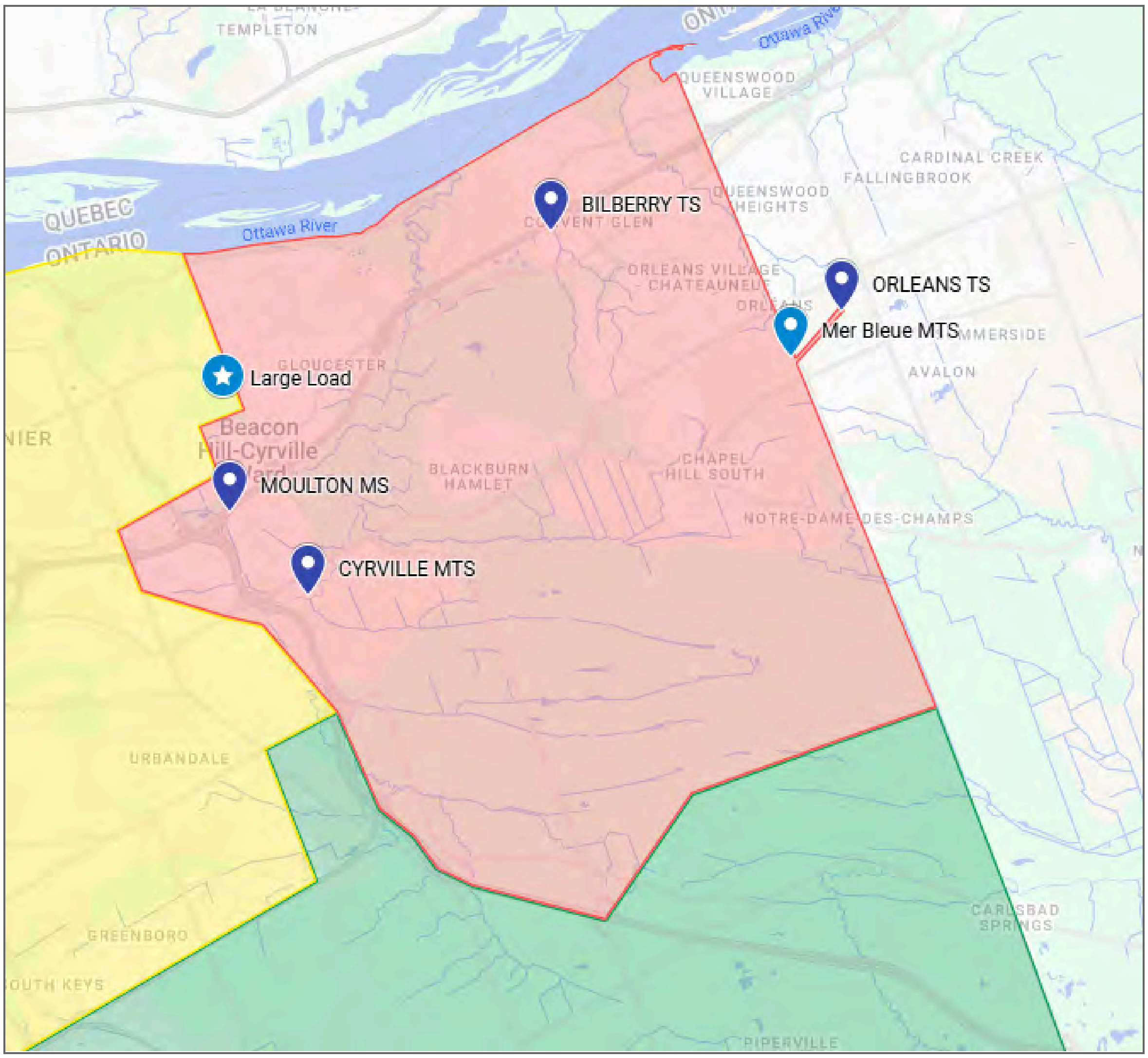
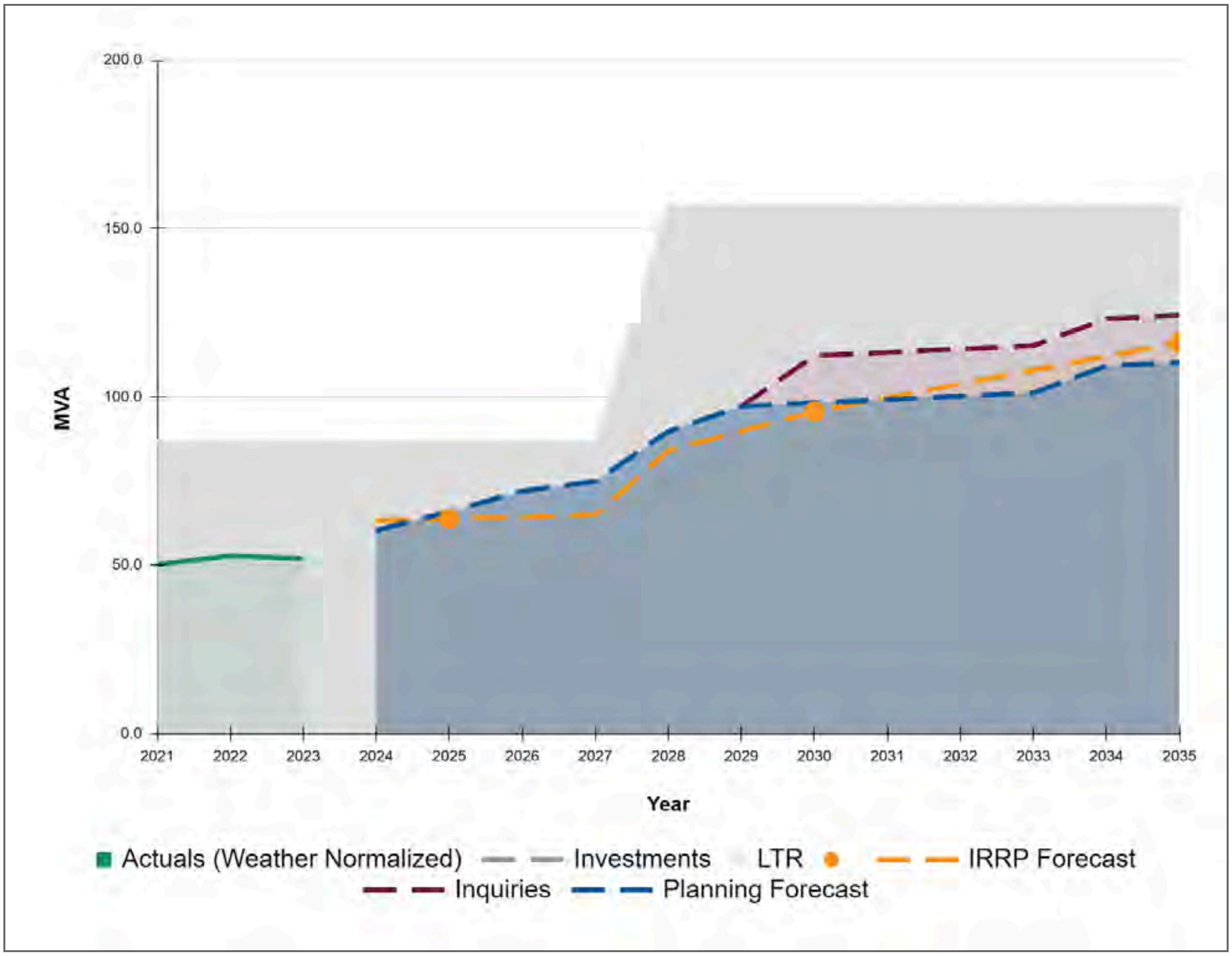


Figure 10 presents the load forecast against planned capacity, factoring the Cyrville MTS upgrade in 2028, which will increase the LTR in the region to 150 MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages for Cyrville MTS and Moulton MS.

Figure 10 - East 28 kV (Western region) Forecast with Cyrville MTS upgrade



The issues that the Cyrville MTS upgrade solution helps address are elaborated below.

- The upgrade of Cyrville MTS is primarily driven by the committed large load request for the TerraCanada National Capital Area project located at the National Research Council of Canada facilities[9] which is expected to be energized in 2028.
- Moulton MTS and Cyrville MTS were both evaluated as options to supply the load request, with Moulton MTS being preferred as it is located closest to the load site. After review, Cyrville MTS was deemed the preferred option due to the transmission line upgrade cost being approximately six times less than the Moulton upgrade option.
- The new Mer Bleue MTS was eliminated as a supply option due to the distance from the load site. This distance would require long costly distribution supply feeders and create the potential for voltage drop issues.
- As part of the transformer upgrade at Cyrville MTS it will be converted to a 230 kV supply. This means that not only will it support future demand growth but has the additional advantage of offloading the constrained 115 kV regional system. For more details, refer to Section 4.3.2 of Schedule 2-5-2 - Coordinated Planning with Third Parties
- Since the existing Cyrville MTS transformers have remaining useful life (manufactured in 2007), Hydro Ottawa plans to relocate them to Moulton MS to gain additional capacity at Moulton MS, which will increase LTR from 33MVA to 50MVA. Also, the two existing transformers at Moulton MS are fairly old (manufactured in 1987), one of them has failed and is set to be out of service for the foreseeable future.
- The proposed Cyrville upgrade will also improve reliability as it would allow for the creation of inter-station ties between Cyrville MTS, Moulton MTS and the new Mer Bleue MTS and better balance customer count and loading of the East 28 kV system.

[9] Government of Canada,"Government of Canada announces milestones for new science facilities in National Capital Area" https://www.canada.ca/en/public-services-procurement/news/2024/07/government-of-canada-announces-milestones-for-new-science-facilities-in-national-capital-area.html

- The East 13 kV system (region highlighted in yellow in Figure 9 above), situated in close vicinity to Cyrville MTS and Moulton MS, is projected to see increased demand in the next 5 years, creating capacity constraints on Overbrook TS. The additional capacity from Cyrville MTS will support new load growth which would have previously been connected to the 13 kV system.

Upgrading Cyrville MTS to cater to the committed large load in the region, support the offloading of the constrained 115 kV and manage demand growth as shown in the Figure 10 above is the most optimal solution.

Bronson DS Upgrade

The proposed solution entails conversion of the existing 4 kV Bronson DS to a 13 kV station with an incoming 115 kV transmission supply to support adjacent stations in the West and Core 13 kV regions. Figure 11 shows the existing 4 kV Bronson DS along with the adjacent 13 kV stations of Carling TM, Lisgar TL and Riverdale TR.

Figure 11 - Downtown 13.2 kV Stations surrounding Bronson DS

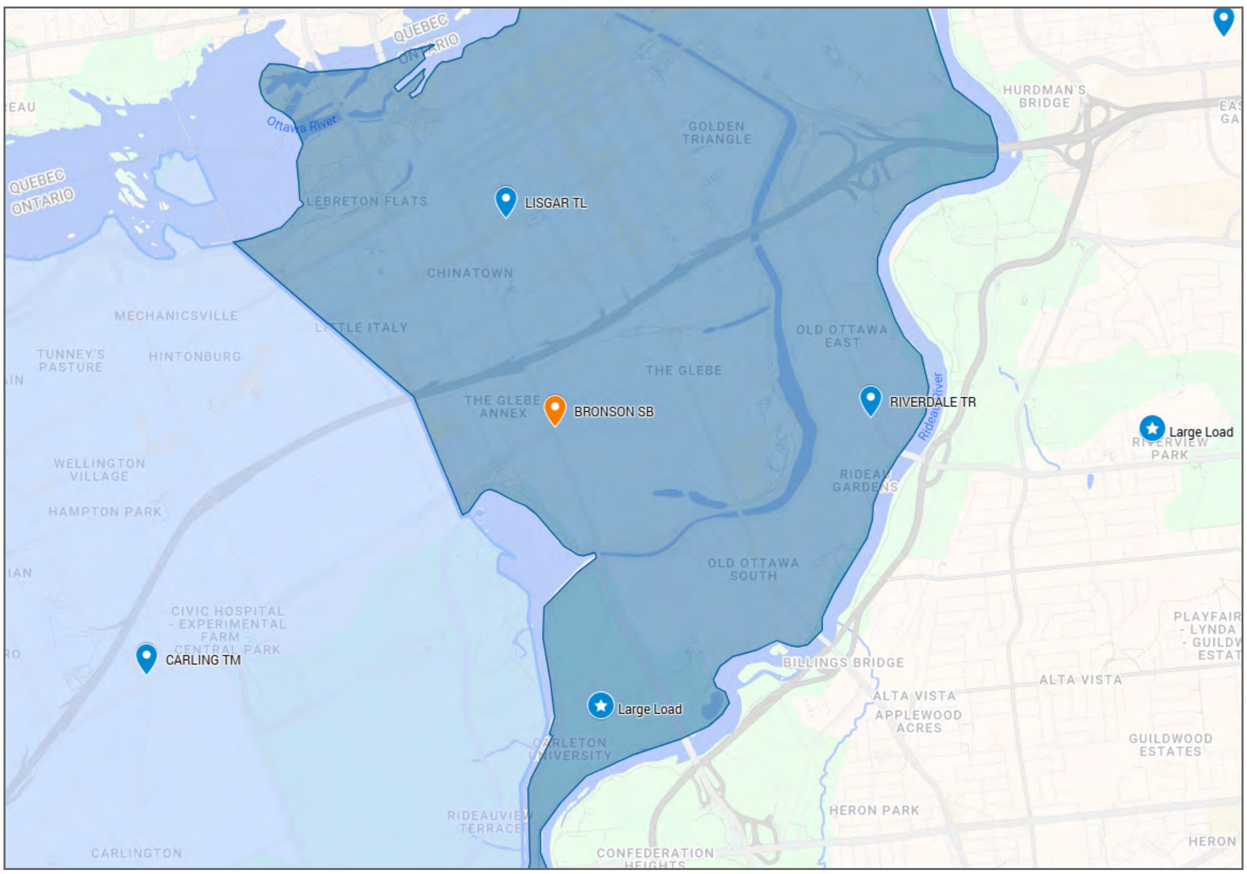
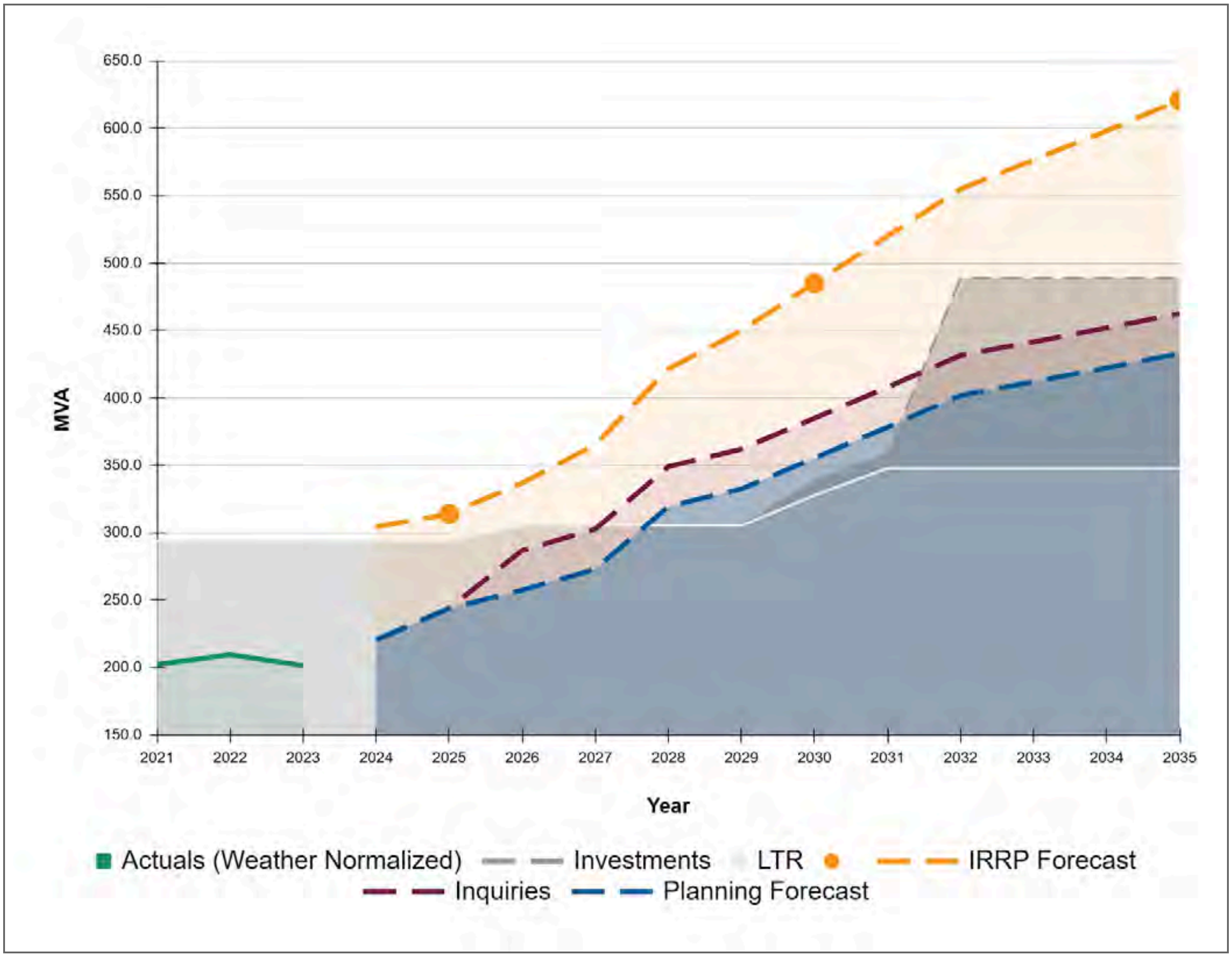


Figure 12, presents the load forecast against planned capacity (LTR), factoring two Hydro Ottawa capacity upgrade investments proposed; a NWSs (utility BESS) energizing in 2030, and the Bronson DS 13 kV upgrade, energizing in 2032 pushing the overall LTR to 500MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages.

Figure 12 - Combined Forecast of stations:
Carling TS, Lisgar TS, and Riverdale TS with Bronson DS Conversion and NWSs



The issues that the proposed capacity upgrade addresses are elaborated below.

- The Bronson upgrade aims to support the three nearby 13 kV stations through inter-station ties: Carling TS, Lisgar TS, and Riverdale TS, the combined planning forecast of which is anticipated to exceed their planning capacity by 2027 without intervention, even earlier if inquiries come to fruition.
- Addition of capacity to the 13 kV system through Bronson DS station upgrade to 13 kV will cater to the load growth in the downtown core due to intensification, transit-oriented development and committed large load customers such as universities and hospitals[10],
- The Bronson DS upgrade also supports strategic voltage conversion of the Bronson DS 4kV distribution system. This is in alignment with growing demand for intensification, transit-oriented development, EV charger-driven customer service size upgrades, which often necessitates transitioning from 4 kV to the more robust 13 kV system. This is due to the challenges presented by the 4 kV system:
    - Compared to 13 kV, 4 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 13 kV remains effective up to 10km.
    - The maximum capacity of a 4 kV feeder is 2.3MVA, versus 9.7MVA for 13 kV, significantly limiting the ability to accommodate the large load requests.
- Based on the above justification, upgrading the 4 kV Bronson DS station adds capacity to the constrained 13 kV system and is also strategically located to support the overloaded 13 kV stations. Capacity needs in the interim (until 2030) is fulfilled through NWSs (more details in Non-wire Program Needs below) until the Bronson 13 kV station is energized in 2032.

[10] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/

2.3.2.2. Distribution Capacity Needs

The planned investments under the Distribution Capacity Upgrades program for 2026-2030 address several issues: adding distribution capacity to leverage new station capacity; reducing demand on existing feeders to below planning ratings; enabling forecasted growth with reduced system expansion requirements for customers; and deferring more expensive alternatives, such as new station builds.

Without these investments, Hydro Ottawa's distribution system will not be able to leverage the new station capacity being built for the committed load requests and forecasted load growth, impacting system accessibility as well as failing to improve reliability of the existing system that would be achieved by offloading feeders running above planning rating. Section 9.1.4 of Schedule 2-5-4 - Asset Management Process outlines the system capacity needs by Planning Region.

The major investments proposed under this program include:

- **Feeder Integration for Piperville MTS:** This project aims to extend distribution feeders from Piperville MTS to connect new customers and establish inter-station ties with Leitrim station. Leitrim station is currently operating above its planning rating. This project will offload a portion of the Leitrim station load, helping to maintain reliability and create capacity for future growth in the community serviced by this station.
- **Feeder Integration for Mer Bleue MTS:** This project aims to extend distribution feeders from Mer Bleue MTS to connect new customers and offload Bilberry MTS, which will be decommissioned as it has reached the end of its useful life.
- **Feeder Integration for Kanata North MTS:** This project aims to extend distribution feeders from Kanata North MTS to connect new customers and create inter-station ties to Marchwood MTS and Kanata MTS. Both of these stations are currently operating above their planning rating. This project will offload a portion of the load on these stations, helping to maintain reliability and creating capacity for future growth in the communities serviced by these stations.

- **Feeder Integration for Greenbank MTS:** This project aims to extend distribution feeders from Greenbank MTS to enable introduction of 28 kV in the capacity-constrained 8 kV system in the Nepean region and connect a large load. This project will help to maintain reliability and address capacity constraints in the Nepean region.
- **Feeder Integration for Cyrville MTS Capacity Upgrade:** This project aims to extend distribution feeders from Cyrville MTS to connect new customers and create inter-station ties to adjacent stations to improve reliability.
- **Voltage Conversion for Bronson DS Upgrade:** This project enables the upgrade of Bronson DS from 4 kV to 13 kV through phased voltage conversions in the 4 kV distribution system to 13 kV to support growth in the downtown core.

2.3.2.3. Non-Wires Program Needs

Hydro Ottawa has identified NWSs as viable solutions to address a variety of challenges on the distribution system. This section describes the options and proposed solutions based on Hydro Ottawa's NWSs assessment process, for more details, see Section 9.2.1, Schedule 2-5-4 - Asset Management Process. Based on this assessment, Hydro Ottawa has proposed utility-owned battery energy storage systems (BESS) and Non-Wire Customer Solutions. Details of each solution and the issues they address are below.

West 28 kV (North)

There is no further feasible wire solution capable of addressing this region's needs prior to station energization. Due to the urgency of the capacity relief needed in the Kanata North region, Hydro Ottawa proposes to deploy Non-Wires Customer Solutions to acquire 10 to 15MW in the Kanata North region by 2030. It is important that Hydro Ottawa act quickly to engage, educate and encourage customers to participate in order to ensure the immediate system needs can be met in the near term.

More details on the justification for choosing this region is available in Section 2.3.2.1- Station Capacity Needs, Kanata North MTS.

West 28kV system

Hydro Ottawa owns one feeder (BECK-F2) supplied from Hydro One-owned Beckwith DS, in Goulbourn, as shown in Figure 13.

Figure 13 - West 28kV (Beckwith Region)

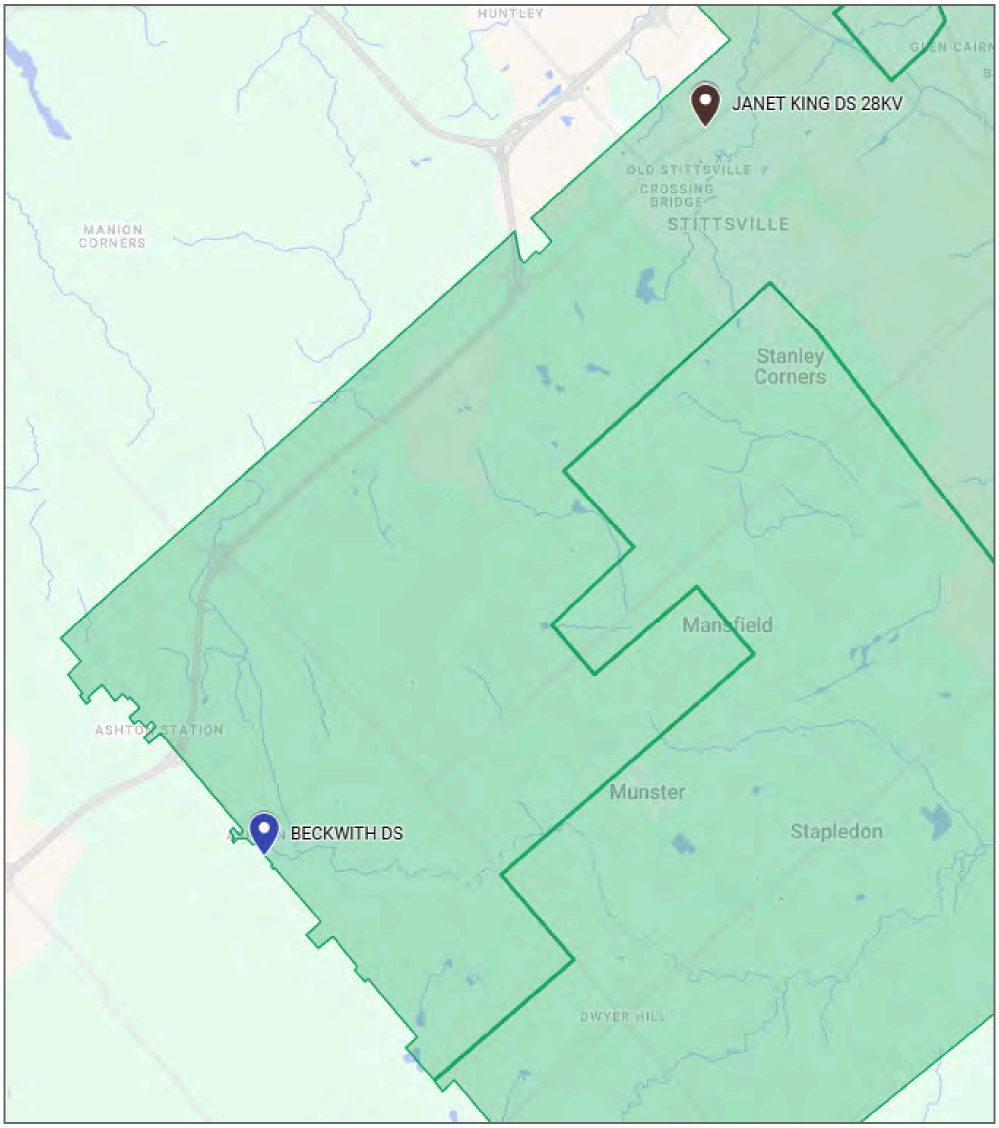
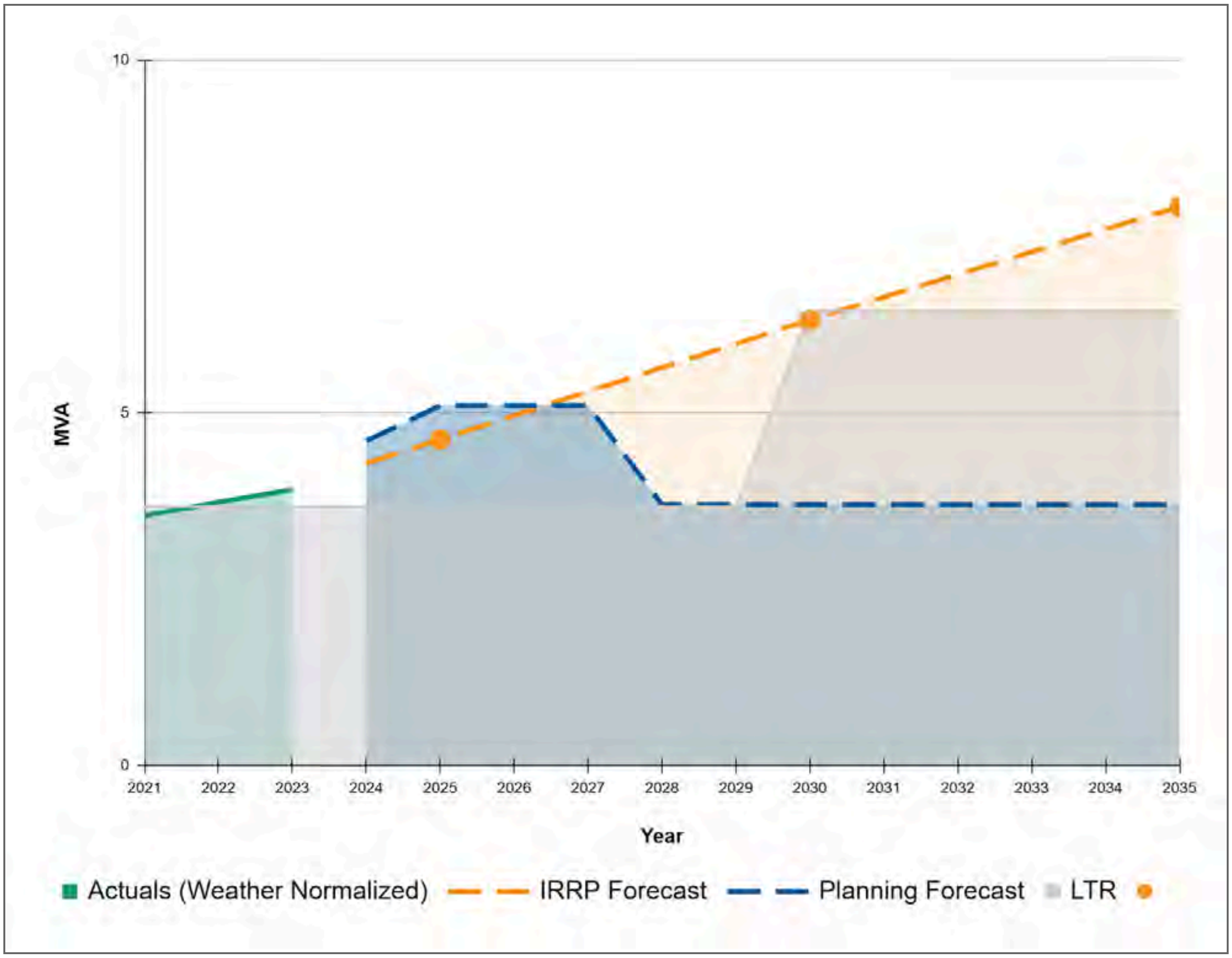


Figure 14, presents the load forecast against planned capacity (LTR) of the BECK-F2 feeder, factoring a 2.5 MW NWSs (utility BESS) energizing in 2030, pushing the overall LTR of the Beckwith region to 6.4MVA. The figure compares the IRRP Forecast and the Planning Forecast of Beckwith DS.

Figure 14 - Beckwith Forecast



The proposed NWSs in this region is to install a 2.5MW utility owned BESS. The issues that this solution addresses are elaborated below:

- **Capacity Constraints:** The BECK-F2 feeder is currently running above its planning capacity. The only ties available to the BECK-F2 feeder is from Janet King F4 feeder which is also heavily loaded (95% of planning capacity). Some load from Beckwith is planned to be moved to

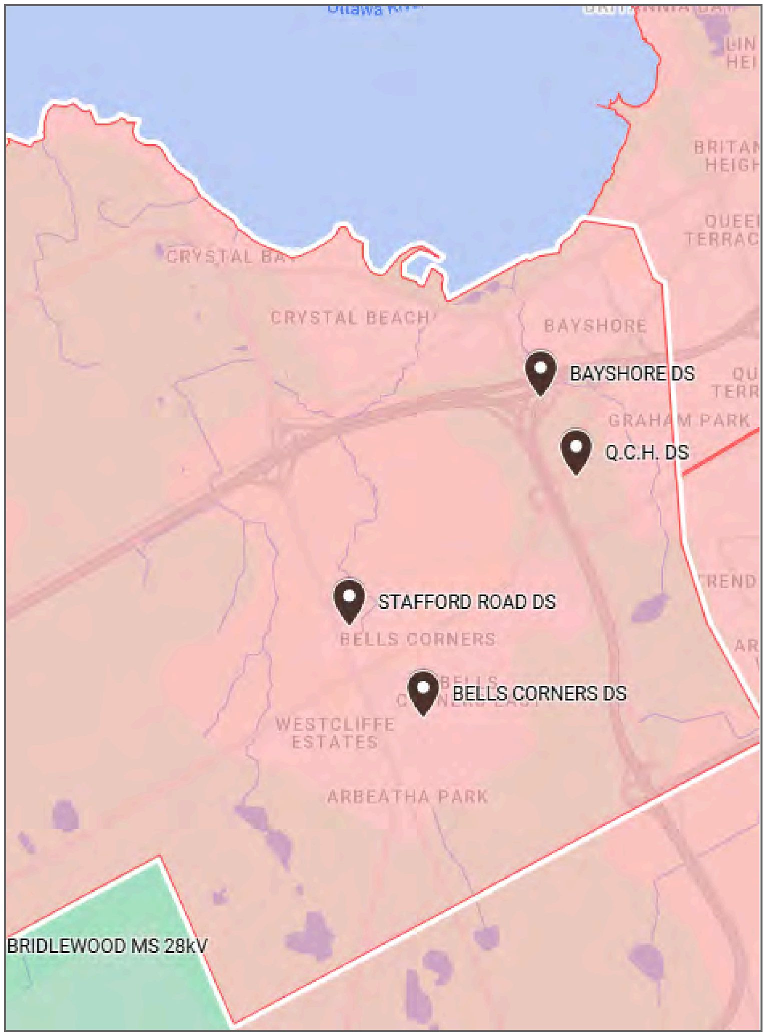
Richmond South MTS in 2028 to reduce loading to its planning capacity but that will not be enough to manage load growth considering the long term outlook (IRRP Forecast).

- **Wire Upgrades**: In consultation with Hydro One, to extend another feeder from the Beckwith DS would cost roughly $12M. Inter-station ties with adjacent Hydro Ottawa stations will not be economically viable considering the location of the station requiring long feeder extensions. In addition, adjacent stations of Janet King DS are approaching capacity limits (90% of planning rating) and Richmond South MTS will support a new large load 2027 onwards reducing its capability to support an offload from Beckwith DS. Also, with the long term outlook considering the IRRP forecast, this would likely trigger transmission upgrades.
- Hence the most optimal solution to manage the load growth in this region until 2030 and possibly beyond is to install a 2.5MW utility owned BESS which assists with peak load management considering the IRRP forecast.

Bells Corners/ Bayshore 8kV system

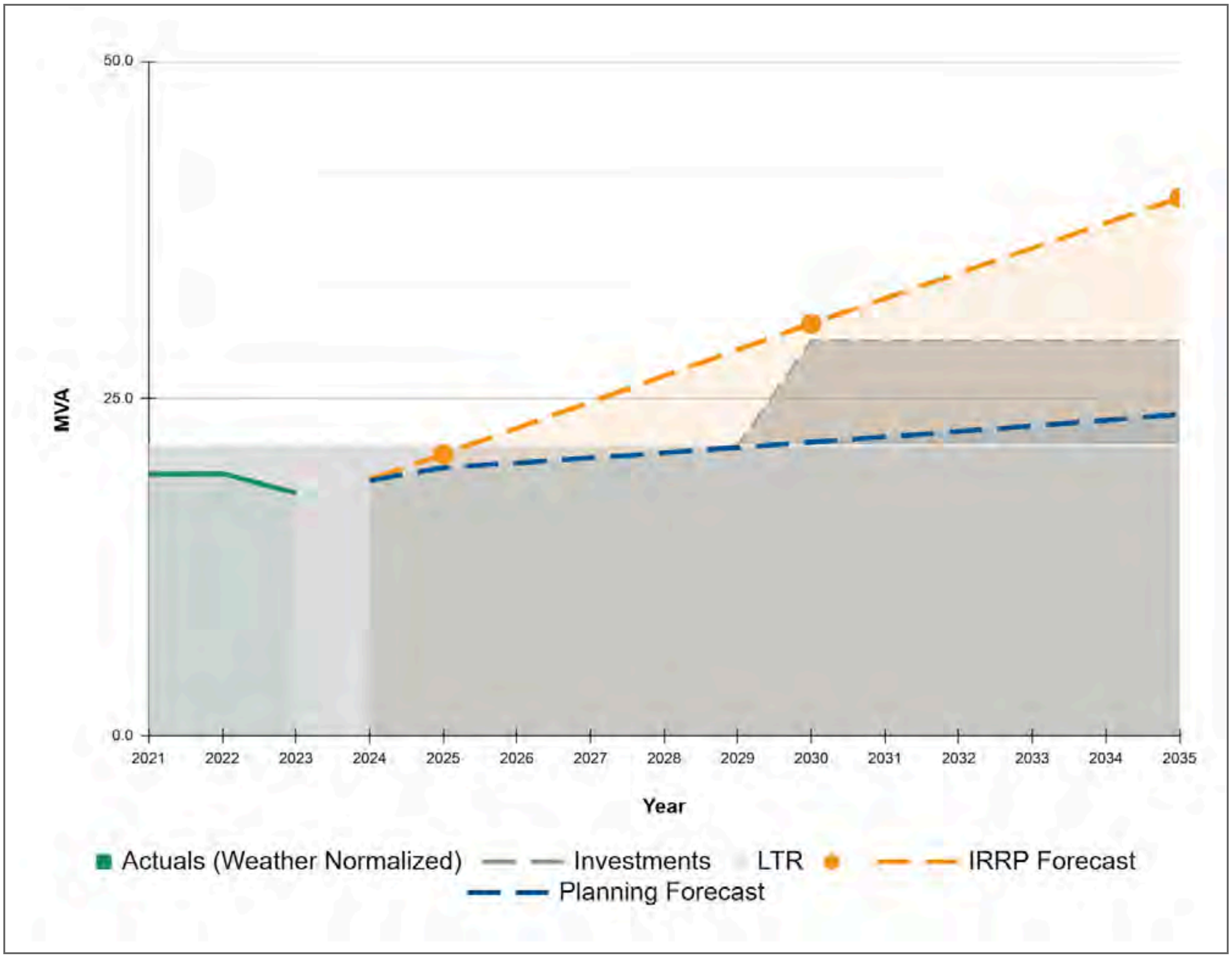
The Bells Corners/Bayshore 8kV supply region covers the northwest portion of Nepean. This region is supplied by Bayshore DS, Queensway-Carleton Hospital (Q.C.H) DS, Stafford Road DS, and Bells Corners DS as shown in Figure 15.

Figure 15 - Bells Corners/Bayshore 8kV Region



Bayshore DS and Q.C.H DS are approaching their planning limits. Figure 16, presents the load forecast against planned capacity (LTR) of Bayshore DS and Q.C.H DS factoring a 7MW NWSs (utility owned BESS) energizing in 2030. The figure compares the IRRP Forecast and Planning Forecast of both these stations.

1 **Figure 16 - Bayshore & QCH stations 8kV Forecast**



2

3

4 The proposed NWSs in this region is to install a 7MW utility owned BESS. The issues that this
5 solution addresses are elaborated below.

6

7 - **Capacity Constraints**: Bayshore DS is currently at 94% of planned capacity and Q.C.H DS is
8 at 74% of planned capacity and based on the planning forecast, capacity will be exceeded by
9 2030. Capacity is also insufficient considering the long term outlook (IRRP forecast).

- **Wire Upgrades**: Both these stations are currently supplied by 44kV feeders. Given the 8kV system is insufficient in dealing with large loads and service upgrades, conversion to 28kV would be optimal. However, this would require a transmission supply from the constrained 115kV system which could trigger transmission upgrades. Also, this region is isolated from the rest of the 8kV system with limited ties to Q.C.H DS. Creating new inter-station ties with Bells Corners DS will not be economically viable given it will support the entire Stafford DS load by 2026 reducing its capability to support an offload from Bayshore DS/ Q.C.H DS. Also, with the long term outlook considering the IRRP forecast, inter-station transfers will not be enough to manage the load growth.
- Hence the most optimal solution to manage the load growth in this region is to install a 7MW utility owned BESS solution which assists with peak load management.

Casselman 8kV system

The Municipality of Casselman is supplied by Casselman DS via four 8kV feeders which is illustrated in Figure 17.

Figure 17 - Casselman 8kV

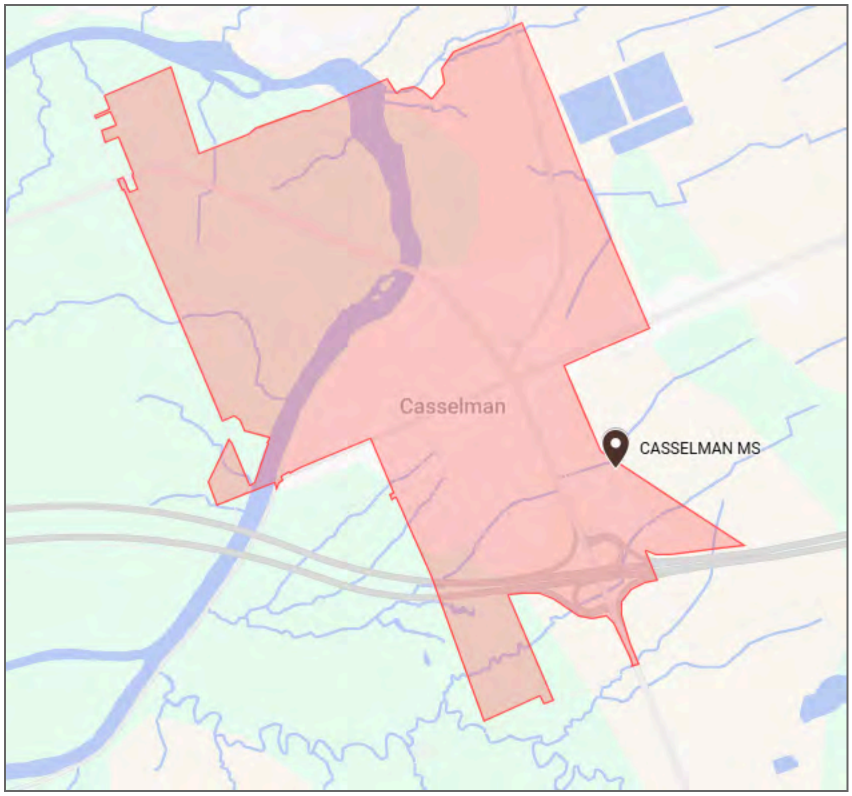
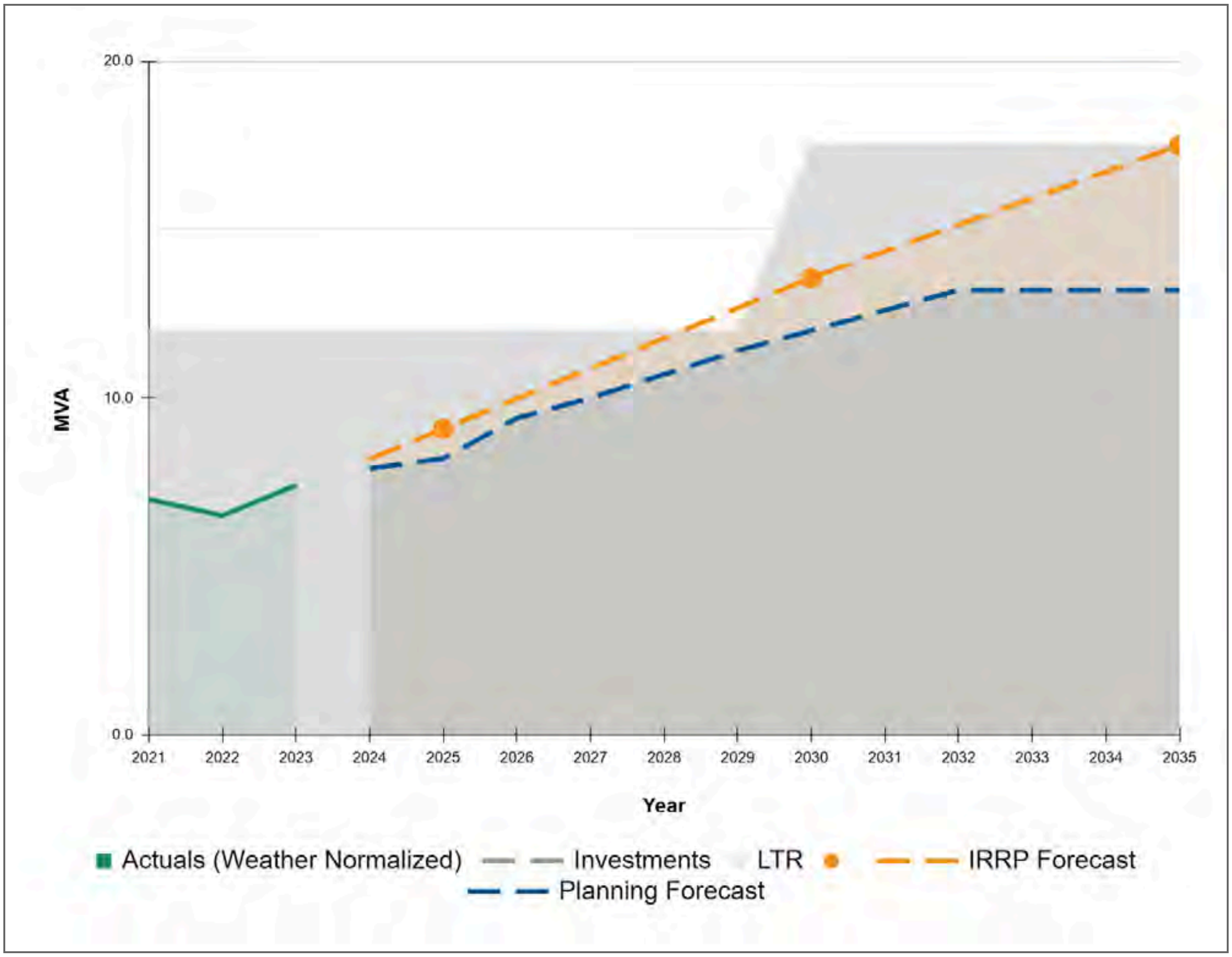


Figure 18 presents the load forecast against planned capacity (LTR) of Casselman DS factoring a 5 MW NWSs (utility BESS) energizing in 2030, pushing the overall LTR of the region to 17 MVA. The figure compares the IRRP Forecast and Planning Forecast of Casselman DS.

Figure 18 - Casselman 8kV Forecast



The proposed NWSs in this region is to install a 5MW utility owned BESS. The issues that this solution addresses are elaborated below.

- **Capacity Constraints**- Casselman DS is expected to exceed its planned capacity by 2030. Two out of the 4 feeders are currently running above planned capacity. In the short term, Hydro Ottawa has plans to balance load on all 4 feeders through feeder reconfigurations, however, that will not sufficiently address the capacity constraints out to 2030 per the planning forecast and is also insufficient considering the long term outlook per the IRRP forecast.

- **Wire Upgrades**- Increasing the station capacity at Casselman will trigger transmission upgrades as Casselman is supplied from a dual transmission supply from Hydro One owned St. Isidore TS. Also, the Casselman region is geographically isolated from the rest of Hydro Ottawa's distribution system, making load transfers an infeasible option.
- Hence the most optimal solution to manage the load growth in this region until 2030 and beyond is to install a 5MW utility owned BESS solution which assists with peak load management.

Core 13kV and West 13kV system

Figure 19 shows a sub-section of the Core 13 kV and the West 13kV system namely the 13kV stations of Carling TM, Lisgar TL and Riverdale TR along with the 4kV Bronson DS.

Figure 19 - Downtown 13.2 kV Stations surrounding Bronson DS

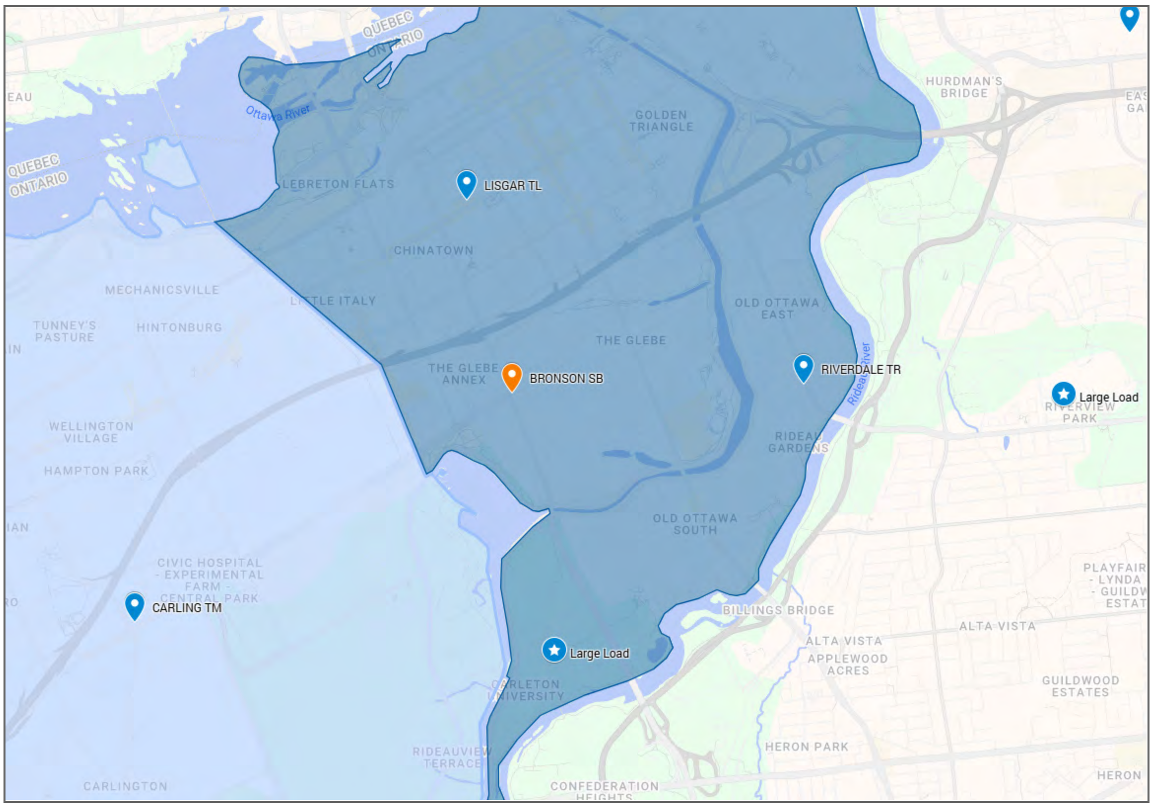
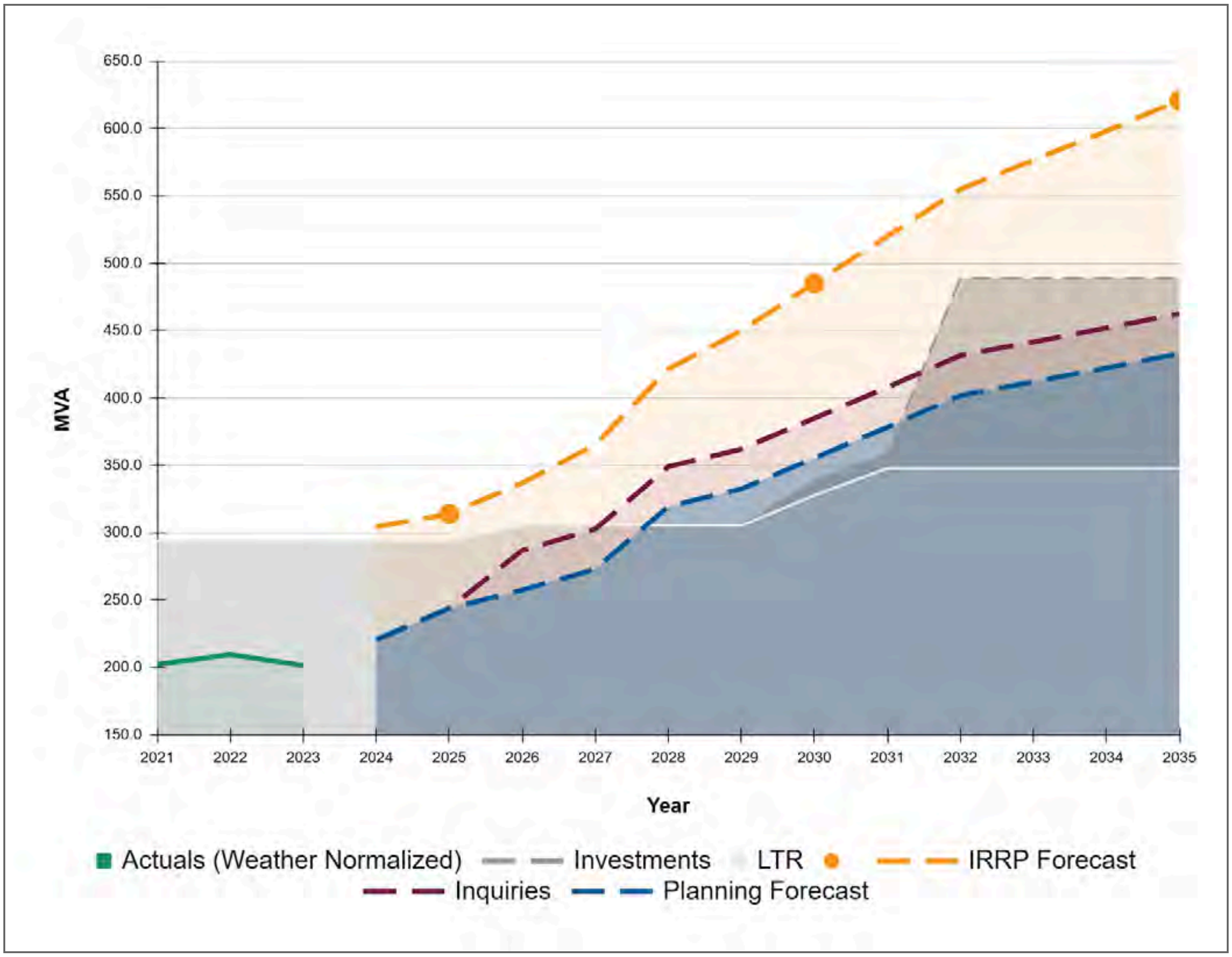


Figure 20 presents the load forecast against planned capacity (LTR), factoring two Hydro Ottawa capacity upgrade investments proposed; a 10MW NWSs (utility BESS) energizing in 2030, and the Bronson DS 13 kV upgrade, energizing in 2032 pushing the overall LTR to 500MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages.

Figure 20 - Combined Forecast of stations:
Carling TS, Lisgar TS, and Riverdale TS with Bronson DS Conversion and NWSs



The proposed NWSs in this region is to install a 10MW utility-owned BESS along with the deployment of Non-Wires Customer Solutions delivering an additional 10 to 15MW to bridge the gap between planned capacity and planning forecast. The issues that this solution addresses are elaborated below.

- **Capacity Constraints**: The planning forecast of the sub-section is anticipated to exceed the planning capacity by 2028 without intervention, even earlier if customer load inquiries come to fruition. Additionally, the transmission supply for these stations is from the constrained 115kV system.
- **Wire Upgrades**: Addition of capacity through the Bronson DS upgrade will eventually be needed to support the load growth in this region due to 4kV voltage conversions, intensification, transit-oriented development and committed large load customers such as universities and hospitals[11].
- The most optimal solution to manage the load growth in the interim until the Bronson station is energized in 2032 is to get support from NWSs. 10MW of utility owned BESS solution which assists with peak load management is proposed for this region along with Non-Wires Customer Solutions to bridge the gap between planned capacity and planning forecast. Following energization of the Bronson station, NWSs will provide support for the long term outlook considering the IRRP forecast.

2.4. PROGRAM BENEFITS

The benefits associated with the proposed Capacity Upgrade program are detailed below.

2.4.1. System Operation Efficiency and Cost Effectiveness

The proposed upgrades in capacity will satisfy upcoming load growth and increase system flexibility to restore power or offload feeders. The additional capacity will avoid cycling power outages and associated switching operations due to stranded load during transformer- or bus-related outages.

NWSs will enhance grid reliability and flexibility by accommodating the growing penetration of DERs and alleviating capacity constraints. These solutions offer peak-reducing technologies to increase system switching potential.

[11] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/

2.4.2. Customer Benefits

This program provides solutions to meet committed load requirements of large loads and the growing capacity needs in the Kanata, Downtown, Orleans and Nepean regions due to organic growth as well as evolving electrification needs. It helps align with customer expectations to prioritize reliability - the top customer need identified in Hydro Ottawa's 2026-2030 investment plan survey - while serving a growing community.

Guidance on energy consumption and technologies was listed as a top three priority by commercial and industrial customers in Hydro Ottawa's 2026-2030 investment plan survey. The various Non-Wires Customer Solutions will help strengthen Hydro Ottawa's role as a trusted advisor and energy partner. These programs will help enhance customer engagement and create the potential for electricity cost savings for customers of all classifications. Please refer to Section 2.4 of Schedule 1-4-1 - Customer Engagement Ongoing for further insight around ongoing customer engagement, specifically related to customer programming and the pursuit of NWSs.

2.4.3. Safety

This program will ensure equipment operates within safe limits, mitigating risks of equipment damage and safety hazards caused by system overload.

Microprocessor protection and control equipment will be used, where necessary, to enable proper device coordination, detailed event analysis, and faster fault detection minimizing equipment damage.

2.4.4. Coordination and Interoperability

As part of the regional planning process, IESO and Hydro One have been involved in the formulation of the capacity-build projects to ensure that there is sufficient capacity and no adverse impact on reliability of the integrated power system.

2.4.5. Economic Development

The investments under this program will help meet the growing needs in developing regions such as Kanata, Nepean and Orleans as well as add more capacity to the Downtown region to cater to the growth due to intensification, transit oriented development as well as growing electrification needs triggered by decarbonization goals.

Investments in NWSs will help promote economic growth by fostering local job creation, enhancing grid resilience and reducing energy costs.

2.4.6. Environment

Hydro Ottawa plans to use lower Global Warming Potential materials and employ innovative design, procurement and construction techniques to reduce the embodied carbon associated with new substation builds.

Where new transformers will be installed to build station capacity, transformer oil containment pits will be installed to avoid adverse environmental impacts of a potential transformer leak.

2.5. PROGRAM COSTS

Table 2 shows the historical and future spending by the underlying Budget Programs, as a part of the Capacity Upgrade program. The 2026-2030 period will see a significant increase in spending, reaching $342.6M net capital, compared to $108.2M net capital in the 2021-2025 period.

Table 2 - Historical, Bridge and Test Year Expenditures for the Capacity Upgrade Program ($'000 000s)[12]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stations Capacity Upgrades	$ 18.5	$ 1.8	$ 1.5	$ 21.3	$ 43.1	$ 56.1	$ 62.1	$ 10.9	$ 26.8	$ 40.6
Distribution Capacity Upgrades	$ 2.2	$ 5.0	$ 6.5	$ 8.5	-	$ 17.3	$ 21.6	$ 18.6	$ 16.2	$ 15.4
Non-Wire Upgrades	-	-	-	-	-	$ 4.1	$ 13.9	$ 20.2	$ 14.3	$ 8.7
Contributed Capital	-	-	-	-	-	$ (1.3)	$ (2.6)	$ (0.4)	-	-
CAPEX-TOTAL	**$ 20.7**	**$ 6.8**	**$ 7.9**	**$ 29.8**	**$ 43.1**	**$ 76.1**	**$ 95.1**	**$ 49.4**	**$ 57.2**	**$ 64.7**
Other Revenue Expense - Non-Wire Solutions	-	-	-	-	-	$ 2.0	$ 2.0	$ 2.0	$ 2.0	$ 2.0
Non-Wire Maintenance	-	-	-	-	-	$ 2.8	$ 2.6	$ 2.8	$ 2.6	$ 2.6
ANNUAL TOTAL	**$ 20.7**	**$ 6.8**	**$ 7.9**	**$ 29.8**	**$ 43.1**	**$ 80.9**	**$ 99.7**	**$ 54.1**	**$ 61.9**	**$ 69.3**
5-YEAR CAPEX					**$ 108.2**					**$ 342.6**
5-YEAR TOTAL					**$ 108.2**					**$ 365.9**

2.5.1. Station Capacity Upgrades

In the 2021-2025 period, this program was primarily focused on new station capacity at Cambrian MTS (previously named South Nepean MTS) in Nepean South and the Piperville MTS[13] (previously named New East Station) in Leitrim as well as upgrades at existing stations such as Limebank MTS, Uplands MTS and Riverdale TS[14]. The need for these additions or upgrades was identified through the System Capacity Assessment and IRRP. The spending in the 2021-2025 period under this program is $86.1M.

The planned net expenditure under this program in the 2026-2030 period is $192.2 M. The increase in funding is due to the increased requirement for station capacity (four new stations and two station

[12] EOL Voltage Conversion investments are included in Stations and Buildings Infrastructure Renewal. Further details can be found in Schedule 2-5-7 - System Renewal Investments.
[13] Piperville MTS planned energization in 2026
[14] Riverdale TS planned energization in 2027

upgrades compared to one new station and three station upgrades in the 2021-2025 period). The investments required in the 2026-2030 period are as follows:

- **Piperville MTS (Total: $42.3M, 2021-2025: $38.7M, 2026-2030: $3.6M):** This station carries forward from the last rate period with energization planned in 2026, is proposed to be 230 kV-28 kV connected with 100 MVA of capacity.
- **Riverdale Switchgear Upgrade (Total: $14M, 2021-2025: $ 13.2M, 2026-2030: $0.8M):** This upgrade project, carrying forward from the last rate period with energization planned in 2026, replaces the switchgear lineup at Riverdale TS with additional breaker positions.
- **Mer Bleue MTS (Total: $47.8M, 2021-2025: $13.8M, 2026-2030: $34M):** This station carries forward from the last rate period with energization planned in 2028, is proposed to be 230 kV-28 kV connected with 100 MVA of capacity, and supply up to eight new feeders.
- **New Kanata North station (Total: $44.8M, 2026-2030: $44.8M):** The station is proposed to be 230 kV-28 kV connected with 100 MVA of capacity and supply up to eight new feeders with a planned energization in 2028.
- **Greenbank MTS (Total: $38.5M, 2026-2030: $38.5M):** The station is proposed to be 230 kV-28 kV connected with 100 MVA of capacity and supply up to eight new feeders in the Greenbank/Hunt Club area with energization in 2028.
- **Cyrville Capacity Upgrade (Total: $35.3M, 2026-2030: $35.3M):** The Cyrville T1 and T2 transformers will be upgraded from 50MVA to 100MVA and is expected to be energized in 2028.
- **Bronson Upgrade (Total: $35.1 M, 2026-2030: $35.1M):** This project is to upgrade the existing 4 kV Bronson station to a 13 kV station with an incoming 115 kV transmission supply with energization planned beyond this rate period.

2.5.2. Distribution Capacity Upgrades

Distribution Capacity Upgrade projects in the 2021-2025 period have mostly been for station egress and feeder integration for the new stations of Cambrian TS and Piperville TS with a spending of $22.1M.

In 2026-2030, the program will build feeder egress and overall feeder integration for the new stations and will offload existing constrained feeders. Feeder integration will allow Hydro Ottawa to effectively leverage capacity of the new stations. This program will also help to eliminate undersized conductor sections in existing feeders and strategic voltage conversions to enable 13 kV conversion of the Bronson station. Eliminating undersized conductor sections will help leverage the full rating of the feeder for better utilization of existing assets. The proposed funding for this program is $89.1M. The increase in spending is predominantly due to the number of new stations requiring higher-distribution feeder extensions. The investments required in the 2026-2030 period are as follows:

- **Piperville MTS distribution upgrades ($6.0M)**: This project involves feeder line extensions, pole line upgrades, and SCADA switch installations. This is necessary to effectively integrate Piperville MTS into the South-East 28kV system and assume supply of two Leitrim MS feeders, maintaining Leitrim MS below its LTR.
- **Mer Bleue MTS distribution upgrades ($16.6M)**: This project involves extending six egress feeders out of the station as well as feeder line extensions, pole line upgrades, and SCADA switch installations. This is necessary to effectively integrate Mer Bleue into the East 28kV region and assume supply of the existing Bilberry and Orleans feeders that are being decommissioned.
- **New Kanata North distribution upgrades ($20.7M):** This project involves extending six egress feeders out of the station, upgrading pole lines and underground cabling, and integrating SCADA-enabled switches. The project is required to support load growth and high-tech industries in the area, and facilitate the conversion of remaining non-28kV systems. Moreover, this project strengthens grid reliability and contingency readiness by offloading load from overloaded substations in the West 28kV (North) and establishing critical ties between existing 28kV stations.

- **Greenbank MTS distribution upgrades ($20.0M):** This project involves extending six egress feeders out of the station, pole lines upgrades, feeder line extensions, as well as 8kV voltage conversion of several substations from the Nepean 8kV and Barrhaven 8kV systems.
- **Cyrville Capacity distribution upgrades ($4.5M):** This project involves extending two egress feeders out of the station and feeder line extensions. The project is required to support growth in the area and increase reliability by creating additional ties between Moulton MTS and the new Mer Bleue MTS
- **Bronson distribution upgrades ($15.0M):** This project involves feeder and pole line upgrades to prepare for and complete partially phased voltage conversions to 13.2kV. This project is required to meet growing demand in the area and increase capacity on the Central 13.2kV network.
- **Undersized conductors ($6.3M):** This project involves upgrading sections of conductor on ten different feeders that are currently undersized. It is necessary to meet increased growth on the feeders and provide additional feeder ties that are not hindered from ampacity constraints to increase feeder reliability.

2.5.3. Non-Wires Solutions

Non-Wires Solutions (NWSs) were evaluated based on the NWSs assessment process, please refer to Section 9.2.1 of Schedule 2-5-4 - Asset Management Process for further details. The proposed investment categories for NWSs are Utility-Owned Battery Energy Storage Solutions and Non-Wires Customer Solutions.

This is a new program being introduced for the 2026-2030 period, and therefore there is no historical spending. Hydro Ottawa is proposing to add 24.5MW of capacity through Utility-Owned Battery Energy Storage Solutions (Beckwith, Casselman, Bayshore/QCH and Core & West 13kV regions) and 20 to 30MW additional capacity from Non-Wires Customer Solutions Program (Kanata North, Core & West 13kV regions). These programs represent a capital investment of $61.2M and an additional $10M of costs included in Other Income and Deductions - Services to Third Parties, (see Schedule 6-3-5 - Other Income and Deductions) and $13.3M costs included in OM&A (see Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs) in the 2026-2030 period.

2.5.4. Cost Factors

Multi-year project considerations: Like any other multi-year project, this program will be subject to inflationary increases in both labour and equipment costs. All equipment costs are estimated and some are yet to be purchased. Equipment costs may increase before a final agreement is signed.

Transmission Cost: Due to the transmission upgrade requirements, costs would be determined through the Connection Impact Assessment (CIA) and System Impact Assessment (SIA) process, and then Hydro Ottawa and Hydro One must execute Connection Cost Recovery Agreements (CCRAs). As CCRAs are finalized for each project, there may be changes to the cost estimates considered at that time.

Regulatory and policy considerations: For NWSs, regulatory and policy work is ongoing. The OEB's cost-benefit analysis framework has a second phase in development and a related cost-sharing mechanism between LDCs and the bulk system needs to be refined through provincial directive or regulatory policy.

2.6. ALTERNATIVES EVALUATION

2.6.1. Alternatives Considered

Hydro Ottawa prioritized investments in areas with existing capacity constraints and immediate, confirmed load requirements. To ensure strategic alignment, immediate capacity investments, informed by Hydro Ottawa's planning forecast, were validated against long-term needs indicated by the IRRP forecast, considering the four to six-year lead time for station upgrades and even longer for transmission upgrades. This approach optimizes capital deployment and asset utilization. Hydro

Ottawa will continuously monitor electrification impacts to minimize disruptions and ensure new customer connections.

In order to meet the capacity needs of the system, three alternatives were considered, as outlined in Table 3.

Table 3 - 2026-2030 Capacity Upgrade Capital Investments ($’000 000s)

Program Investments	Alternative 1: Decelerated Growth Approach	Alternative 2: Accelerated Growth Approach	Alternative 3: Economical Growth Approach (Recommended)
System Capacity - Wires	360 MVA	770 MVA	550 MVA
System Capacity- NWSs	None	None	24.5MW BESS + 20-30MW NWCS
Stations overloaded by 2030 (Planning Forecast)*	23	0	0
Planning Regions overloaded by 2035 (IRRP Forecast)	55% (10/18)	0%	6% (1/18)
Supports Economic Development	Minor	Highest	Medium
Supports Environmental Sustainability	Minor	Highest	Medium
Station Capacity Upgrades	$82.4	$384.2	$192.2
Distribution Capacity Upgrades	$65.1	$121.2	$89.1
Non-Wires Capacity Upgrades	-	-	$61.2
SUBTOTAL CAPACITY UPGRADES	**$147.5**	**$505.4**	**$342.6**

*Excluding 4kV stations

Alternative 1: Decelerated Growth Approach- This alternative involves only continuing with in-progress station projects. The required investments include:

- Piperville MTS
- Mer Bleue MTS
- New Kanata North MTS

This alternative will provide:

- Continued strain on the system due to capacity lagging behind growth resulting in inability to connect all committed customer load requests.
- Station loads exceeding planning ratings, negatively impacting system accessibility, reliability and the ability to support service upgrades or new connections.
- Inability to support decarbonization goals since many planning regions will be above its planning rating considering the IRRP forecast.

Alternative 2: Accelerated Growth Approach: This alternative involves solely wire solutions to meet demand levels based on the IRRP forecast. The required investments include:

- Ongoing new stations: Piperville MTS, Mer Bleue MTS, New Kanata North MTS
- New stations: New Casselman station, Greenbank MTS, New Carling station
- Upgrades to existing stations: Cyrville (full station), Bronson (13 kV upgrade), QCH (transformer), Ellwood (transformer), King Edward (Hydro One-Sec cable), Lisgar (Hydro One-sec cable), Albion (Hydro One-transformer), Russell (Hydro One-transformer), South March (Hydro One-Transformer)
- Distribution upgrades: Voltage conversion for Bayshore transfer to 13 kV system, Beaverbrook, South March, Augusta, Bayswater, Bronson, Fisher, Slater, Florence, Gladstone, Henderson, Nepean, Shillington, Brookfield, Cahill, Church, Dagmar, Eastview, Langs Road, McCarthy, Urbandale, Vaughan, Wakley.

This alternative will provide:

- Ability to connect all committed projects.
- Station loads below planning ratings, positively impacting system accessibility and the ability to support service upgrades or new connections.
- Ability to support government decarbonization goals since all planning regions will be below its

planning rating considering the IRRP forecast.

Alternative 3: Economical Growth Approach (Recommended Alternative):
This alternative involves a more economical approach that involves building regional capacity with support from NWSs that meet the criterion defined in Section 9.2.1 of Schedule 2-5-4 - Asset Management Process. The investments required in this alternative include:

- New Stations: Piperville MTS, Mer Bleue MTS, New Kanata North MTS, Greenbank MTS
- Upgrades to existing stations: Cyrville (full station), Bronson (13 kV upgrade), King Edward (Hydro One-Secondary cable upgrade), Lisgar (Hydro One-Secondary cable upgrade), Carling (Hydro One-Secondary cable upgrade), Russell (Hydro One-transformer), South March (Hydro One-Transformer), Albion (Hydro One-transformer)
- Distribution transfers: as required to keep stations below their planning rating.
- Non-Wires Solutions: Utility-Owned Battery Storage Solutions at West 28 kV, Casselman, Core 13 kV and 8 kV systems and targeted Non-Wires Customer Solutions

This alternative will provide:
- Ability to connect all committed projects.
- Station loads at or below planning ratings by 2030, positively impacting system accessibility and the ability to support service upgrades or new connections over the next 5 years.
- Support from NWSs and grid modernization efforts for expected overloads due to decarbonization goals (as per the IRRP forecast) enhancing grid reliability, flexibility, resilience, and customer engagement.

2.6.2. Evaluation Criteria

System Accessibility

In order to meet the increasing power demands and predicted growth associated with electrification, it is crucial to focus on improving system accessibility (capacity). The preferred approach should enhance the system capacity available by ensuring robust and scalable infrastructure. This includes satisfying N-1 capacity requirements (feeders and stations that have exceeded or are approaching planning ratings) for seamless and quick load transfers as well as to accommodate future load growth.

If an alternative is required, the selected alternative should meet the needs identified through the IRRP to ensure enough reliable electricity is made available to the Hydro Ottawa service territory through the provincial grid over the long term to support the community's growth and economic development plans.

Financial

Investment cost-effectiveness is paramount when upgrading electric infrastructure to meet the immediate and long-term needs of the community and to support economic development. The evaluation criteria balance the necessity for robust infrastructure enhancements with the need to minimize impact to customer rates. Key considerations for cost-effective investments include:

- Prioritization of critical upgrades, phased implementation, advanced planning and forecasting, and Benefit-Cost Analysis completed through the capital expenditure process, refer to Section 5.3.1 of Schedule 2-5-4 - Asset Management Process;
- Leveraging existing assets through risk-based assessments done by Predictive Analytics, refer to Section 5.1.4 of Schedule 2-5-4 - Asset Management Process;
- Integration of smart technologies to modernize the grid and enable NWSs, refer to Section 3.4.2 of Schedule 2-5-4 - Asset Management Process;

System Reliability & Resiliency

Reliability remains critical to Hydro Ottawa's customers, with a focus on reducing the duration and frequency of outages while enhancing resilience against extreme weather events. It is essential to maintain reliability as electrical demand continues to increase at local, feeder-wide, and system-wide levels through continuous system optimization and the deployment of cost-effective technologies and solutions. Key strategies include implementing N-1 contingency plans, which ensure the system can handle the failure of any single major component without disrupting service. Additionally, infrastructure hardening initiatives are vital to bolster resilience against extreme weather events. The goal is to ensure a more robust and reliable electric distribution network that meets the demands of its growing communities and supports sustainable economic development.

Economic Development

The program should contribute to the City of Ottawa's growth and sustainability. This criterion evaluates the program's contribution to the economic growth and sustainability of the City of Ottawa. This includes supporting development projects, enabling business expansion, and fostering a stable and reliable electrical infrastructure that attracts investment and supports job creation. A robust and adaptable electrical grid is essential for economic development. Infrastructure relocations and upgrades can facilitate new construction, business operations, and the expansion of services, contributing to the overall economic health and vitality of the City of Ottawa.

Environmental Sustainability

The program should promote environmental sustainability by supporting electrification, renewable energy integration, and energy efficiency. This criterion examines the program's impact on environmental sustainability, including its support for electrification (transitioning to electric vehicles and heating systems), renewable energy integration (connecting solar and wind power to the grid), and energy efficiency initiatives. Hydro Ottawa has a responsibility to contribute to a cleaner environment. By considering these factors in relocation projects, the program can help reduce greenhouse gas emissions, promote the use of clean energy sources, and improve overall energy efficiency.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

2.6.3. Preferred Alternative

Hydro Ottawa assessed the three alternatives outlined in Section 2.6.1 - Alternatives Considered under the evaluation criteria provided in Section 2.6.2 - Evaluation Criteria.

Hydro Ottawa's primary strategic objective is to ensure customer affordability while significantly expanding the overall capacity of the electrical grid. This dual approach is essential to address the projected surge in energy demand by 2030 and adapt to the rapidly changing landscape of government policies and technological innovations.

To achieve these ambitious goals, Hydro Ottawa proposes a hybrid model that strategically integrates traditional wire upgrades with innovative NWSs, as presented in Alternative Three (Economical Approach). This approach encompasses the construction of new and upgraded stations and the expansion of existing and new distribution lines. These traditional wire upgrades will form the backbone of the grid, ensuring reliable and efficient power delivery. Simultaneously, the integration of NWSs, which may include technologies such as utility owned BESS and other Non-Wires Customer Solutions, will provide additional flexibility and resilience to the grid.

By implementing this comprehensive strategy, Hydro Ottawa aims to bolster economic growth and promote sustainability within the region. This will be achieved by removing existing capacity constraints, ensuring that all committed projects can be seamlessly connected to the grid, with additional capacity built in to accommodate future electrification growth through efficient capital deployment. These projects are poised to play a pivotal role in supporting development, enabling business expansion, and fostering a stable electrical infrastructure that will attract investment and stimulate job creation.

The preferred hybrid alternative strikes a delicate balance between meeting capacity needs, ensuring system reliability, and managing investment costs. This will be accomplished through the strategic deployment of traditional wire upgrades in conjunction with NWSs, thereby enhancing grid reliability, flexibility, resilience, and customer engagement. NWSs can provide customers with greater control over their energy usage and offer the choice and flexibility to actively participate in demand response programs, further enhancing grid stability and efficiency.

Hydro Ottawa's projections indicate that this hybrid approach will reduce the number of planning regions operating above planned capacity, bringing the number down from 10 to just 1. In regions that may still experience capacity constraints, NWSs will be instrumental in managing overloads. This will ensure that Hydro Ottawa can continue to connect new customers without compromising system accessibility, all while providing uninterrupted service at a lower cost. By proactively addressing capacity constraints and leveraging innovative solutions, Hydro Ottawa aims to create a sustainable and resilient electrical grid that can meet the needs of a growing population and a rapidly evolving energy landscape.

2.7. PROGRAM EXECUTION AND RISK MITIGATIONS

2.7.1. Implementation Plan

The capacity upgrades to be executed between 2026 and 2030 were assessed based on critical needs of the system. Station Capacity Upgrade projects typically span four to six years while Distribution Capacity Upgrade projects are usually completed in one to two years. Non-Wires Upgrade projects for utility owned solutions could take two to three years while Non-Wires Customer Solutions can be deployed quickly once the foundation is set, and would be an ongoing program. Table 4 shows the projects proposed for the 2026-2030 period as a part of the Capacity Upgrade program.

1 **Table 4 - Proposed Projects Under the Capacity Upgrade Program**

Year	Proposed Projects
2026	• Piperville TS energization • Riverdale Switchgear Upgrade • Mer Bleue TS, station egress and and feeder integration • New Kanata North TS, stations design, feeder integration • Greenbank TS station design • Cyrville station upgrade design • Lisgar TL secondary cable upgrade • Carling TS secondary cable upgrade • Russell TB transformer replacement • Utility Owned Battery Storage • Non-Wires Customer Solutions
2027	• Mer Bleue TS, station egress and feeder integration • New Kanata North TS, station egress and feeder integration • Greenbank TS, station egress and feeder integration • New Bronson 13 kV and associated voltage conversion • Cyrville station upgrade • Carling TS secondary cable upgrade • King Edward TK secondary cable • Russell TB transformer replacement • Utility Owned Battery Storage • Non-Wires Customer Solutions
2028	• Mer Bleue TS energization • New Kanata North TS energization • Greenbank TS energization • New Bronson 13 kV and associated voltage conversion • Cyrville station upgrade • Carling TS secondary cable upgrade • King Edward TK secondary cable • Russell TB transformer replacement • Utility Owned Battery Storage • Non-Wires Customer Solutions
2029	• New Bronson 13 kV and associated voltage conversion • Carling TS secondary cable upgrade • King Edward TKsecondary cable • Russell TB transformer replacement • Utility Owned Battery Storage • Non-Wires Customer Solutions
2030	• New Bronson 13 kV and associated voltage conversion • Carling TS secondary cable upgrade • King Edward TK secondary cable • Russell TB transformer replacement

Year	Proposed Projects
	• Utility Owned Battery Storage • Non-Wires Customer Solutions

2.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in executing the Capacity Upgrades Program, particularly the transformational landscape of decarbonization, and the evolving needs of customers, paired with the ever increasing demand for reliable electricity in the community, presents various pressures on the distribution grid. Table 5 identifies the key risks and corresponding mitigation strategies that Hydro Ottawa will undertake as needed.

1 **Table 5 - Key Risks for the Capacity Upgrades Program and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing solutions on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Stakeholder Approvals	The time required to obtain approval from the OEB, Hydro One and the IESO for some of the transmission upgrades poses a risk to the program delivery schedule.	Coordinate closely with stakeholders and plan in advance with regular touchpoints with stakeholders to secure necessary approvals in a timely manner
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute	Create and where required implement contingency plans to account for

Category	Risk	Mitigation
	work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labour which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Regulatory and Compliance Risks	Rapidly changing regulations that may require changes to designs (such as how DER's are managed) pose a risk to project delivery, schedule, and budget.	Maintain compliance by integrating industry best practices and regulatory requirements into the upgrade planning process. Conduct regular audits and risk assessments to stay ahead of regulatory deadlines. Participate in regulatory committees and proactively prepare designs for compliance.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

2.7.3. Other Factors

Regulatory and policy work around the OEB's Benefit-Cost Analysis framework for NWSs is not yet complete. Only phase 1 has been completed and phase 2 - which outlines the calculation to include both local and bulk system benefits costs, known as the Energy System Test (EST) - is still underway. An IESO-LDC Working Group has also been established to examine approaches to cost-sharing of "Stream 2" Electricity Demand Side Management (eDSM) activities (local programs designed and administered by LDCs that will have both bulk and local system benefits). When these two initiatives are completed - during 2026 or 2027 - Hydro Ottawa will transition its NWSs work to conform to the revised model as described in Section 9.2 of Schedule 2-5-4 - Asset Management Process.

2.8. LEAVE-TO-CONSTRUCT

Assessment pertaining to Section 92 of the OEB Act, 1998 will likely be needed for the transmission lines that Hydro One will build to support Hydro Ottawa's capacity upgrade projects such as the New Kanata North station, Greenbank MTS, Cyrville upgrade and Bronson 13 kV upgrade. Hydro Ottawa's contribution to these projects will be captured under the General Plant Connection Cost Recovery Agreement, please refer to Section 7 of Schedule 2-5-9 - General Plant Investments for additional details.

3. DISTRIBUTION ENHANCEMENTS

3.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $27.5M

2026-2030: $92.8M

Budget Program: Distribution System Reliability, Distribution Enhancements, Distribution System Observability, Distribution System Resiliency.

Main Driver: Reliability

Secondary Driver: Capacity Constraints, Resilience, Observability

Outcomes: Operational Effectiveness, Customer Focus

Hydro Ottawa's investment plan for the Distribution Enhancements Capital Program (2026-2030) focuses on modernizing and strengthening the electricity distribution network, enabling it to adapt to the challenges of climate change, growing demand, reliability concerns and the increasing integration of Distributed Energy Resources (DERs). Together, these programs provide the necessary real-time data, control capabilities, and grid stability to dynamically forecast and adjust electricity consumption and generation. This allows for optimized grid performance, seamless integration of renewables, and the implementation of demand response programs. Ultimately, these investments ensure a more flexible, reliable, and responsive energy grid, crucial for Hydro Ottawa's long-term sustainability and customer satisfaction.

Hydro Ottawa's Distribution Enhancements Capital Program (2026-2030) outlines a strategic investment of $92.8M to modernize and reinforce the electricity distribution network. This represents a substantial increase compared to the historical spending of $27.5M in the 2021-2025 period. This increase is primarily driven by the imperative to enhance grid resilience against increasingly severe weather events, augment grid observability for proactive management, and modernize the grid to accommodate the growing integration of DERs. The expenditure plans detailed in this document are aligned with and in response to feedback received from customers through Hydro Ottawa's customer engagement survey, please refer to Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

This Distribution Enhancements Capital Program encompasses the following Budget Programs over the 2026-2030 period:

Distribution System Reliability

This program is designed to enhance the overall reliability of the electricity distribution system. This program encompasses a range of initiatives aimed at bolstering system performance and mitigating outages, including:

- **Feeder Optimization and Capacity Management:** Reconfiguring feeders, adding tie points, and addressing capacity constraints to optimize the electricity distribution network. This creates a more stable and responsive grid, essential for handling dynamic load adjustments and the integration of DERs.
- **Enhancing System Observability:** Deployment of advanced automation to achieve real-time distribution system observation & control, enhancing efficiency and outage response. Real-time observability is a critical component of managing DERs as it allows for immediate responses to changing load patterns and facilitates precise control of grid assets.
- **Improving Distribution Efficiency:** Mitigation of voltage imbalances and overload by implementing feeder phase balancing to improve distribution efficiency. Efficient distribution increased the grid’s capabilities to handle dynamic loads, ensuring optimal performance during periods of fluctuating demand.

These initiatives are informed by a comprehensive reliability assessment process detailed in Section 5.2.2.3 of Schedule 2-5-4 - Asset Management Process.

Distribution Enhancements

The Distribution Enhancements Program is designed to modernize and enhance grid infrastructure to accommodate the growing integration of DERs and optimize system performance. This program encompasses a range of initiatives aimed at system reliability, system observability, and fostering technological innovation, including:

- **Strategic Grid Infrastructure Enhancements:** Strategically enhance grid infrastructure by extending station neutral ties and mitigating third-party pole risks, improving system stability and reliability.
- **DER Integration and Grid Optimization:** Enable DER integration and optimize load management through advanced forecasting, scheduling, and aggregation tools, supported by AMI 2.0 and federal funding, to enhance grid flexibility and resilience. This initiative directly enables Hydro Ottawa's ability to manage flexible loads by providing the tools and infrastructure necessary for real-time control and optimization of DERs. Advanced forecasting and scheduling are critical for predicting and managing load fluctuations, supported by granular data needed for precise load control and demand response.

Distribution System Resilience

The Distribution System Resilience Program is a new budget program designed to enhance the resilience of the electricity distribution network against the increasing frequency and intensity of adverse weather events. This emphasis on resilience is of paramount importance given that Ottawa has become the weather-alert capital of Canada[15], experiencing a surge in extreme weather events that place significant strain on and cause damage to the electricity grid. Recent events, such as the devastating 2022 Derecho, tornadoes, ice storms, and flooding, have underscored the vulnerability of the grid and the critical need for proactive measures to enhance its resilience. Refer to Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement for details on the impacts of major weather events on Hydro Ottawa's distribution system. By proactively

[15] Environment and Climate Change Canada - https://www.canada.ca/en/environment-climate-change.html

strengthening the grid against extreme weather, the Distribution System Resilience Program ensures that the grid can quickly recover and reinstate critical functions to maintain responsive control to balance electricity demand and adapt to fluctuating energy needs and optimize its performance under diverse conditions.

This program encompasses the following initiatives:

- **Strategic Undergrounding:** Strategic undergrounding of vulnerable overhead lines, to mitigate risks associated with severe weather, enhancing grid resilience.
- **Storm Hardening:** Strengthening overhead infrastructure against extreme weather by reinforcing poles, reducing spans and attachments, and utilizing composite/concrete poles in critical areas.
- **Feeder Reconfiguration:** Optimizing the configuration of electricity feeders to improve system redundancy and minimize the impact of outages.
- **Station Egress Undergrounding:** Burying existing overhead station egress points to protect critical infrastructure.
- **Line Relocation:** Relocating vulnerable power lines to less exposed areas or underground to reduce the risk of damage.

Through proactive investment in grid resilience, Hydro Ottawa aims to mitigate the reliability impacts posed by a changing climate and provide customer value by strengthening the resilience of the grid to withstand and bounce back from extreme weather events. Further details are available in Section 5.2.2.4 of Schedule 2-5-4 - Asset Management Process.

Distribution System Observability

The Distribution System Observability Program is a new budget program introduced to enhance grid reliability, flexibility, resilience, and customer engagement, while promoting sustainability. This program aligns with Hydro Ottawa's Grid Modernization Strategy. This strategy responds to the need to modernize deteriorating infrastructure, accommodate decarbonization efforts, and meet changing customer expectations.

Real-time observability is foundational for effective advanced flexible load management, providing the essential data needed to dynamically balance grid demand. Investments in advanced monitoring systems empower grid operators with the visibility to predict and respond to load fluctuations, enhancing grid stability and resilience. By enabling precise, data-driven control, observability optimizes the integration of distributed energy resources and facilitates targeted demand response programs. Observability provides the data that allows for the real-time reaction to grid conditions, a necessity to maintain grid stability while effectively managing flexible loads.

Investments under this program will focus on data-driven and technologically-advanced grid management, utilizing new assets that provide real-time condition data, loading data, and fault-detecting capabilities; remote switching capability (Smart Switches); installation of fault circuit indicators (FCIs); and monitoring and control boxes. Examples of these technologies follow in Figures 21 through 23.

Figure 21 - Example of Automated Switchgear with Control Box

Figure 22 - Example of Overhead Automated Switch with Control Box

Figure 23 - Example of Smart FCI Device on Overhead Pole Line

These investments will enable the adoption of innovative control and optimization technologies, such as Advanced Distribution Management Systems (ADMS). By enhancing system observability, Hydro Ottawa aims to support the following Grid Modernization objectives:

- **Enhanced Reliability:** Improve grid reliability through advanced monitoring, proactive failure detection, and faster fault localization.
- **Adaptive Grid Flexibility:** Enable the grid to adapt to changing energy demand and incorporate diverse energy sources, including renewables.
- **Fortified Resilience & Robust Security:** Improve the grid's ability to withstand disruptions caused by system faults or extreme weather events.
- **Strengthened Customer Engagement & Empowerment:** Engage and empower customers by providing them with real-time data and tools to manage their energy use.
- **Sustainable Decarbonization & Renewable Integration:** Reduce carbon emissions and promote sustainability by optimizing grid planning and operations to support the integration of renewable energy sources.

Further details are available in Section 5.2.2.1 of Schedule 2-5-4 - Asset Management Process.

3.2. PERFORMANCE OUTCOMES

The following outcomes are expected to be achieved through the Distribution Enhancement Capital Program:

Table 6 - Distribution Enhancement Program Performance Outcomes

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	● Improve system reliability by reducing the number of worst performing feeders. This will contribute to improving system reliability by reduced outage duration and frequency achieved through reliability and distribution enhancement investments. ● Improve grid control and observability through the installation of Smart FCIs and Smart Switches, contributing to improved productivity and system performance. ● Mitigating reliability risk by strengthening the grid's resilience against extreme weather. These outages can create safety risks, particularly for vulnerable populations reliant on electricity for medical devices and other essential needs.
Customer Focus	● Improve Customer Reliability by mitigating capacity and reliability risks. Reduce disruptions to businesses, schools, and other essential services, impacting productivity and economic activity.

3.3. PROGRAM DRIVERS AND NEED

3.3.1. Drivers

Primary Driver: Reliability;

This program supports Hydro Ottawa's commitment to enhancing the reliability of its electricity distribution services, as detailed in Section 5.2.2 of Schedule 2-5-4 - Asset Management Process. This commitment involves continuous assessment of system performance and implementing appropriate actions to address any identified reliability issues. The program focuses on:

- **Real-time Monitoring of Distribution Asset Performance:** This facilitates early issue detection and proactive intervention, mitigating the risk of failures and associated downtime.
- **Enhanced Grid Resilience to Adverse Weather Events:** This reduces the likelihood of weather-related outages and strengthens the overall resilience of the distribution network.

- **System Reconfiguration to Optimize Outage Management and Load Restoration:** This provides enhanced flexibility to isolate outages and restore load, thereby building redundancy, minimizing outage durations, and improving key reliability metrics (SAIFI and SAIDI). This facilitates the foundation to dynamically respond to real-time grid conditions and maintain stability during energy fluctuations or outages.

Secondary Drivers: Capacity Constraints, Resilience, Observability.

Capacity Constraints: As detailed in Schedule 2-5-4 - Asset Management Process, Hydro Ottawa regularly evaluates the capability and reliability of the distribution system to ensure a stable and dependable power supply for customers. This program will contribute to these efforts by implementing system reconfiguration and creating ties to help maintain feeders and stations at or below planning ratings, thereby reducing capacity constraints and ensuring the system can accommodate growing demand.

Resilience: Investments in undergrounding, storm hardening, and feeder reconfiguration will mitigate the consequences of failures by increasing asset resilience to extreme weather events and improving power restoration capabilities.

Observability: In line with Section 3.4.2 of Schedule 2-5-4 - Asset Management Process, investments will enhance system observability and efficiency through the adoption of innovative control and optimization technologies, integration of DERs, comprehensive sensing, and measurement strategies. This will enable advanced grid control, rapid fault detection and localization, improved overload detectability, and automated/remote system restoration, ultimately supporting both daily operations and long-term system planning. Enhanced observability allows for precise load forecasting and targeted demand response, while improved grid controllability enables the dynamic adjustment of loads to balance demand. This program is a critical step towards enabling flexible load management for optimizing grid operations, integrating renewable energy, and enhancing overall grid flexibility.

3.3.2. Current Issues

Hydro Ottawa's Distribution Enhancements Program aims to address several challenges facing Hydro Ottawa's electricity distribution system:

- **Feeders Exceeding Planning Limits**: Feeders that operate beyond their planning capacity limit Hydro Ottawa's ability to meet customer demand. This increases the risk of overloads, equipment failure, and voltage drops, potentially leading to service disruptions and increased maintenance costs. System upgrades or load transfers are required to ensure continued service quality and system longevity. Refer to Section 8.4.2 of Schedule 2-5-4 - Asset Management Process for details on feeder capacity assessment including the calculation of the Feeder Load Index (FLI). Feeders with an FLI of 4 (≥ 100% of Planning Rating) or 5 (> 70% of Design Rating) require intervention to rectify their loading levels. In 2023 there are 12 feeders with an index of 4 and 19 with an index of 5.
- **Feeder Phase Imbalance**: Phase imbalance is the uneven electrical load distribution across a three-phase feeder, causing increased energy losses and inefficient operation of the system. Additionally, these imbalances cause higher temperatures in conductors and transformers, reducing equipment typical useful life and increasing failure risks. This program supports the optimization of the distribution of electrical load across the system to improve efficiency and mitigate these challenges.
- **Station Neutral Ties**: The absence of neutral ties in Hydro Ottawa's 13 kV delta subtransmission system presents a significant challenge to reliable and efficient service delivery. The absence of neutral ties in the 13 kV system presents a technical challenge, as it limits the effective utilization of standard pad-mounted transformers, which are designed for wye-connected systems with a neutral connection. Pad-mounted transformers rely on the neutral for providing a stable reference point for the secondary voltage - a delta system does not

inherently provide this. Specifically, the lack of a neutral path results in several key issues: it necessitates costly and complex alternative solutions for customer connections, increases the complexity of system design, operation, and maintenance (leading to longer restoration times), and contributes to higher system losses due to voltage imbalances and increased current magnitudes, ultimately causing longer restoration times, increased operational costs and potentially impacting equipment typical useful life.

- **Critical Overhead lines on poles not owned by Hydro Ottawa:** Hydro Ottawa has identified operational and reliability risks regarding some critical overhead lines situated on poles not owned or managed by Hydro Ottawa. The reliance on external infrastructure introduces several challenges, including the potential for delayed maintenance, inconsistent inspection schedules, and a lack of direct control over the condition and safety of the supporting structures. Furthermore, addressing emergent issues on these third-party poles can impede timely responses to potential hazards or necessary repairs.
- **Extreme Weather Events**: The increasing frequency and severity of extreme weather events, such as ice storms, high winds, and heavy rainfall, pose a significant threat to the electricity distribution network, particularly deteriorating overhead infrastructure. These events can cause widespread damage, leading to prolonged outages and costly repairs. This heightened vulnerability to severe weather events is further underscored by the documented increase in such events in the Ottawa region, as detailed in Section 6.4.1 of Schedule 2-5-4 - Asset Management Process.
- **System Observability**: Hydro Ottawa's current system observability presents challenges to the efficient monitoring, control, and troubleshooting of the electricity distribution network. This limitation hinders the ability to proactively identify and address potential issues, optimize grid performance, and fully leverage the benefits of DERs. Furthermore, while real-time data is available from substations and remote operable devices (leveraging Hydro Ottawa's SCADA system), this currently provides a limited view of the overall grid's operational state. To compensate for these limitations and ensure the safe and reliable operation of the grid, Hydro Ottawa currently relies primarily on labour-intensive manual monitoring and control processes.

This reliance increases response times to outages and limits the ability to respond quickly and efficiently to emerging grid events.

- **DER Integration:** The increasing prevalence of DERs presents a challenge to Hydro Ottawa's current grid infrastructure. While DERs offer potential benefits, their integration requires a modernized grid capable of handling variable and intermittent generation. The current grid infrastructure that Hydro Ottawa operates is challenged by the increased DER integrations facing operational inefficiencies, reduced grid reliability, and an inability to fully realize the benefits of DERs. This limitation hinders the ability to optimize grid operations, maintain stability, and ensure reliable power delivery as DER adoption increases.

3.4. PROGRAM BENEFITS

3.4.1. System Operation Efficiency and Cost Effectiveness

Capacity Management: This program addresses capacity constraints on feeders that exceed planning limits by reconfiguring circuits and adding feeder ties. Additionally, it provides backup supply options in contingency scenarios, contributing to overall system reliability and cost-effectiveness. This strategy optimizes asset utilization, accommodates future growth, and expedites restoration efforts during outages. By ensuring the system can meet both current and future electricity demand, this approach contributes to long-term cost management and enhanced system reliability.

Feeder Phase Balancing: This program will optimize the distribution of electrical load across the system through feeder phase balancing. This will ensure that each phase of a three-phase feeder carries a similar amount of current, minimizing power losses due to imbalances. This optimization will also reduce stress on equipment, prolonging the lifespan of grid assets and reducing the need for premature replacements.

Strategic Grid Infrastructure Enhancements: This program will implement strategic grid infrastructure enhancements to address existing inefficiencies and improve the overall performance of the electricity distribution system. This includes extending 13 kV station neutral ties to enhance system stability and reliability by providing a stable reference voltage and ensuring proper operation of protective devices. This will minimize the risk of voltage imbalances and potential equipment damage, contributing to a more reliable and resilient network. Additionally, the program will strategically transfer critical overhead lines to Hydro Ottawa-owned poles to enhance control and maintenance capabilities, improving overall system reliability and efficiency. By owning and managing these poles, Hydro Ottawa can ensure timely maintenance, implement consistent inspection schedules, and proactively address potential issues, minimizing the risk of outages and disruptions, and improving the overall efficiency of grid operations. These strategic enhancements will address existing inefficiencies and improve the long-term reliability, resilience, and efficiency of the electricity distribution system.

System Observability: This program will enhance system observability by implementing advanced monitoring and control technologies, providing Hydro Ottawa with greater visibility into the real-time operation of the electricity distribution network. Improved monitoring capabilities will also lead to faster and more accurate identification of outage locations and causes, enabling more efficient outage response and reduced outage durations. Furthermore, real-time data will provide valuable insights into grid performance, enabling Hydro Ottawa to optimize grid operations. This enhanced observability is also crucial for effectively managing the integration of DERs, such as solar panels and energy storage systems, by enabling better coordination and optimization of DERs to enhance grid stability and reliability. By investing in advanced monitoring and control technologies, Hydro Ottawa will improve its ability to efficiently monitor, control, and troubleshoot the grid, leading to more reliable service, optimized grid operations, and a more resilient and adaptable electricity distribution network.

3.4.2. Customer

Reliable and Accessible Electricity Service: The program will enhance the reliability and accessibility of electricity services, ensuring a more consistent and dependable electricity supply.

This translates to fewer outages, improved power quality, and faster restoration in the event of a disruption, ultimately providing greater convenience and peace of mind. Automated switches, additional feeder ties, and feeder reconfiguration will further enhance reliability by providing backup supply options and faster restoration times.

Improved Resilience to Extreme Weather: Customers will benefit from investments in grid resilience as extreme weather events become more frequent and severe. These investments will help to prevent prolonged and frequent power outages, reduce costs associated with emergency repairs and restoration, minimize economic disruptions, and maintain public confidence in Hydro Ottawa's ability to provide reliable service. Established maintenance programs, along with resilience measures such as strategic undergrounding and pole line reinforcement, will contribute to further improvements in overall service reliability.

Increased Customer Engagement: As a result of the efforts around DER enablement and the work within the “ODERA” project, as detailed in Section 3.6.3.1 - Preferred Alternative Details, there will be increased customer engagement by providing opportunities for customers to actively enroll their DERs and participate in demand response programming.

3.4.3. Safety

Protecting Vulnerable Customers: The program's focus on resilience measures, such as strategic undergrounding and pole line reinforcement, aims to mitigate the risks to vulnerable populations who rely on electricity for essential medical equipment and other needs. By reducing the likelihood of pole failures and power outages, the program will help ensure the safety and well-being of these customers.

Mitigating Weather-Related Hazards: Enhancing grid resilience through strategic undergrounding, line reinforcement, and other measures will reduce the risk of downed power lines and other safety hazards during extreme weather events, protecting both the public and Hydro Ottawa crews responding to these events.

System Observability: Improved system observability will enable faster response times to outages, minimizing the duration of safety hazards caused by power disruptions. This will benefit both customers and Hydro Ottawa employees who are working to restore power.

3.4.4. Cyber Security and Privacy

Enhancing Grid Resilience and Security: Projects will prioritize cyber security measures to protect grid assets from cyberattacks, unauthorized access, and data breaches.

Safeguarding Customer Data: Customer data collected through smart grid technology will be protected through strict privacy protocols, ensuring data security and compliance with regulatory standards.

3.4.5. Coordination and Interoperability

Improved System Interconnectivity: Investments in feeder ties and other reliability improvements will enhance the grid's interconnectivity, providing system operators with greater flexibility to manage load transfers during contingencies and to dynamically adjust the grid power flow. This enhanced interconnectivity supports the efficient coordination and control of distributed energy resources and load adjustments, contributing to overall grid stability and optimized energy utilization.

Streamline Decision-Making: By enhancing system observability, the program will improve communication and facilitate more informed decision-making, supporting the adoption and implementation of innovative control and optimization technologies. This includes the ability to rapidly assess grid conditions, forecast load fluctuations, and deploy targeted responses to balance demand in real-time, improving overall grid efficiency and responsiveness.

Collaboration: This program fosters proactive collaboration with key stakeholders, including customers, the transmitter (Hydro One), the IESO, and municipalities, to ensure efficient integration of program initiatives with existing infrastructure and future plans. This collaborative approach, further detailed in Schedule 2-5-2 - Coordinated Planning with Third Parties, supports Hydro Ottawa's broader grid modernization efforts and ensures seamless integration of advanced grid functions, promoting grid stability and maximizing the benefits of distributed energy resources and demand-side flexibility. This will also allow for better communication with customers who are participating in demand side programs, and allow for better data sharing.

3.4.6. Economic Development

Enabling Growth and Investment: The program facilitates economic expansion by ensuring a reliable and scalable electricity supply to connect new customers and accommodate increased demand. Through investments in reliability, resilience, and grid modernization, the program enables the connection of new businesses, residential developments, and commercial facilities, thereby attracting investment, creating employment opportunities, and stimulating economic growth.

Adapting to Evolving Energy Needs: The program proactively addresses the evolving energy requirements of the community by ensuring the electricity distribution network can accommodate increasing demand, including the growing adoption of electric vehicles and other electrification initiatives, without compromising the safety or reliability of electricity services. This adaptability is essential to foster a thriving and prosperous economy.

Supporting Existing Businesses: Recognizing that a reliable and accessible power grid is fundamental to economic development, the program prioritizes providing consistent and dependable electricity services to support the operational efficiency, expansion, and competitiveness of existing businesses. This commitment to reliability helps retain businesses within the region and contributes to sustained job creation.

3.4.7. Environment

Reducing Emissions: By enhancing operational observability, the program will reduce the need for on-site crew investigations during service interruptions. This will decrease the emissions by Hydro Ottawa vehicles, leading to a reduction in greenhouse gas emissions and contributing to improved air quality. Enhanced grid monitoring and control capabilities will allow for more dynamic and efficient energy delivery, reducing losses and minimizing the environmental impact of electricity distribution.

Support Energy Transition: This program supports the transition to electrification by ensuring sufficient grid capacity to accommodate the wider adoption of DERs and electric vehicles. This will contribute to a reduction in emissions, promoting cleaner air and a healthier environment.

Minimize Environmental Contamination: This program contributes to minimizing the risk of environmental contamination from the electricity distribution system and enhances grid sustainability. Reducing the likelihood of pole failures and potential oil spills from overhead transformers, by strategically burying overhead power lines and reinforcing existing and new overhead infrastructure. The reinforcement of new and existing overhead assets also promotes sustainability by extending the lifespan of grid assets, reducing the need for replacements and minimizing the environmental impact of manufacturing and disposal processes. The program also promotes the use of observability devices to improve monitoring of grid assets, enabling preventative maintenance and reducing the likelihood of environmental contamination through failure

3.5. PROGRAM COSTS

The annual spend for the Distribution Enhancement Capital Program is expected to total $92.8M over the 2026-2030 period which is an increase from the $27.5M spend during the 2021-2025 timeframe.

The increased expenditure in this program is driven by the creation of two new budget programs: Distribution System Observability and Distribution System Resilience. These programs were established in response to the increasing frequency of adverse weather events, the need for grid modernization, and customer feedback. Investments in these programs include strategic undergrounding of distribution assets, grid modernization technologies, and enablement of DERs to enhance grid resilience and observability. This increased investment aligns with customer priorities for improved reliability, resilience during extreme weather events, and grid modernization, as reflected in the customer engagement survey, please refer to Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

Table 7 presents the historical and projected future expenditures by the underlying Budget Programs, as a part of the Distribution Enhancement Capital Program. The underlying Budget Programs are detailed in the subsequent sections.

Table 7 - Historical, Bridge and Test Year Distribution Enhancements Budget Program Costs ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EOL Voltage Conversion	$ 1.4	$ 0.2	$ 0.1	-	-	-	-	-	-	-
Distribution System Reliability	$ 0.4	$ 1.0	$ 1.5	$ 8.0	$ 6.0	$ 0.9	$ 2.2	$ 0.8	$ 0.9	$ 0.9
Distribution Enhancements	$ 0.6	$ 2.0	$ 1.2	$ 2.7	$ 2.3	$ 3.7	$ 3.9	$ 4.1	$ 4.2	$ 4.4
Distribution System Observability	-	-	-	-	-	$ 5.6	$ 5.8	$ 6.1	$ 6.3	$ 6.6
Distribution System Resilience	-	-	-	-	-	$ 7.2	$ 7.6	$ 7.4	$ 7.2	$ 6.9
ANNUAL TOTAL	**$ 2.4**	**$ 3.3**	**$ 2.8**	**$ 10.7**	**$ 8.3**	**$ 17.5**	**$ 19.4**	**$ 18.5**	**$ 18.6**	**$ 18.8**
5-YEAR TOTAL	**$ 27.5**					**$ 92.8**				

3.5.1. Distribution System Reliability

The spend for the Distribution System Reliability Budget Program, as a part of the Distribution Enhancement Capital Program, is expected to total $5.8M over the 2026-2030 period which is a decrease from the $16.9M spend during the 2021-2025 timeframe.

This program is designed to enhance the overall reliability of the electricity distribution system through a range of initiatives that bolster system performance and mitigate outages. This program accounts for 6% of the overall Distribution Enhancement Capital Program budget.

3.5.2. Distribution Enhancements

The spend for the Distribution Enhancements Budget Program, as a part of the Distribution Enhancement Capital Program, is expected to total $20.3M over the 2026-2030 period which is an increase from the $8.9M spend during the 2021-2025 timeframe.

The Distribution Enhancements Program is designed to modernize and enhance grid infrastructure to accommodate the growing integration of DERs and optimize system performance. This program accounts for 22% of the overall Distribution Enhancement Capital Program budget.

3.5.3. Distribution System Resilience

The spend for the Distribution System Resilience Budget Program, as a part of the Distribution Enhancement Capital Program, is expected to total $36.3M over the 2026-2030 period with investments in strategic distribution system resilience, balancing risk mitigation with program costs. Key investments include $23.4M for feeder undergrounding of vulnerable OH sections, $1.0M for line reinforcement, $1.1M for feeder reconfiguration, $8.6M for station egress undergrounding, and $2.1M for line relocation.

The Distribution System Resilience Program is a new budget program designed to enhance the resilience of the electricity distribution network against the increasing frequency and intensity of adverse weather events. This program accounts for 39% of the overall Distribution Enhancement Capital Program budget.

3.5.4. Distribution System Observability

The spend for the Distribution System Observability Budget Program, as a part of the Distribution Enhancement Capital Program, is expected to total $30.4M over the 2026-2030 period. To enable remote feeder control, the program entails installing 20 automated overhead switches and 5 automated underground switches annually. This would achieve 30% automation of existing normally-open switches on the 8kV, 28kV and 44kV systems for a total investment of $25.4M. Additionally, implementing real-time visibility requires installing 50 Fault Circuit Indicators (FCIs) annually for a total of $5.0M.

The Distribution System Observability Program is a new budget program introduced to enhance grid reliability, flexibility, resilience, and customer engagement, while promoting sustainability. This program aligns with Hydro Ottawa's Grid Modernization Strategy. This program accounts for 33% of the overall Distribution Enhancement Capital Program budget. This strategy responds to the need to modernize deteriorating infrastructure, accommodate decarbonization efforts, and meet changing customer expectations. Further details on the Grid Modernization Strategy are available in Section 5.2.2.1 of Schedule 2-5-4 - Asset Management Process.

3.5.5. Cost Factors

Infrastructure Costs: This covers the direct costs of new equipment (transformers, feeders, substations, etc.), materials, labour for installation and construction, and any necessary land acquisition or easements. The complexity and scale of the infrastructure required directly impact these costs.

Project Complexity: The complexity of a project influences engineering, design, and project management costs. Projects requiring significant system reconfiguration, upgrades in congested areas, or specialized engineering solutions will incur higher costs. For example, upgrading a substation in a densely populated area is more complex and expensive than a similar upgrade in a less congested location.

Location and Terrain: Geographic factors, such as terrain, accessibility, and proximity to existing infrastructure, can significantly affect costs. Difficult terrain may require specialized construction techniques, while remote locations can increase material transportation and labour costs. Urban environments often present challenges related to right-of-way acquisition and traffic management, adding to project expenses.

Material Costs: Fluctuations in the cost of materials, particularly copper, steel, and electrical components, can lead to higher-than-anticipated expenses due to market volatility or supply chain disruptions.

Labour Costs: Labour shortages or the need for specialized skills could drive up labour costs.

Project Scope Changes: Unexpected changes in project scope, such as the need for additional capacity or the emergence of new regulatory requirements, can lead to cost increases. The contingency provides a financial cushion to absorb these unforeseen expenses.

Technical Challenges: Unforeseen technical challenges encountered during construction or the integration of new infrastructure with existing systems may necessitate additional resources, design modifications, or specialized expertise, all of which can impact project costs.

Project Delays: Delays caused by external factors, such as adverse weather conditions, community opposition, or permitting issues, can prolong project timelines. Extended timelines often result in increased labour and material costs, which are mitigated by the contingency allocation.

Financing and External Funding: The cost of financing the program, including interest rates on any borrowed capital, is a component of the overall program cost. These costs can vary based on market conditions and Hydro Ottawa's financing strategies. To help offset costs, Hydro Ottawa has pursued external funding opportunities, such as the contribution agreement for federal funding to support the ODERA project, more details can be found in Section 3.6.3.1 - Preferred Alternative Details.

Inflation: The impact of inflation on material, labour, and other project costs is considered in long-term planning. Inflation can erode the purchasing power of budgeted funds, so appropriate escalation factors are applied to cost estimates.

3.6. ALTERNATIVES EVALUATION

Hydro Ottawa assessed the three alternatives described below in Section 3.6.1 - Alternatives Considered under the evaluation criteria of Section 3.6.2 - Evaluation Criteria. Table 8 summarizes the costs for each of the three alternatives.

Table 8 - 2026-2030 Distribution Enhancements Program ($'000 000s)

Budget Programs	Alternative 1: Historical Approach	Alternative 2: Accelerated Approach	Alternative 3: Balanced Approach (Preferred)
Distribution System Reliability	$ 5.0	$ 5.8	$ 5.8
Distribution System Enhancement	$ 16.8	$ 20.3	$ 20.3
Distribution System Observability	-	$ 166.3	$ 30.4
Distribution System Resiliency	-	$ 178.5	$ 36.3
TOTAL	**$ 21.7**	**$ 370.9**	**$ 92.8**

Alternative 1 - Historical Approach

This alternative represents a continuation of Hydro Ottawa's historical investment strategy, focusing solely on maintaining existing programs and initiatives related to the Distribution Enhancements Capital Program. This approach prioritizes the established Distribution System Reliability and Distribution System Enhancements budget programs but does not include any new initiatives to improve system resilience or observability.

Alternative 2 - Accelerated Approach

This alternative demonstrates a proactive approach to addressing emerging challenges, it proposes an aggressive acceleration of investment in Hydro Ottawa's Distribution Enhancements Capital Program. This includes significant increases in funding for the established Distribution System Reliability and Distribution System Enhancements budget programs, along with substantial investments in the Distribution System Observability Program and the Distribution System Resilience Program. Specifically, Option 2 involves the installation of more automated devices and more extensive storm hardening and undergrounding resilience projects. This option provides customers with a more immediate improvement in grid reliability, resilience, and observability. While this accelerated approach aims to expedite grid modernization initiatives and proactively address the challenges of climate change, growing demand, and DER integration, it has significant financial implications, notably resulting in higher increased rates for customers due to the substantial investments required for these upgrades and automated systems.

Alternative 3 - Balanced Approach

This alternative represents a balanced and strategic approach to enhancing Hydro Ottawa's Distribution Enhancements Capital Program. It proposes increasing investments in the established Distribution System Reliability and Distribution System Enhancements budget programs while also prioritizing targeted investments in the Distribution System Observability Program and the Distribution System Resilience Program. This approach complements the existing programs and strikes a balance between enhancing grid resilience and observability while maintaining fiscal responsibility and ensuring a reasonable overall cost.

3.6.1. Alternatives Considered

Alternative 1 - Historical Approach

This alternative represents a continuation of Hydro Ottawa's historical investment strategy, focusing on maintaining existing programs and initiatives related to the Distribution Enhancements Capital Program. This approach prioritizes the established Distribution System Reliability and Distribution System Enhancements budget programs but does not include any new initiatives to improve system resilience or observability. While this approach may address immediate operational needs, it lacks the foresight to adapt to the evolving energy landscape, including the increasing need for climate change resilience. It potentially leaves the electricity distribution network vulnerable to emerging challenges and hinders the ability to fully leverage new technologies and opportunities.

The total cost for Distribution Enhancements Capital Program would be $21.7 M which equates to an annual average spend of $4.3M over the 2026-2030 period which is a decrease from the $5.5M average annual spend during the 2021-2025 timeframe. The breakdown of these costs under this scenario is as follows:

- **Reliability**: This alternative would encompass distribution system reliability initiatives which include worst feeder betterment through feeder reconfiguration, load balancing, protection coordination, new feeder ties and animal guards. The initiative also includes phase balancing across distribution feeders, transfers and reconfiguration for feeders exceeding planning capacity, second supply for radial feeds, and ties between stations. These initiatives would total $5.0M over the five year period.
- **Enhancements**: Minor distribution enhancement initiatives encompass third party pole ownership transfers, 13 kV neutral ties between subtransmission stations. The investment required would be $16.8 M over the five year period.
- **Resilience & Flexibility**: None
- **Grid Modernization**: None

Alternative 2 - Accelerated Approach

Hydro Ottawa will continue its existing Distribution Enhancements Capital Program investments, with a reinforced commitment to bolstering resilience and observability. This will be achieved by allocating additional resources to undergrounding, reinforcing, and automating a larger proportion of the distribution system. This alternative builds upon the existing System Reliability and Distribution Enhancements programs by significantly increasing investments in resilience and grid modernization initiatives in order to complete a greater number of projects.

The investment required for the accelerated approach is estimated to be $5.8M for distribution system reliability, $20.3M for distribution enhancements, $166.3M for observability and $178.5M for resilience, for a total of $370.9M over the 2026-2030 period.

- **Reliability**: Increase in reliability investment over the decelerating scenario, with a total of $5.8M spent over five years for worst feeder betterment, phase balancing, reconfiguration, and station ties.
- **Enhancements**: Increase in system enhancement investment over the decelerating scenario, with a total of $20.3M spent over five years for third party pole ownership transfers, 13 kV

neutral ties and DER enablement initiatives. This alternative introduces flexible load dispatch enablement activities through a pilot project that will leverage Predictive Analytics and customer-owned DERs/assets with advanced integrations to predict both grid loading and available load curtailment potential. This information will facilitate granular scheduling and deployment of load curtailment to mitigate predicted equipment overload and maximize the grid capacity.

- **Resilience & Flexibility**: Investment for undergrounding and storm hardening measures to further enhance the system's ability to withstand severe weather through additional line reinforcement, line relocation, and station egress undergrounding. These investments will improve flexibility in outage response by allowing the grid to be more adaptable and responsive to outages, enabling faster power restoration. They will also allow the grid to recover more rapidly from disruptions, leading to improved overall system stability. Investment in strategic undergrounding of distribution feeders would total $115M over five years, line reinforcement would total $5M, feeder reconfiguration $5.5M, station egress undergrounding $42.5M, and line relocation $10.5M, for a total investment of $178.5M over five years for distribution system resilience.
- **Grid Modernization**: Under the new Distribution System Observability program introduces substantial investments in real-time visibility and remote control of feeders, a pilot of self-healing grid capabilities, and a centralized wireless device management system. Remote control of feeders would entail the annual installation of 92 new automated overhead switches and 45 new automated underground switches annually, resulting in 100% automation of all existing normally-open overhead and underground switches on the 8kV, 28kV and 44kV systems over the 5 year periods. The cost of the automated switch investment would be $158.8M over the five year period. Investment in real-time visibility would entail the installation of 75 FCIs on an annual basis for a total of $7.5M over the 5 years. These projects aim to improve situational awareness, reduce outage durations, enhance efficiency, and bolster cyber security for a total of $166.3M over 2026-2030.

Alternative 3 - Balanced Approach

In this alternative, in addition to the existing programs of System Reliability and Distribution Enhancements, targeted and strategic investments will be made in the System Resilience and System Observability programs.

The investment required for the recommended approach is estimated to be $5.8M for distribution system reliability, $20.3M for distribution enhancements, $30.4M for observability and $36.3M for resilience, for a total of $92.8M.

- **Reliability**: Total of $5.8M invested over five years for worst feeder betterment, phase balancing, reconfiguration, and station ties, the same proposal as under Alternative 2.
- **Enhancement**: Total of $20.3M invested over five years for third party pole ownership transfers, 13 kV neutral ties and DER enablement initiatives. This alternative introduces flexible load dispatch enablement activities through a pilot project that will leverage Predictive Analytics and customer-owned DERs/assets with advanced integrations to predict both grid loading and available load curtailment potential. This information will facilitate granular scheduling and deployment of load curtailment to mitigate predicted equipment overload and maximize the grid capacity. This is the same proposal as under Alternative 2.
- **Resilience & Flexibility**: This option will enable fewer customers affected by major storms, faster restoration efforts, increased flexibility in responding to outages, and quicker system recovery and stabilization after storms, all at a significantly lower cost compared to the accelerated approach. In this alternative, resilience investments were proposed to balance resilience risk mitigation with investment levels. Investment in strategic undergrounding of distribution feeders would total $23.4M over five years, line reinforcement would total $1.0M, feeder reconfiguration $1.1M, station egress undergrounding $8.6M, and line relocation $2.1M, for a total investment of $36.3M over five years for strategic distribution system resilience.
- **Grid Modernization**: Targeted investments in real-time visibility and remote control of feeders to enhance situational awareness and reduce outage duration. Remote control of feeders would

entail the annual installation of 20 new automated overhead switches and 5 new automated underground switches, resulting in 30% automation of all existing normally-open overhead and underground switches on the 8kV, 28kV and 44kV systems over the five year period. The cost of the automated switch investment would be a total of $25.4M over the five year period. Investment in real-time visibility would entail the installation of 50 FCI's on an annual basis for a total of $5.0M over the five year period. These projects aim to improve situational awareness, reduce outage durations, enhance efficiency, and bolster cyber security at a total cost of $30.4M over the five year period.

3.6.2. Evaluation Criteria

System Reliability

This criterion assesses the distribution system's ability to provide uninterrupted power to customers. Reliability enhancements aim to reduce the frequency and duration of outages by addressing aging infrastructure, load imbalances, early detection of equipment failures and system reconfiguration to build redundancy.

System Resilience

This criterion evaluates the distribution system's ability to withstand disruptions and recover quickly from extreme weather events or unexpected events.

Hydro Ottawa's distribution system has been significantly impacted by a recent series of severe weather events, notably the 2022 Derecho storm. The Ottawa region is also experiencing an increase in the frequency and intensity of extreme weather events, including tornados, lightning storms, ice storms and heavy snowfalls, highlighting the need for ongoing investment in grid resilience to mitigate the effects of climate change.

System Observability

System observability is critical for enhancing operational awareness and enabling informed decision-making. Increased grid visibility allows Hydro Ottawa to monitor asset health in real-time, detect faults quicker, and optimize power flow. Grid modernization projects under this criterion focus on integrating smart technologies, automated switches, and real-time data analytics. These technologies enable Hydro Ottawa to operate the grid more efficiently, minimize energy losses, improve load management, and support the integration of renewable energy sources.

System Accessibility

This criterion focuses on the ease of accessing available capacity on the distribution network to accommodate growing demand. Projects under this criterion ensure the grid can handle increasing loads without compromising service quality. This may include expanding feeder capacity, building redundancy through inter-station ties, or reinforcing key network sections to support new customer connections or growing energy needs. By improving capacity availability, Hydro Ottawa ensures a flexible system capable of supporting both current and future loads, while minimizing the risk of overloads and voltage drops.

Safety

This criterion prioritizes the protection of both the public and Hydro Ottawa's personnel from electrical hazards. This includes modernizing outdated infrastructure, ensuring proper insulation of overhead lines, increasing clearances in densely populated areas, and adhering to the latest safety codes and standards. Projects may also focus on reducing the risk of faults that could lead to fires, electrical shocks, or equipment failures. By prioritizing safety, Hydro Ottawa minimizes potential risks, enhances system reliability, and creates a safer working environment for utility crews and a more secure electrical system for customers.

Financial

This criterion assesses alternatives based on their cost-effectiveness in meeting system requirements, while simultaneously balancing improvements in distribution system resilience, reliability, automation, and real-time visibility against the goal of minimizing customer rate impacts.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

3.6.3. Preferred Alternative

While Alternative 1 - the Historical Approach offers lower initial costs, it fails to address critical reliability and resilience needs. Maintaining the status quo would leave Hydro Ottawa vulnerable to increasingly severe weather events, resulting in more frequent and prolonged outages, escalating repair costs, and missed opportunities for grid modernization and the enablement of DER integration. Specifically, this approach neglects essential investments in resilience improvements, real-time grid visibility, and remote control capabilities hindering progress towards a modern, reliable, and resilient grid.

The "Do Nothing" approach of Alternative One fails to address the growing challenges facing the distribution system. It prioritizes short-term cost savings over long-term reliability and adaptability, potentially leading to increased costs and service disruptions in the future.

Alternative Two - Accelerated Approach, offers significant enhancements to grid resilience, flexibility, and outage response. However, the high cost and resource requirements associated with its implementation renders it less favourable. The substantial financial investment required does not justify the incremental benefits of completing a larger number of initiatives.

Alternative Three - Balanced Approach, is preferred due to its strategic combination of existing programs with targeted investments in resilience and grid modernization. This approach achieves a balance between enhancing grid reliability and observability while maintaining cost-effectiveness. By prioritizing targeted investments, it provides a strong and adaptable foundation for improving grid performance and enabling advanced flexible load management in a staged approach, allowing for future optimization as technology and the grid needs evolve.

3.6.3.1. Preferred Alternative Details

Distribution System Reliability

This program is designed to enhance the overall reliability of the electricity distribution system through a range of initiatives that bolster system performance and mitigate outages. The initiatives include optimizing feeder configurations, proactively addressing capacity constraints, enhancing system observability through advanced technologies, and improving distribution efficiency.

This program encompasses the following initiatives:

- **Worst Feeder Betterment:** Improving the performance of the most problematic feeders by installing sectionalizing devices (e.g. reclosers and automated switches), upgrading distribution protection, adding animal guards, and reconfiguring feeders. Prioritization for worst feeder betterment is determined through the annual poor performing feeder evaluation and report.
- **Distribution Phase Balancing:** Optimizing the balance of electrical load across feeders to improve efficiency and reduce losses. This is achieved through a combination of strategies, including switching operations and new switch installations, to ensure a more efficient, reliable, and cost-effective power supply for all customers.
- **Feeder Loading Limits:** Addressing overloaded feeders by transferring load through switching operations and installing new switches. These switches provide flexibility for managing load during peak demand periods, enabling system operators to distribute electricity effectively and prevent overloads. Feeder loading limits are assessed and prioritized based on annual peak loading analysis.

- **Feeder Ties:** Enhancing redundancy by extending feeders to provide alternative supply paths, thereby reducing the impact of outages on customers. This involves establishing new connections between existing feeders, allowing for faster restoration of service by isolating faulted sections and rerouting power through alternative pathways.

These initiatives are informed by the reliability assessment process which is further detailed in Section 5.2.2.3 of Schedule 2-5-4 - Asset Management Process.

Distribution Enhancements

The Distribution Enhancements Program is designed to modernize and enhance grid infrastructure to accommodate the growing integration of DERs and optimize system performance. This program encompasses a range of initiatives aimed at improving system reliability, system observability, and fostering technological innovation to enhance grid flexibility and resilience.

This program encompasses the following initiatives:

- **Extending 13 kV Neutral Ties:** This project will establish 13 kV station neutral ties to extend the system neutral between subtransmission stations, along with other minor enhancements. Specifically, this work will be performed on the existing 13 kV distribution system, entailing the installation of approximately 6,700 meters of neutral conductor per year. This will be accomplished by pulling neutral cable through existing ducts of the 13 kV sub-transmission network. Establishing 13 kV station neutral ties will enhance system stability and reliability by providing a stable reference voltage and ensuring proper operation of protective devices. This will minimize the risk of voltage imbalances and potential equipment damage, contributing to a more reliable and resilient network. Annual system studies will inform the prioritization and scheduling of these initiatives.
- **Transferring Critical Lines:** The program will strategically transfer critical overhead lines to Hydro Ottawa-owned poles to enhance control and maintenance capabilities, improving overall

system reliability and efficiency. By owning and managing these poles, Hydro Ottawa can ensure timely maintenance, implement consistent inspection schedules, and proactively address potential issues, minimizing the risk of outages and disruptions, and improving the overall efficiency of grid operations.

- **DER Enablement Initiatives:** This includes pursuing projects that explore DER enablement through renewable energy integration, grid modernization, energy storage, and system integrations that will leverage demand-side resources. Hydro Ottawa is preparing to launch The Ottawa DER Accelerator (ODERA) Project. In March 2025, Hydro Ottawa executed a contribution agreement to access federal funding towards this project, in addition to the investment requested in this program allowing Hydro Ottawa to execute work sooner while not burdening the ratepayer with the associated cost. This innovative pilot project will leverage Predictive Analytics and customer-owned DERs/assets with advanced integrations to predict both grid loading and available load curtailment potential. This information will facilitate granular scheduling and deployment of load curtailment to mitigate predicted equipment overload and maximize the grid capacity.

ODERA Project

The ODERA project is a pilot initiative in the Kanata North region designed to enhance grid reliability and efficiency by optimizing asset utilization, mitigating capacity constraints, and improving long-term asset planning through the strategic deployment of demand-side resources. This approach empowers customers to actively participate in the evolving energy landscape by leveraging their distributed energy resources (DERs). The Kanata North region was selected for this pilot as it has capacity constraints and a higher-than-average history of equipment-related outages, providing an opportunity to test and validate this NWSs while addressing real grid needs.

Planning for the ODERA project commenced in Q4 2024, with the project planned to begin in Q1 2025 and continue through 2028. When complete, Hydro Ottawa will evaluate the feasibility of scaling the technology for use across its distribution territory.

This innovative project will utilize Predictive Analytics and advanced integration of customer-owned DERs/assets to forecast grid loading and assess available load curtailment potential. This information will enable granular scheduling and deployment of load curtailment to mitigate predicted equipment overload and optimizing grid capacity. In this project customers will be incentivized to enroll their devices.

The ODERA project is expected to enhance grid flexibility through the implementation of NWSs and reduce overloading of distribution assets in capacity constrained Kanata North. With sufficient customer participation, this project can effectively manage electricity demand peaks, alleviating capacity constraints and deferring or eliminating the need for costly infrastructure upgrades. Furthermore, it will mitigate equipment overloads, extending asset useful life and reducing premature equipment replacement.

This project aligns with Hydro Ottawa's Grid Modernization roadmap, showcasing the effective integration and management of DERs to address grid capacity challenges.

Distribution System Resilience

The Distribution System Resilience Program is a new budget program designed to enhance the resilience of the electricity distribution network against the increasing frequency and intensity of adverse weather events.

This emphasis on resilience is of paramount importance given that Ottawa has become the weather-alert capital of Canada, experiencing a surge in extreme weather events that place significant strain on and cause damage to the electricity grid. Recent events, such as the devastating 2022 Derecho, tornadoes, ice storms, and flooding, have underscored the vulnerability of the grid and the critical need for proactive measures to enhance its resilience.

This program encompasses the following initiatives:

- **Strategic Undergrounding:** The strategic burying of vulnerable overhead power lines to reduce exposure to weather-related damage. Unlike broad overhead system renewal, strategic undergrounding targets specific vulnerabilities to improve distribution system resilience. This involves undergrounding feeders with the highest benefit-to-cost ratio, focusing on: increasing resilience for critical infrastructure (hospitals, emergency services), addressing wind-related vulnerabilities in open areas with north-south pole lines, and targeting high-impact pole lines to reduce the number of overhead circuits. The identification and prioritization for strategic undergrounding is detailed in Hydro Ottawa's resilience assessment in Section 5.2.2.4 of Schedule 2-5-4 - Asset Management Process.
- **Storm Hardening:** This initiative aims to strengthen existing and new overhead infrastructure against extreme weather by replacing vulnerable wooden poles at critical locations like railway and highway crossings with stronger concrete and composite poles, and by implementing more robust construction standards for lines carrying more than two circuits. To increase loading capability and prevent cascading failures, additional guying and anchoring will be installed on approximately every fifth pole along north-south lines. Stress on poles will be further reduced by shortening span lengths or installing mid-span poles. Prioritization of these reinforcements will be based on pole line orientation and exposure to predominant wind patterns, with north-south lines and areas prone to severe weather receiving immediate attention.

- **Feeder Reconfiguration:** This initiative will optimize the configuration of electricity feeders to improve system redundancy and minimize the impact of outages. This includes reducing the number of customers served by each primary supply segment, implementing ties and distributed automation for looped supplies, and strategic segmentation. Feeder reconfiguration is prioritized based on customer count and the number of laterals.
- **Station Egress Undergrounding:** This initiative will enhance the protection of critical station infrastructure by burying station egress points with more than two circuits.
- **Line Relocation:** This initiative will relocate vulnerable power lines to less exposed areas to reduce the risk of damage. This includes relocating lines from areas that are difficult to access,

with prioritization based on surrounding vegetation and insights from Hydro Ottawa inspections. These inspections consider factors such as the age and condition of the lines, the terrain, proximity to trees, and the history of outages and repairs. This allows for prioritizing line relocations that will have the greatest impact on reducing the risk of damage and improving the reliability of electricity supply.

Distribution System Observability

The Distribution System Observability Program is a new budget program introduced to enhance grid reliability, flexibility, resilience, and customer engagement, while promoting sustainability. This program aligns with Hydro Ottawa's Grid Modernization Strategy.

This program encompasses the following initiatives:

- **Remote Operable Switches:** Remote control of feeders through automated overhead and underground switches on the distribution system. Prioritization of locations based on normally-open tie-points, peak feeder loading, and respective customer count. Hydro Ottawa has set a target to improve Controllability & Observability to provide remote operability to 30% of all normally-open overhead and underground switches by 2030. Refer to Section 6 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement.
- **Smart Fault Circuit Indicators:** Real-time telemetry visibility of distribution feeders at strategic locations on the distribution network. Prioritization of locations based on history of frequent faults, long feeders, major intersections, and worst performing feeders.

These initiatives are critical to provide real time data to enable the adoption and implementation of innovative control and optimization technologies. Hydro Ottawa’s Grid Modernization Strategy, as described in Section 3.4.2 of Schedule 2-5-4 - Asset Management Process, serves as the foundation for the Grid Modernization Roadmap. This Roadmap will guide the prioritization and execution of initiatives to modernize the grid and achieve corporate objectives.

The planned initiatives as guided by the Grid Modernization Roadmap will be executed within the 2026-2030 timeframe. Annual studies will inform the prioritization and scheduling of these initiatives.

If any projects require expedited action due to higher urgency, adjustments may be made, including, switching, deferring, adding, adjusting or removing projects as needed.

3.7. PROGRAM EXECUTION AND RISK MITIGATIONS

3.7.1. Implementation Plan

All initiatives under the Distribution Enhancements Program will be implemented throughout the 2026-2030 period, as shown in Table 9. Annual system studies will inform the program prioritization, and if any projects under this category require expedited action, adjustments may be made, including switching, deferring, adding, altering or removing projects as necessary.

Table 9 - Proposed Projects Under the Distribution Enhancement Program

Year	Proposed Projects
2026-2030	• Worst Feeder Betterment • Distribution Phase Balancing • Feeder Loading Limits • DER Enablement - ODERA Project • 13 kV Neutral Ties • Distribution System Resiliency- Strategic Undergrounding and other Storm Hardening Measures • Distribution System Observability- Switch Automation, Installation of Fault Circuit Indicators, Monitoring and Control Boxes

3.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Distribution Enhancements Program; Table 10 identifies the key risks and corresponding mitigation strategies.

1 **Table 10 - Key Risks for the Distribution Enhancement Program and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.
Regulatory and Compliance Risks	Rapidly changing regulations may require changes to designs (such as how DER's are managed) pose a risk to project delivery, schedule, and budget.	Maintain compliance by integrating industry best practices and regulatory requirements into the upgrade planning process. Conduct regular audits and risk assessments to stay ahead of regulatory deadlines.Participate in regulatory committees and proactively prepare designs for compliance.
Customer Participation and Engagement	Programs involving DER's are reliant on customer participation (such as the ODERA project). Insufficient customer participation in DER programs pose a risk to program delivery and schedule.	Review best practices around customer engagement for DER programming from neighbouring utilities already utilizing similar DERs with programs. Building on those learnings, a pilot program in a targeted area allows Hydro Ottawa to learn about the technological capabilities while gaining a better understanding of the value and experience customers require to participate.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks

Category	Risk	Mitigation
	risk to program delivery cost, schedule, and scope.	early and implementing on a case by case basis.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labour which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.

4. STATIONS ENHANCEMENTS

4.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $2.6M

2026-2030: $3.0M

Budget Program: Station Cyber Security, Station Temp Sensors

Main Driver: Asset Controllability & Observability

Secondary Driver: System Reliability

Outcomes: Operational Effectiveness

The expenditures under the Station Enhancements Program are aimed at increasing visibility into the station assets and improving reliability and operability through increasing remote operability and reporting/alarms. Additionally, this program includes station investments driven by the Station Cyber Security initiative to ensure Hydro Ottawa is able to identify, protect and detect cyber threats on these critical systems. The prioritized projects under the Station Enhancements Program include modifications to existing stations that are made to improve system operating characteristics.

Hydro Ottawa plans to invest $3.0M to address needs under the following categories over the 2026-2030 rate period:

Station Temp Sensors: This initiative's focus is to continue to deploy online monitoring solutions to support the real-time temperature and dissolved gas monitoring of station transformers.

Station Cyber Security: This program's focus is to continue to deploy OT Cyber Security devices in the remaining Hydro Ottawa substations as a network traffic anomaly detection monitoring tool.

4.2. PERFORMANCE OUTCOMES

The implementation of the Station Enhancements Program is expected to lead to improvements in the outcomes detailed in Table 11.

Table 11 - Performance Targets for the Station Enhancement Program

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	Online station transformer monitoring shall help contribute to the proactive management of station transformers and improve observability in terms of available real-time condition information.

4.3. PROGRAM DRIVERS AND NEED

4.3.1. Main and Secondary Drivers

The main and secondary drivers for this program are as follows:

Primary Driver: Asset Controllability & Observability;

Online monitoring solutions are vital in proactively identifying transformers with developing faults. Once a transformer is identified as having a developing fault (electrical or thermal), it can be planned to be removed from service for maintenance, and corrective actions can be proactively implemented. The use of online monitoring helps improve the observability of Hydro Ottawa's station transformers and their relevant proactive management. Asset controllability is also met by implementing station transformer online monitoring systems, based on the control upgrade and automation implementation.

Secondary Driver: System Reliability;

Station transformers have a direct impact on system reliability, as all customers connected would experience a power outage in the event of a failure. Online monitoring solutions will decrease the likelihood of an unexpected transformer failure due to an electrical/thermal fault.

4.3.2. Current Issues

Station Transformer Monitoring

Over half (53%) of Hydro Ottawa's 170 station transformers have reached, or are within 10 years of reaching, their typical useful life. In order to better manage its station transformer fleet, Hydro Ottawa needs to continue to invest in transformer monitoring technologies. Winding temperature and dissolved gas data are necessary to evaluate the health of station transformers and to determine if there are any growing internal defects. However, such online monitoring solutions are not available at many stations. With electrification and growing power demands, the number of station transformers exceeding their planning capacity rating has increased, thereby having electrical or thermal implications on the transformer's remaining useful life.

At several of these stations, transformers can be retrofitted with magnetic-mount Resistance Temperature Detectors (RTDs) and temperature monitoring units to capture, store, and communicate thermal data. Transformers can also benefit from the use of Online Dissolved Gas Analyzers (ODGAs). ODGAs periodically draw samples of oil from the transformer's tank and determine the concentration of various fault gases within the oil. This data is useful for identifying potential electrical and thermal faults as the transformer's condition worsens, but before an actual fault occurs. This allows Hydro Ottawa to remove the transformer from service and plan maintenance strategies accordingly. Existing transformers can be retrofitted with ODGAs to monitor the concentration of combustible gases. Only transformers connected to transmission or sub-transmission systems (44 kV and higher) will be fitted with ODGA units to balance cost vs. benefit.

Station Cyber Security

Remaining substations that don't have the OT Cyber Security sensors represent critical vulnerabilities in the security infrastructure, refer to Section 4.4.4 - Cyber Security and Privacy. These gaps create blind spots in network visibility, hindering real-time threat detection and response capabilities. This leaves these substations susceptible to cyberattacks that can disrupt operations, compromise grid stability, and potentially lead to power outages. Additionally, the lack of comprehensive monitoring across all substations makes it difficult to identify and respond to anomalies, potentially delaying mitigation efforts and increasing the impact of security incidents. This fragmented security posture increases the overall risk profile of the utility company and jeopardizes its ability to maintain reliable and secure power delivery.

4.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the Station Enhancements Program are summarized in the section below.

4.4.1. System Operation Efficiency and Cost Effectiveness

The proposed station enhancements will increase observability on the system by providing live monitoring data, enable more efficient response to station transformer issues and allow for proactive management. Online monitoring solutions provide real-time data for condition assessment and help prevent a potential catastrophic transformer failure and related emergency replacement costs.

4.4.2. Customer

This program improves reliability for customers by enabling proactive management of station transformers reducing the risk of failures from electrical or thermal faults. Additionally, these investments enable Hydro Ottawa to respond more efficiently to station outages, minimizing disruptions and upholding public confidence in Hydro Ottawa's ability to provide reliable service.

4.4.3. Safety

Installing temperature and ODGA monitoring systems reduces the risk of thermal and electrical faults, as well as hot oil being expelled from the pressure release valve. Installing ODGA units reduces the risk of internal faults, as they can be detected in a proactive manner. The program's focus - to mitigate the risks by reducing the likelihood of station transformer failures - enhances the safety of Hydro Ottawa station employees, in particular.

4.4.4. Cyber Security and Privacy

Continuing the deployment of OT Cyber Security sensors in its substations significantly enhances cyber security and privacy. By continuously monitoring network traffic and device behavior, these sensors provide real-time visibility into potential threats, enabling proactive identification and mitigation of cyberattacks. This strengthens the security posture of the substation, reducing the risk of disruptions to critical operations and protecting sensitive data from unauthorized access. With improved anomaly detection and threat intelligence, OT Cyber Security sensors help safeguard grid stability and ensure the reliable delivery of electricity while maintaining the privacy of sensitive operational data.

4.4.5. Coordination and Interoperability

Enhancing system observability through station transformer monitoring will facilitate informed decision-making and support the proactive management of station transformers. Real-time information from ODGA units (specifically on combustible gases) and temperature monitors help detect developing internal faults and plan the next course of action. For example a partial discharge (PD) issue caused by elevated hydrogen gassing would require transformer detanking and an internal inspection to fix the PD source. Potential carbonization of insulating paper in addition to elevated winding temperatures would require transformer offloading and a removal of moisture in paper. By reviewing real-time dissolved gas/temperature data, Hydro Ottawa performs additional analyses to decide on the potential maintenance/refurbishment activity, to avoid a catastrophic transformer failure.

4.4.6. Economic Development

Investing in station transformer monitoring solutions allows for improving the reliability of Hydro Ottawa's distribution system (at its substations). A reliable and accessible power grid is a fundamental requirement for economic development, and this program ensures that Hydro Ottawa can meet the evolving energy needs of the community, fostering a thriving and prosperous economy.

4.4.7. Environment

Implementing station transformer online monitoring systems will reduce the risk of environmental oil contamination caused by failure and oil expulsion.

4.5. PROGRAM COSTS

In the 2021-2025 rate period, a total of $2.6M was invested in station enhancements/improvements through the installation of temperature and ODGA units. In the upcoming 2026-2030 rate period, a planned expenditure of $3.0M will be allocated to the Stations Enhancements Program. This increased level of expenditure will support additional investments for Hydro Ottawa's cyber security program and continue to leverage the installation of station transformer online monitoring systems.

Table 12 summarizes the historical and proposed future spending for the Stations Enhancements Program.

Table 12 - Historical, Bridge and Test Year Stations Enhancement Budget Program Costs ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stations Enhancements	$ 0.1	$ 1.2	$ 0.2	$ 0.7	$ 0.4	$ 0.5	$ 0.6	$ 0.6	$ 0.7	$ 0.7
ANNUAL TOTAL	**$ 0.1**	**$ 1.2**	**$ 0.2**	**$ 0.7**	**$ 0.4**	**$ 0.5**	**$ 0.6**	**$ 0.6**	**$ 0.7**	**$ 0.7**
5-YEAR TOTAL					**$ 2.6**					**$ 3.0**

4.5.1. Station Enhancements

The scope of the Stations Enhancements Program encompasses proposed investments in station transformer online monitors and continuing to enhance station cyber security. Currently, 55 (approximately 32%) of Hydro Ottawas' station transformers have an ODGA monitor installed, while 27 units (approximately 16%) have an online temperature monitor.

Through the station enhancements program, Hydro Ottawa will install temperature monitoring systems on a select fleet of station transformers that currently do not have the ability to monitor winding temperature. The candidate transformers chosen would be based on stations that are close to or exceeding the planning capacity rating, alongside signs of other insulation aging factors such as high insulation moisture content and the presence of dissolved gases.

Hydro Ottawa would also install ODGA units on a select population of station transformers connected to a transmission or sub-transmission system (44 kV and over) without any existing monitoring available. The candidate transformers chosen would be based on the presence of dissolved gases with the potential to result in thermal or electrical faults.

The scope of the station enhancements program through 2026-2030 involves:

- Retrofitting 22 transformers with temperature monitoring systems, which will increase the overall proportion of transformers with a temperature monitor from 16% in 2024 to 28% by 2030
- Retrofitting 10 transformers with ODGA units, which will increase the overall proportion of transformers with an ODGA monitor from 32% in 2024 to 38% by 2030

4.5.2. Cyber Security

The Station Enhancements Program involves a continuation of Hydro Ottawa's cyber security initiatives. It is to continue deploying OT Cyber Security sensors in the 45 remaining substations as a network traffic anomaly detection monitoring medium.

4.5.3. Cost Factors

The cost of initiatives under the Stations Enhancements Program could be influenced by factors such as resource constraints, which may require outsourcing work to third parties, and potential increases in material costs. To mitigate this risk, a dedicated Project Manager shall be assigned to oversee the station enhancement initiatives, alongside planning resourcing for the relevant implementation on-site.

4.6. ALTERNATIVES EVALUATION

4.6.1. Alternatives Considered

To achieve the objectives of the Stations Enhancement program, two alternatives were considered:

Alternative 1: Do nothing; This alternative involves no investments or plans to implement the initiatives of the Stations Enhancements Program.

Alternative 2: Implement the Program as described above; This alternative involves implementing the ODGA and winding temperature monitoring solutions at select station transformers, as determined by analyzing the extent of utilization, loading profile, insulation condition and extent of dissolved gases present.

4.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. By reducing the risk of thermal, electrical, and internal faults, the installation of temperature and ODGA monitoring systems enhances the safety of Hydro Ottawa station employees and the safety of a public reliant on electricity by mitigating the likelihood of station transformer failures.

System Reliability and Observability

This criterion assesses the distribution system's ability to provide uninterrupted power to customers. Station enhancements aim to reduce the frequency and duration of outages by addressing deteriorating station transformer infrastructure and helping with their proactive management. The preferred alternative shall also enhance the ability to monitor or diagnose the state of the station transformers, in line with Hydro Ottawa's grid modernization initiatives/efforts, and reduce the probability of potential failures, leading to improved reliability, fewer outages, and cost savings.

Financial

The preferred alternative is one that leads to relevant planned renewal projects (through proactive monitoring of station transformer condition), where appropriate staffing resources can be allocated, rather than unplanned renewal projects that would lead to costly transformer renewal and take resources away from other work.

Environmental

The chosen alternative shall help mitigate potential environmental risks/concerns around station transformer leaks due to unplanned failures.

Resources

The preferred alternative shall result in fewer unplanned or reactive renewal projects. Advanced planning and visibility into actual station transformer condition will result in greater optimization and allocation of internal and external project resources.

Cyber Security

Deploying OT Cyber Security sensors across all remaining substations strengthens Hydro Ottawa's security posture by eliminating blind spots, enabling proactive threat detection and response, and ensuring the reliable and secure delivery of electricity across the entire grid.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

4.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 4.6.1 - Alternatives Considered under the evaluation criteria of Section 4.6.2 - Evaluation Criteria.

If the Stations Enhancements Program is not executed in the 2026-2030 period (Alternative 1), then station transformers will pose an increased risk to safety and reliability due to an imminent failure risk. Transformers would continue to be unmonitored and new monitoring systems would have to be implemented over a longer timeline alongside new transformer installations.

Failure to implement the Stations Enhancement Program will result in a backlog of end-of-life transformers with unknown operational and condition status. Without online monitoring to detect thermal and electrical faults, the risk of catastrophic transformer failures increases, leading to substantial financial loss. Additionally, long lead times for new station transformer procurement will strain the existing fleet, further elevating failure risk and potentially necessitating additional spending for emergency transformer relocation from other stations.

Failing to deploy OT Cyber Security sensors in all remaining substations leaves Hydro Ottawa vulnerable to cyberattacks and operational disruptions. These unprotected substations become weak points in the grid, susceptible to breaches that could compromise critical systems, disrupt power distribution, and potentially lead to cascading failures across the network. This lack of comprehensive security monitoring hinders timely threat detection and response, increasing the risk of prolonged outages and financial losses. Additionally, it leaves the utility with an incomplete picture of its overall security posture, making it difficult to identify vulnerabilities and implement effective mitigation strategies.

4.7. PROGRAM EXECUTION AND RISK MITIGATIONS

4.7.1. Implementation Plan

Table 13 shows the timeline of proposed projects for the 2026-2030 period.

Table 13 - Proposed Projects under the Stations Enhancements Program

Year	Proposed Projects
2026	Winding Temperature Sensor Installation: • Terry Fox MTS (T1 and T2) • Cyrville MTS (T1 and T2) • South March DS (T2) ODGA Sensor Installation: • Parkwood Hills DS (T1 and T2) Deploy OT Cyber Security sensors: • 15 Substations
2027	Winding Temperature Sensor Installation: • Limebank MS (T1, T2 and T4) • Beaverbrook MS (T1 and T2) ODGA Sensor Installation: • Beaverbrook MS (T1 and T2) Deploy OT Cyber Security sensors: • 15 Substations
2028	Winding Temperature Sensor Installation: • Richmond North DS (T1) • Parkwood Hills DS (T1 and T2) ODGA Sensor Installation: • Rideau Heights DS (T1 and T2) Deploy OT Cyber Security sensors: • 15 Substations
2029	Winding Temperature Sensor Installation: • Janet King DS (T2) • Longfields DS (T1) • Woodroffe DS (T1) • Centrepointe DS (T1 and T2) ODGA Sensor Installation: • Centrepointe DS (T1 and T2)

Year	Proposed Projects
2030	Winding Temperature Sensor Installation: ● Jockvale DS (T1) ● Bayshore DS (T1) ● Moulton MS (T1 and T2) ODGA Sensor Installation: ● Bayshore DS (T1) ● Jockvale DS (T1)

4.7.2. Risks to Completion and Risks Mitigation Strategies

Hydro Ottawa faces several risks in managing its Stations Enhancements Program; Table 14 outlines the key risks and corresponding mitigation strategies.

Table 14 - Key Risks to Stations Enhancements Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.

Category	Risk	Mitigation
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implement mitigation strategies on a case by case basis.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labour which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.

5. GRID TECHNOLOGIES

5.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $20.8M

2026-2030: $6.4M

Budget Program: SCADA Upgrades

Main Driver: System Efficiency

Secondary Driver: Reliability and Security

Outcomes: Operational Effectiveness

The Grid Technologies Program implements robust technical solutions that enhance observability and controllability by combining data acquisition, monitoring and control capabilities to actively manage electricity distribution grid operations. This program focuses on the Advanced Distribution Management System (ADMS) and supports the automation of grid troubleshooting and asset monitoring. This includes the collection of data that supports adjacent programs such as the Enterprise Asset Management system, Data and Systems Integration as well as the complimentary Grid Technology program under the General Plant investment category. The data and adjacent programs are used for preventative, condition-based, and predictive maintenance through data-driven decision-making. These initiatives are key components of the Hydro Ottawa Grid Modernization Strategy, refer to Section 3.4.2 of Schedule 2-5-4 - Asset Management Process.

In total, Hydro Ottawa plans to invest an estimated $6.4M through the Grid Technology program in the 2026-2030 rate period compared to a historical spending of $20.8M in the 2021-2025 rate period. The 2021-2025 rate period was a time of growth and evolution in this program and Hydro Ottawa proactively invested in a consolidated ADMS, which drove a majority of the budget spend. In the 2026-2030 rate period, this program will focus on maintaining the ADMS system through regular platform upgrades and minor enhancements. Implementing a regular cadence of system upgrades is a key practice recommended by the Canadian Center for Cyber Security[16] to reduce vulnerabilities in critical infrastructure.

This program will also integrate a real-time Operational Historian directly into the ADMS platform. While Hydro Ottawa currently uses a Data Historian, as described in Section 6 of Schedule 2-5-9 - General Plant Investments, for long-term planning, analysis, and strategic decisions, this new Operational Historian will focus on real-time operations, process monitoring, and immediate decision support for the control room. It will provide real-time trends and operational insights to enable data-driven decisions.

5.2. PERFORMANCE OBJECTIVES AND TARGETS

The implementation of the Grid Technologies program is expected to maintain outcomes as detailed in Table 15.

Table 15 - Performance Outcomes for Grid Technologies

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	Hydro Ottawa's Operational Effectiveness objectives are supported by: ● The performance target for Hydro Ottawa's Class A Systems is 99.9% availability. This target is defined as a maximum allowable downtime of 4 hours and a maximum allowable data loss of 24 hours.

[16] Canadian Center for Cyber Security, Cyber threat to operational technology https://www.cyber.gc.ca/en/guidance/cyber-threat-bulletin-cyber-threat-operational-technology

5.3. PROGRAM DRIVERS AND NEED

5.3.1. Main and Secondary Drivers

Primary Driver: System Efficiency

- **Unified Platform:** Upgrading the ADMS modules and implementing an Operational Historian creates a single, cohesive platform. This simplifies data management, reduces potential points of failure, and streamlines system configuration and maintenance.
- **Seamless Data Exchange:** The Operational Historian is built to work directly within the ADMS ecosystem. This eliminates the need for complex interfaces and allows for smooth, efficient data transfer between the upgraded ADMS modules and the Historian. This reduces latency and ensures data integrity.
- **Optimized Data Handling:** The proposed solutions are designed to handle the increasing volume and velocity of data generated by modern grid operations. This allows the ADMS system to scale to meet future demands without compromising performance. It also prevents the ADMS from being cluttered with data needed for long term planning and analysis.
- **Faster Processing and Analysis:** Upgrading the ADMS modules unlocks performance enhancements for data processing and analysis. Combined with the Operational Historian's efficient data storage and retrieval, this leads to faster response times for critical applications and improved overall system responsiveness.

Secondary Driver: Enhanced Reliability and Adaptive Grid Flexibility. The proposed solution will provide the control room with a reliable, resilient platform that supports effective decision-making based on real-time conditions and immediate trends, reducing time for error identification and correction.

5.3.2. Current Issues

The Grid Technology program aims to address the following challenges:

- **Missed Opportunities for Optimization:** Simplification of systems used by the control room and specialization of systems to support operational trends and analysis supporting corrective or preventative actions.
- **Increased Cyber Security Risks:** Older ADMS modules might have known vulnerabilities, increasing the risk of cyberattacks.

5.4. PROGRAM BENEFITS

The benefits of this program are as follows:

Unified Platform: This streamlines data flow, enhances interoperability between applications, and simplifies system management.

- **Enhanced Performance:** Upgrading the ADMS modules unlocks performance improvements in data processing, analysis, and visualization. Combined with the Operational Historian's optimized data handling capabilities, this results in faster response times, improved grid awareness, and enhanced decision-making.
- **Advanced Analytics:** An upgraded ADMS platform, coupled with the Operational Historian, enables advanced analytics and reporting functionalities. This allows Hydro Ottawa to gain deeper insights into grid performance, identify trends, optimize operations, and proactively address potential issues.

5.5. PROGRAM COSTS

The historical period represents the purchase and installation of the ADMS platform which extended functionality beyond the pre-existing SCADA system. This was a period of significant growth in functionality and resulted in a temporary increase in program expenditure. Details on the increase over initial cost expectations are explained in Section 5.3.2 of Schedule 2-5-5 - Capital Expenditure Plan.

Hydro Ottawa notes that the ADMS program is currently undergoing a comprehensive review. Therefore, specific details of the Grid Technology budget program, including the capital budget, are subject to significant change. Updated information and supporting documentation related to the program will be filed no later than with responses to interrogatories. Hydro Ottawa believes this approach will still allow stakeholders to assess the program within the context of the rate application process.

The future costs are to maintain this platform, adopt incremental enhancements, improve performance as the vendor releases new updates, and ensure the system is running on suitable and reliable hardware. Hydro Ottawa has minimized the controllable costs with this program as it is replacing multiple standalone operational tools with the ADMS platform.
It is also important to note that Communications Infrastructure has been removed from this program and is now represented in Section 6 - Field Area Network.

Table 16 - Grid Technology Historical, Bridge and Test Year Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SCADA Upgrades	$ 0.2	$ 2.6	$ 5.6	$ 5.7	$ 6.8	-	-	-	-	-
ADMS Upgrades & Enhancements	-	-	-	-	-	-	$ 1.0	$ 0.1	$ 5.0	$ 0.3
TOTAL	**$ 0.2**	**$ 2.6**	**$ 5.6**	**$ 5.7**	**$ 6.8**	**-**	**$ 1.0**	**$ 0.1**	**$ 5.0**	**$ 0.3**
5-YEAR TOTAL					**$ 20.8**					**$ 6.4**

5.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations from established partners to inform the expected costs of the Grid Technology program. Special attention has also been spent on improving forecasting models to reflect a unified software implementation approach that does not just look at technical implementation costs but considers a more comprehensive approach inclusive of internal labour. Forecasted costs included the following factors:

- Software licenses
- Professional services
- Internal and external labour
- Annual support fees as included in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs

Like any other multi-year project, this program will be subject to inflationary increases in labour costs. All equipment costs are estimated and many are yet to be purchased. Software and professional service costs may increase before a final agreement is signed.

5.6. ALTERNATIVES EVALUATION

5.6.1. Alternatives Considered

In order to meet the objectives of the Grid Technology program, three alternatives were considered:

Alternative One: Run to Failure; Do not upgrade, or enhance the systems. This alternative can result in a cascade of negative outcomes that impact various aspects of the business, including:

- Inability to meet service level agreements: outdated software and hardware are error-prone and system availability will not meet operational needs.
- Increased security risks: Outdated software is more vulnerable to cyberattacks, risking outages, equipment damage, data breaches, and safety hazards. This risk grows exponentially as systems age and vulnerabilities are discovered.
- Inefficient grid operations: This leads to slower outage response, higher energy losses, difficulty integrating renewable energy sources, and challenges in meeting growing demand, ultimately impacting customer satisfaction and grid reliability.
- Compliance challenges: Using outdated software may make it difficult to comply with evolving regulatory requirements for grid reliability, cyber security, and data protection, leading to penalties.
- Missed opportunities: Neglecting upgrades means missing out on new features, functionalities,

and improvements that could enhance efficiency, optimize the grid, and support innovation.

- Increased technical debt: Delaying upgrades makes future modernization efforts more complex and costly.

Alternative Two: Maintain; Upgrade the system when it reaches end-of-life, do not deploy new modules or enhance ADMS. This alternative will provide:

- Enhanced security: Upgrading to the latest versions ensures Hydro Ottawa core software has the latest security patches, minimizing vulnerabilities and strengthening defenses against cyberattacks.
- Improved system performance and stability: Newer versions often come with performance enhancements, bug fixes, and new features, improving the efficiency and reliability of individual systems.

Alternative Three: Upgrade and Enhance (Recommended); Upgrade the system and enhance capabilities with an Operational Historian. This will provide all the benefits of Alternative Two plus:

- Better data accessibility and analysis: Consolidating the Operational Historian into the ADMS platform will enable better analysis, informed decision-making, and optimized grid operations.
- Streamlined workflows: Consolidating software and moving functionalities to existing systems reduces complexity, eliminates redundancies, and streamlines workflows, which improves productivity and reduces manual effort.
- Improved innovation and agility: A modernized and integrated software environment allows for better data analysis, supporting innovation and faster adaptation to changing business needs.
- New functionalities: The fully-integrated Operational Historian offers built-in features and functionalities that are not available from a Planning Historian.

5.6.2. Evaluation Criteria

Reliability & Resilience

This criterion assesses the ability to meet service level agreements and provide uninterrupted connectivity to grid assets to enable observability and control during any adverse conditions. System upgrades aim to improve the network resilience and security. Resilience focuses on the system's ability to quickly recover from physical damage, as well as cyber attacks.

Operational Efficiency

This criterion considers the ability to position Hydro Ottawa to “do more, more quickly” in response to increasingly complex demands. Incorporating automation reduces manual effort, which improves efficiency. Facilitating data analysis and visualization enables informed decision-making and grid optimization.

Enabling Grid Modernization

This criterion evaluates how effectively the alternative can handle the need to monitor and control an increasing number of field devices. This capability is crucial for Hydro Ottawa to ensure safe supply of electricity for customers. The ideal solution should integrate seamlessly with AMI, DERs, and remote sensors.

5.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 5.6.1 - Alternatives Considered under the evaluation criteria of Section 5.6.2 - Evaluation Criteria.

The recommended approach, Alternative Three, involves implementing the Operational Historian within the ADMS platform and committing to ongoing upgrades. This approach creates a centralized hub for all grid data, empowering comprehensive analysis and informed decision-making through advanced analytics and reporting tools. By having access to both historical and real-time data, operators can identify trends, predict potential failures, and optimize grid operations for enhanced efficiency and stability. Furthermore, staying current with the latest ADMS version unlocks access to cutting-edge features, security enhancements, and improved performance, while ensuring ongoing vendor support and performance of this mission-critical tool.

This strategy also positions Hydro Ottawa to respond to Grid Modernization requirements such as integrating new technologies (e.g. DERs), and adapting to the evolving energy landscape with agility and resilience. Ultimately, this investment translates to improved reliability, reduced downtime and faster outage restoration, leading to increased customer satisfaction and a more robust and sustainable grid.

5.7. PROGRAM EXECUTION AND RISK MITIGATION

5.7.1. Implementation Plan

The Grid Technology Program projects are planned to be executed over the 2026-2030 rate period. Each project has a different duration, can be divided into phases, and can overlap with other projects depending on the resources and systems involved. Table 17 shows the projects proposed for the 2026-2030 rate period.

Table 17 - Proposed Projects under the Grid Technologies Program

Year	Proposed Projects
2026-2027	• ADMS Platform Upgrade Phase 1: Upgrade all software modules
2029-2030	• ADMS Platform Upgrade Phase 2: Upgrade all modules and supporting hardware • Operational Historian module deployment

5.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Grid Technologies Program. The key risks and corresponding mitigation strategies are detailed in Table 18.

Table 18 - Key Risks of the Grid Technologies Program and Mitigation Strategies

Category	Risk	Mitigation
Business Requirements and schedule	Changing business requirements or schedules can complicate project planning and increase costs.	Regularly engage with business to anticipate and adjust for changing business needs due to the evolution of electrification. Follow the larger IT project intake process for annual planning, ensuring resource availability and mitigating delays.
Financial Impact	Cost overruns or budget shortfalls may occur due to unexpected expenses.	Develop detailed budgets with contingencies and monitor financial performance closely throughout the project lifecycle.
Project Management	Poor project management could lead to delays or inefficiencies.	Utilize skilled Project Managers to ensure adequate management and oversight.
Resource Availability	Shortages in skilled labour may hinder project progress.	Plan resource needs well in advance and maintain strong relationships with suppliers and contractors to secure reliable access to critical resources.
User adoption and training challenges	Resistance to change or inadequate training could lead to low user adoption and hinder the realization of project benefits.	Involve users in the planning and implementation process. Provide comprehensive training programs and support materials. Communicate the benefits of the new system clearly. Encourage user feedback and address any concerns.
Vendor dependence	Over-reliance on a single vendor for the ADMS platform and historian could lead to limited flexibility and potential lock-in.	Negotiate favorable contract terms and service level agreements. Ensure close follow-up on items and tasks.

5.8. RENEWABLE ENERGY GENERATION

By renewing the ADMS platform, Hydro Ottawa is better prepared to add additional products for renewable energy generation like a DERMS module. This module is part of the Control and Optimization Program discussed in Section 7 - Control and Optimization. It will provide visibility to operators and other relative departments for system loading and data captures for renewable energy generation.

6. FIELD AREA NETWORK

6.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $1.9M

2026-2030: $20.8M

Budget Program: OTN Fiber Network Resilience, Wireless Communication, Reliability & Remote Testing, Intelligent Electronic Device Management (IEDM), OTN Cyber Security

Main Driver: System Efficiency

Secondary Driver: Enhanced Reliability

Outcomes: Operational Effectiveness

The Field Area Network (FAN) Program is key to Hydro Ottawa's Digital Strategy detailed in Attachment 1-3-4(B) - Digital Strategy and Grid Modernization Strategy described in Section 3.4.2 of Schedule 2-5-4 - Asset Management Process, enabling grid automation and modernization initiatives.

This program is composed of initiatives that ensure robust, reliable communication infrastructure to handle Hydro Ottawa’s most sensitive, mission-critical information. This infrastructure connects grid-edge devices with central monitoring and control systems such as ADMS and is a key enabling technology for Grid Modernization. This builds on Hydro Ottawa’s Telecommunications Master Plan investment from 2016-2020 which created a fiber optic ring connecting Hydro Ottawa offices and substations. This plan also builds on pivotal decisions made by the Canadian Radio-television and Telecommunications Commission (CRTC)[17] and Innovation, Science and Economic Development

[17] CRTC, Telecom Decision CRTC2022-181 https://crtc.gc.ca/eng/archive/2022/2022-181.htm

Canada (ISED)[18] during the 2021-2025 rate period which creates opportunity for critical infrastructure to leverage the flexibility of a low cost, reliable Long-Term Evolution (LTE) network.

The Field Area Network Program is comprised of the following initiatives over the 2026-2030 rate period:

Optical Transport Network (OTN) Fiber Network Resilience: Expand and upgrade network infrastructure through the installation of diverse network paths, modernize the optical transport network with higher-capacity technology, and implement remote optical time-domain reflectometry (OTDR) capabilities for proactive and faster fault detection. This will create a more efficient and resilient communication network.

Wireless Communication: This is a continuation of the wireless communication initiative deferred from the 2021 to 2025 rate period. Wireless communication is increasing in application and importance with the expansion of Internet of Things (IoT) devices. Utilities are now facing decisions on whether to continue with public LTE or to explore more tailored, reliable, private LTE (PLTE) networks to meet enhanced security, reliability, and resilience requirements of wireless communication. In the 2021-2025 rate period, Hydro Ottawa engaged Black & Veatch to perform an assessment of wireless technologies. This study detailed in Attachment 2-5-8(A) - Wireless Technology Study assessed Hydro Ottawa's objectives and technical requirements against various solutions. Based upon the study findings, Hydro Ottawa has elected to adopt a cautious but future-focused approach and will pilot wireless technologies to advance learning in this space. The pilot will consist of deploying a PLTE pilot site and an Evolved Packet Core which is responsible for ensuring secure and reliable data transmission and maintaining quality of service for various components. The results of the pilot will be used for the 2031-2035 Wireless Network Strategy.

[18] ISED, Technical Requirements for Non-Competitive Local Licensed Services, Including Fixed and/or Mobile Systems, and Flexible Use Broadband Systems, in the Band 3900-3980 MHz. https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/devices-and-equipment/standard-radio-system-plans/srsp-521

Intelligent Electronic Device Management (IEDM): The convergence of IT and OT has been the focus of much discussion across the industry. A recent Global Cyber Security Alliance post[19] noted that one aspect of this convergence is the need to use IT tools and practices to manage intelligently connected OT solutions. The IEDM initiative will deploy a central configuration management solution to provide a real-time device inventory for connected Remote Terminal Units (RTU's), including installed patches and firmware versions. This solution will also provide a repository for security patches as well as patch deployment capabilities to reduce vulnerabilities.

This solution will also enable the collection of oscillographic data and sequence of event (SOE) data providing a centralized, easily accessible repository of information to begin troubleshooting a disturbance or fault. Additional efficiency will be realized through this solution by reducing the need for on-site service visits.

OTN Cyber Security: This initiative will implement necessary cyber security improvements in the FAN to protect critical infrastructure, ensure grid stability, and safeguard data integrity.

6.2. PERFORMANCE OBJECTIVES AND TARGETS

The implementation of the Field Area Network Program is expected to lead to improvements in the outcomes detailed in Table 19.

[19] Global Cybersecurity Alliance, The Top 7 Operational Technology Patch Management Best Practices https://gca.isa.org/blog/the-top-7-operational-technology-patch-management-best-practices

Table 19 - Performance Outcomes for Field Area Network Program

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	Hydro Ottawa's Operational Effectiveness objectives are supported by: ● Reducing network outages and minimizing downtime through improving network diversity, proactive fiber network fault detection and faster restoration. Service Level Agreement for Class A systems is maximum allowable downtime of 4 hours and a maximum allowable data loss of 24 hours. ● Centralizing the management of 60% of eligible RTUs within the 2026-2030 rate period. ● Piloting different technologies to define the optimal technology or combination of technologies for the future wireless communication infrastructure required for Hydro Ottawa's communication with distribution automation devices, metering devices, land mobile radio, field crew, etc.
Customer Focus and Financial Performance	Hydro Ottawa's Customer Focus and Financial Performance objectives are supported by: ● Contributing to improved asset controllability and system observability through the provision of physical fiber and wireless network connectivity. ● Mitigating escalating telecommunications costs by pro-actively assessing alternatives.

6.3. PROGRAM DRIVERS AND NEED

6.3.1. Main and Secondary Drivers

Primary Driver: System Efficiency; Expansion of intelligent grid-edge devices and the resulting data streams drive grid modernization, creating a flexible system capable of adapting to changing demands and integrating diverse energy resources. Enabling real-time data sharing coupled with remote management and security, optimizes grid performance and avoids costly physical site visits. Essentially, by enabling data sharing and automation, this program minimizes waste, maximizes resource utilization, and enhances grid flexibility.

Secondary Driver: Enhanced reliability; in order to effectively and quickly respond to outage events, the Hydro Ottawa control room must have the ability to view real-time information from sensors and meters as well as to remotely operate switches or other devices (either manually or through advanced software systems such as the ADMS platforms) so that any service interruptions are minimized in both duration and the number of customers affected. Implementing diverse fiber optic cable paths will minimize the impact of disruptions such as rodent damage, construction accidents or natural disasters. Data from the IEDM will enhance the scheduling of maintenance of the equipment and avoiding unplanned downtime. Management of the expanding population of intelligent grid-edge devices is also paramount to ensure Hydro Ottawa's cyber security posture.

6.3.2. Current Issues

The proposed FAN investments are aimed at addressing the following challenges:

Reliability & Resilience: The OTN is designed to be highly available, with most of it featuring both logical and physical redundancy. However, some substations and facilities currently rely solely on logical redundancy. In the event the fiber optic cable serving these locations is damaged, communication outages could last for several days. Implementing physically-diverse fiber connections will minimize the risk of lengthy communication outages.

Number of Grid Devices: Grid Modernization is driving the exponential increase in intelligent grid-edge devices. As more smart meters, sensors and other connected devices are added, the volume of data can lead to network congestion, making it difficult to transmit real-time data. Using a technically-relevant Multiprotocol Label Switching (MPLS) network is paramount to managing the influx of data.

Reliable Final-Mile Connectivity: Connecting intelligent grid-edge devices via a robust, reliable communication channel is a challenge. Using physical fiber to connect major hubs of connected devices, like in a substation, is cost-effective and reliable. However, the exponential increase in grid-edge devices dispersed through Hydro Ottawa's service territory is impossible to connect with physical fiber in a cost-effective manner. Using public carrier networks for hundreds, if not thousands, of devices will be prohibitively expensive and these networks struggle to meet reliability objectives during major events, when situational awareness is paramount.

Lack of Commercially Available Solutions for Critical Infrastructure

Current wireless technologies do not provide the reliability, security, capacity for data-intensive applications, or the resilience in emergencies, needed for utility wireless networks. Grid Modernization and the increased reliance on real-time data from the field emphasize this gap in commercially available solutions.

Technology: Hydro Ottawa faces technology advancement challenges with its communication network as modern smart field devices shift toward next generation communication mediums. The effectiveness of grid operations will heavily depend on seamless communication between these devices and the central controller. Adapting communication infrastructure to meet these requirements will be essential for enhancing the reliability and performance of the grid.

Cyber Security: Hydro Ottawa faces cyber security challenges that can be dangerous, not just to the operations, but also to public safety if the cyberattacks cause outages. To address these challenges, implementing platforms that monitor the grid network devices in real time and refreshing the network in accordance with useful life to ensure the latest security measures are put in place are crucial steps.

6.4. PROGRAM BENEFITS

6.4.1. Support Observability and Advanced Applications

The proposed OTN Fiber Network Resilience initiative will extend Hydro Ottawa's fiber optic network and add targeted diversity for resilience. This initiative will also ensure a stable, supportable MPLS network critical for transporting grid data in real-time. Finally, it will also lead to faster restoration times, improved situational awareness and decision-making.

Hydro Ottawa's enhanced communication network will enable better integration and management of DERs, such as solar and wind power. This improved network allows for greater flexibility and control in managing the variability of these renewable energy sources. This network will also provide access to real-time data required for advanced grid management applications inherent in Grid Modernization.

6.4.2. Increased Efficiency

The proposed initiatives bring several mechanisms of increased efficiency. Robust, reliable communication infrastructure enables remote monitoring and control of grid assets, reducing the need for costly and time-consuming site visits. Facilitating the collection and analysis of real-time data will enable Hydro Ottawa to perform preventative maintenance, reducing the occurrence of unplanned outages as well as their duration.

6.4.3. Flexibility

The proposed OTN Fiber Network Resilience initiative will ensure Hydro Ottawa’s communication backbone is flexible enough to handle both high data volumes and diverse applications across substations and control centers, while also prioritizing critical functions. The variety of data will continue to expand and the MPLS network will be essential in routing traffic based on Quality of Service (QoS) parameters, allowing the network to adapt to changing demands and prioritize the most urgent communications to maintain grid reliability.

6.4.4. Carbon Reduction Through Digitization

Connecting additional grid devices and supplying increased remote capabilities will contribute to cost savings as well as carbon reduction by avoiding unnecessary crew deployment.

6.4.5. Innovation

The proposed wireless pilot will trial two potential wireless spectrums that may be used for critical infrastructure. This work will complement Public Safety Canada’s efforts to establish a public safety broadband network[20] as well as Electricity Canada's efforts to advance spectrum innovation through the Operating Technology & Telecommunications Committee[21].

6.4.6. Cyber Security

As the grid continues to evolve, cyber security must be incorporated at the ground level. All of the proposed initiatives contribute to this benefit in the following ways:

- OTN Fiber Network Resilience will update the MPLS infrastructure to meet compliance with the latest cyber security standards.
- The IEDM initiative will help maintain cyber security compliance by utilizing a managed platform for centrally deploying firmware patches and upgrades to field devices.
- The OTN Cyber Security initiative will aid in early threat protection, detection, response and recovery.

[20] Public Safety Canada, A Public Safety Broadband Network (PSBN) for Canada https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/2021-psbn/index-en.aspx

[21] Canadian Electricity Association, https://www.electricity.ca/news/electricity-canada-hosts-successful-ottc-workshop-in-ottawa-to-advance-utility-innovation-and-spectrum-strategy/

6.5. PROGRAM COSTS

Table 20 provides proposed future spending for FAN programs.

Table 20 - Historical, Bridge, and Test Year Field Area Network Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
OTN Fiber Network Resilience	$ 0.6	-	-	$ 0.3	$ 1.1	$ 1.1	$ 1.4	$ 5.8	$ 3.6	$ 1.6
Wireless Communication	-	-	-	-	-	$ 0.5	$ 2.7	$ 1.0	$ 0.3	$ 0.4
Intelligent Electronic Device Management	-	-	-	-	-	$ 0.7	$ 0.2	$ 0.1	$ 0.1	$ 0.1
OTN Cybersecurity	-	-	-	-	-	$ 0.6	$ 0.6	-	-	-
TOTAL	**$ 0.6**	**-**	**-**	**$ 0.3**	**$ 1.1**	**$ 3.0**	**$ 4.8**	**$ 6.9**	**$ 4.0**	**$ 2.1**
5-YEAR TOTAL					**$ 2.0**					**$ 20.8**

6.5.1. Cost Factors

Hydro Ottawa has received quotations from established partners to inform the expected costs of the Field Area Network program. Forecasted costs for new fiber segments are based on an average cost per kilometer observed in prior fiber installation projects as well as the following other factors:

- Software licenses and hardware
- Professional services
- Internal and external labour
- Annual support fees (included in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs)

Like any other multi-year project, this program may be subject to inflationary increases in labour and equipment costs.

6.6. ALTERNATIVES EVALUATION

6.6.1. Alternatives Considered

Alternative One: Resilience & Security; This option is characterized by a maintain and protect approach. It includes an upgrade of the MPLS to maintain supportability and cyber security compliance and minimal additional fiber footprint to address critical areas of network diversity. Hydro Ottawa's ability to modernize its electric grid, realize operational efficiencies and meet increased demands of intelligent grid devices will be significantly impeded in this scenario.

Alternative Two: Balanced; This option includes a judicious focus on all portions on the Field Area Network Program. It will address physical fiber diversity and grow the fiber footprint to new, operationally meaningful, substations; upgrade the MPLS; and implement remote troubleshooting capabilities to reduce fault location time.

This alternative will also conduct pilots of two non-public wireless spectrums to gain a better understanding of the feasibility and application for utility-specific private LTE. The 700 MHz spectrum, also known as B14, provides dedicated coverage for critical infrastructure that ensures uninterrupted communication during emergencies or periods of high network congestion. This spectrum is well established in the United States for public safety and critical infrastructure but has not yet been widely implemented across Canada due to the pending award of licensing and infrastructure[22]. Until licensing is formally awarded, this spectrum is available for pilot licensing to critical infrastructure. This spectrum is attractive as multiple device manufacturers are already B14-ready.

The N77 (3.9 GHz) spectrum will also be assessed for its ability to support distribution and substation automation. This spectrum has a good balance of capacity and coverage but would have

[22] Innovation, Science and Economic Development Canada. June 2017. Decisions on Policy, Technical and Licensing Framework for Use of the Public Safety Broadband Spectrum https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/learn-more/key-documents/consultations/decisions-policy-technical-and-licensing-framework-use-public-safety-broadband-spectrum-758-763-mhz#sec5.2.

more targeted applications due to its limited range compared with lower bands. This spectrum is already widely recognized by multiple device manufacturers and deployed globally.
The results of these pilots will inform Hydro Ottawa's decision on how best to support and meet the growing need for wireless communication in the modern grid.

This option will also implement an IEDM solution to monitor and collect device performance data to a central location. This platform will allow remote access to information such as switch opening and exchange and oscillographic events to assist in troubleshooting. Access to this information today requires an on-site visit, which is time consuming, inefficient and contributes to carbon emissions. The proposed solution would enable a central inventory updated in real time with immediate "anywhere, anytime" access to error logs. It will also bolster Hydro Ottawa's cyber security stance by ensuring firmware upgrades occur.

This alternative also includes special focus on improving the fiber network cyber security to improve Hydro Ottawa's detect, protect, respond and recover capabilities in its most mission-critical network.

Alternative Three: Accelerated; This option goes beyond Alternative 2 by advocating for a full-fledged deployment of a dedicated communication network. Instead of simply testing wireless spectrum, it proposes a significant investment in infrastructure, including building new towers, acquiring spectrum, and deploying compatible devices. This comprehensive approach would enable Hydro Ottawa to establish a robust and secure network capable of supporting AMI and other smart grid technologies, ultimately enhancing grid reliability and efficiency.

This option also includes additional physical fiber footprint and selection and deployment of additional solutions to centrally manage intelligent, connected grid devices.

6.6.2. Evaluation Criteria

Reliability & Resilience

This criterion assesses the ability to meet service level agreements and provide uninterrupted connectivity to grid assets that will enable observability and control during any adverse conditions. System upgrades aim to improve the network resilience and security. Resilience focuses on the system's ability to quickly recover from physical damage, as well as cyber attack.

Operational Efficiency

This criterion considers the ability to position Hydro Ottawa to “do more, more quickly” in response to increasingly complex demands. Incorporating automation reduces manual effort and improves efficiency. Facilitating data analysis and visualization enables informed decision-making and grid optimization.

Enabling Grid Modernization

This criterion assesses the ability to address the anticipated rise in field intelligence needed to ensure Hydro Ottawa can optimize capacity to meet growing demands due to electrification. The network’s ability to support current communication needs as well as AMI, DERs and remote sensors supplying observability must be considered to respond to the IoT evolution.

Technical Feasibility

This criterion assesses a solution’s commercial availability, interoperability, and long-term availability. This is particularly material to the FAN given the evolving nature of wireless solutions and the rapid evolution of IoT.

Cost Effectiveness

This criterion analyses the impact of each alternative and looks to identify the most cost-effective means of meeting requirements.

6.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 6.6.1 - Alternatives Considered under the evaluation criteria of Section 6.6.2 - Evaluation Criteria.

The preferred alternative is Alternative 2. Initiatives such as network security, IEDM and remote testing are critical for the continued stability, reliability and operational efficiency of the communication network. Observations from the wireless pilot will help Hydro Ottawa make informed decisions about the future of PLTE networks. Operational needs for widespread wireless communication will continue to be satisfied through a variety of means including public carrier LTE networks (e.g. Rogers, Bell, Telus), point-to-point microwave, and 900 MHz radio. While Hydro Ottawa is conducting pilots in specific wireless bands it will also continue to participate and support Electricity Canada and fellow utilities in pursuing alternate solutions.

This option reflects a judicious investment in reusable assets such as towers and represents a balanced approach to explore wireless options in the evolving Canadian telecommunication industry.

6.7. PROGRAM EXECUTION AND RISK MITIGATION

6.7.1. Implementation Plan

All initiatives under the Field Area Network Program will be implemented in the 2026-2030 rate period as outlined in Table 21. Regular initiative review will inform the program prioritization, and if any projects under this category require expedited action, adjustments may be made, including switching, deferring, adding, altering or removing projects as necessary.

Table 21 - Proposed Projects for the Field Area Network Program

Year	Proposed Projects
2026	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● Wireless pilot design ● Implement the IEDM solution ● Begin cyber security enhancement implementation
2027	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● MPLS refresh design ● Wireless Pilot - purchase and install EPC Core and Base Stations ● Complete IEDM solution implementation ● Complete cyber security enhancement implementation
2028	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● Begin MPLS refresh ● Wireless pilot execution ● Continued onboarding of IEDM devices
2029	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● Complete the MPLS refresh ● Wireless pilot execution ● Continued onboarding of IEDM devices
2030	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● Implement remote OTDR Testing ● Wireless pilot execution ● Continued onboarding of IEDM devices

6.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Field Area Network Program, particularly as technology evolves to offer greater advanced application capabilities and customer expectations shift with electricity transformation. Table 22 identifies the key risks and corresponding mitigation strategies.

1 **Table 22 - Key Risks for the Field Area Network Program and Mitigation Strategies**

Category	Risk	Mitigation
Rapidly evolving technology landscape	The technology sector is characterized by constant innovation. New, more efficient, and cost-effective technologies emerge frequently and the expectations and needs of Grid Modernization will continue to evolve. There is a risk that solutions could be superseded by a superior standard or become incompatible with newer systems relatively quickly.	**Flexible architecture:** Designing solutions with a degree of flexibility and modularity can enable easier upgrades and integration with new technologies as they emerge. **Phased implementation:** Instead of a large-scale rollout, a phased approach allows the utility to test the technology, assess its performance, and make adjustments as needed while minimizing initial investment. **Collaboration and partnerships:** Partnering with technology providers and research institutions can provide access to expertise and insights on the evolving technological landscape.
Changing business needs driven by Grid Modernization	Grid Modernization is rapidly evolving and may drive a shift in priorities or core functionality that has not been anticipated.	Continued monitoring of Grid Modernization to ensure Hydro Ottawa's roadmap continues to align with required capabilities. Use a data-driven approach for the Field Area Network annual planning.
Sudden significant shifts in product, or implementation costs	This program includes both physical assets as well as software costs. There is a risk that one or both of these may see a significant rise in costs.	Continued evaluation of technology and negotiation of contracts to maintain the lowest cost increase possible. Well defined projects will continue to favour a fixed price model to minimize the impacts of rapid inflation or other market pressures. Where cost increases are unavoidable, the scope will be adjusted.
Regulatory decisions in the telecommunications industry	With the use of LTE technology and licensed spectrum, there are a number of organizations that could alter regulations that could have an impact on the planned FAN wireless communication pilot.	The mitigation strategy for this is to engage with other utilities making similar investments in forums such as the Utility Telecommunications Council and the Canadian Electricity Association.

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3

7. CONTROL AND OPTIMIZATION

7.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $0

2026-2030: $3.6M

Budget Program: Control and Optimization

Main Driver: Observability

Secondary Driver: System Efficiency, Enhanced Reliability, and Adaptive Grid Flexibility

Outcomes: Operational Effectiveness

The Control and Optimization Program is a key component of Grid Modernization. This program builds on the foundation of the ADMS with new capabilities such as DER management, optimization and automation of grid operations. The primary focus in the 2026-2030 rate period is the implementation of the Distributed Energy Resource Management System (DERMS). The DERMS module will enable Hydro Ottawa to manage and optimize the growing complexity of DERs, thereby enhancing grid stability, reliability, efficiency, and resilience in a cost-effective manner. Smaller modules like DMS Switch Order Manager (SOM), DMS Volt/VAR (VVO) and Feeder Reconfiguration (FR) could be deployed to help improve Hydro Ottawa's efficiency and outage restoration performance in real-time.

In total, Hydro Ottawa plans to invest an estimated $3.6M through the Control and Optimization program in the 2026-2030 rate period compared to no investment in the 2021-2025 rate period.

7.2. PERFORMANCE OBJECTIVES AND TARGETS

The implementation of the Control and Optimization Program is expected to lead to improvements in the outcomes detailed in Table 23.

Table 23 - Performance Outcomes for Control and Optimization Program

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	Implementation of a DERMS will: ● Improve visibility and control of DERs (e.g. solar panels, wind turbines, BESS) by gaining real-time insights into their operation . ● Effectively manage and coordinate DERs to ensure grid stability, minimize voltage fluctuations, and minimize instances of voltage exceeding or falling below acceptable limits. ● Accommodate a higher percentage of DERs and leverage them for grid services like voltage support, peak demand reduction, and ancillary services. ● Improve grid efficiency by utilizing DERs to improve the grid's ability to handle fluctuations in demand and supply and respond to outages. ● Facilitate customer engagement in DER programs and grid services.
Customer Focus	The Distributed Energy Resource Management system supports Hydro Ottawa's Customer Focus objectives by: ● Facilitating the adoption of DERs ● Contributing the improved flexibility of the electricity grid to meet customer needs for reliable electricity.
Public Policy Responsiveness	Hydro Ottawa's Public Policy Responsiveness objectives by: ● Enabling electrification by investing in operational flexibility

7.3. PROGRAM DRIVERS AND NEED

7.3.1. Main and Secondary Drivers

Primary Driver: Observability; Effectively manage the complexities introduced by DERs and grid modernization efforts. DERMS, SOM, Volt/VAR, and feeder reconfiguration modules generate a massive amount of data about grid conditions, DER activity, and switching actions. Enhanced observability through the ADMS platform allows the utility to collect, analyze, and visualize this data in real-time, providing valuable insights into grid behavior and enabling proactive decision-making for optimized performance, improved reliability, and increased safety.

Secondary Driver: System Efficiency, Enhanced Reliability, Adaptive Grid Flexibility. The DERMS module will allow system operators a consolidated platform to view and control DERs. The number of DERs connected to Hydro Ottawa's system increased by nearly 50% between 2018 and 2023. This customer trend is expected to continue and be further augmented through the adoption of Non-Wires Solutions described in Section 2.1 - Capacity Upgrade. Implementing a central monitoring and control platform for distributed energy resources will enable grid flexibility and reliability.

This program will continue to enhance Grid Operations through digital transformation to support sustainable business practices. Through additional modules such as SOM, VVO, and FR, the program will reduce process time and errors and employ new capabilities to automate functions, thereby reducing system losses and improving performance.

7.3.2. Current Issues

The Control and Optimization program aims to address the following challenges:

Adapting To Rising Numbers of DERs

The availability of DERs and their popularity caused by the energy transition has introduced unique challenges for local distribution companies including:

- DERs, especially renewable energy sources like solar and wind, can introduce variability and unpredictability into the distribution grid. This makes it more difficult for LDCs to balance supply and demand, maintain voltage levels, and ensure grid stability.
- DERs can inject power back into the grid, creating two-way flows. This requires LDCs to upgrade their infrastructure and systems to manage these flows effectively.
- DERs can complicate the protection of the grid against faults and other disturbances.
- The integration of DERs makes it more challenging for LDCs to plan for future grid needs and forecast electricity demand. They need to develop new tools and methods to account for the impact of DERs on their networks.

Inefficient Paper-Based Processes

Current paper-based switch order processes present a variety of challenges for Hydro Ottawa, impacting efficiency, cost, and customer satisfaction. Digitizing this process via the SOM module will address:

- Slow Processing Times: Manual data entry, physical transfer of documents, and potential for errors all contribute to significant delays in completing switch orders. This can lead to missed deadlines and frustrated customers.
- Lack of Transparency and Tracking: It is difficult to track the status of a switch order in a paper-based system. This lack of visibility can cause confusion and make it challenging to identify and resolve bottlenecks.
- Potential for Errors: Manual data entry increases the risk of errors, which can lead to incorrect billing, service disruptions, and regulatory compliance issues.
- Security Risks: Physical documents are vulnerable to loss, theft, or damage. Sensitive customer information may be exposed without proper security measures.

Managing Voltage Levels Across the Grid

The Voltage Optimization module addresses several key grid challenges. Primarily, it maintains optimal voltage levels across the network, minimizing losses and improving energy efficiency. This is especially critical with the rise of DERs, which can cause voltage fluctuations. By dynamically adjusting voltage setpoints, the module will contribute to grid stability and power quality, reducing instances of over- or under-voltage that can damage equipment or disrupt customer service. Voltage optimization can also contribute to conservation efforts by lowering overall energy consumption.

Managing the Efficiency and Reliability of the Distribution Network

The Feeder Reconfiguration module addresses critical challenges in managing Hydro Ottawa distribution networks. It helps minimize power losses, improve voltage profiles, and enhance overall network reliability. By intelligently altering the network topology through switchgear operations, the module can reduce wasted energy, ensure adequate voltage levels for consumers, and quickly restore power in case of outages.

7.4. PROGRAM BENEFITS

The Control and Optimization Program will serve to improve several areas of Hydro Ottawa operations, including efficiency and outage restoration. Adding DERMS, SOM and other modules to an ADMS platform allows these modules to work together to modernize grid operations, optimize resource utilization, and improve overall grid performance.

7.4.1. Enhanced Grid Reliability and Resilience

This program enhances grid reliability and resilience by supplying tools for predictive analysis, automating response to failures and integrating DERs to help balance supply and demand.

7.4.2. Optimized Grid Operations

Smart grid technologies like VVO and FR help utilities to reduce wasted energy and work more efficiently. By automatically adjusting how electricity flows through the grid, these technologies minimize losses and deliver power more effectively. The automation reduces the need for manual adjustments, allowing operators to focus on more important tasks and ultimately saving time and resources.

7.4.3. Increased DER Penetration and Utilization

DERMS offers a comprehensive solution for integrating and optimizing DERs like solar panels, batteries and wind turbines. It ensures the safe and efficient integration of large amounts of DERs and actively manages DER output for voltage support and peak demand reduction, further enhancing grid stability.

7.4.4. Improved Safety

Automating switching procedures minimizes the potential for human error, protecting field crews and reducing the risk of outages.

7.4.5. Improved Customer Satisfaction

Enabling faster outage restoration and improving overall grid reliability will minimize service disruptions and enhance customer satisfaction. Simultaneously, VVO features within the ADMS provide better power quality by minimizing voltage fluctuations. This results in a more stable and reliable power supply, further improving the customer experience and building trust in the utility.

7.4.6. Enhanced Grid Visibility and Control

Advanced analytics and optimization tools support informed decision-making for grid operations and planning. By implementing these modules and realizing these benefits, Hydro Ottawa can create a more modern, efficient, reliable, and sustainable grid that is well-equipped to handle the challenges of increasing DER penetration and evolving customer demands.

7.5. PROGRAM COSTS

The costs for this program will include both third-party software and services and internal labour. The timing of these investments is dependent on the progress made by Hydro Ottawa on the deployment of each module, which will be rolled out sequentially. The program costs are included in Table 24.

Table 24 - Historical, Bridge and Test Year Control and Optimization Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Control and Optimization	-	-	-	-	-	$ 0.7	$ 1.8	$ 0.4	$ 0.4	$ 0.4
TOTAL	**-**	**-**	**-**	**-**	**-**	**$ 0.7**	**$ 1.8**	**$ 0.4**	**$ 0.4**	**$ 0.4**
5-YEAR TOTAL	**-**					**$ 3.6**				

7.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations from established partners to inform the expected costs of the Optimization and Control program. Special attention has also been spent on improving forecasting models to reflect a unified software implementation approach that does not just look at technical implementation costs but considers a more comprehensive approach inclusive of internal labour. Forecasted costs include the following factors:

- Software Licenses
- Professional Services
- Internal and External Labour
- Annual support fees (included in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs)

7.6. ALTERNATIVES EVALUATION

7.6.1. Alternatives Considered

To achieve the objectives of the Control and Optimization program, three alternatives were considered:

Alternative One: Do nothing - Not investing in new ADMS modules presents the following considerations:

- Limited DER integration: Difficulty accommodating growing DER penetration, leading to constraints on DER interconnection and potential grid instability.
- Reduced grid efficiency: Inability to optimize voltage/VAR control and feeder configurations, resulting in greater energy losses and higher operational costs.
- Increased outage risks and durations: Manual switching processes are slower and more prone to errors, potentially leading to longer outages and safety risks.
- Decreased grid visibility: Lack of real-time data and analytics hinders proactive grid management and informed decision-making.
- Missed opportunities for cost savings: Inability to leverage DERs for grid services and optimize grid operations may result in missed cost savings opportunities.
- Lower upfront costs: Avoiding the project will save on immediate investment in software, implementation, and training.
- Reduced complexity: Maintaining existing systems is simpler in the short-term than integrating new modules and functionalities.
- Less disruption: Implementation of new software can be disruptive to existing workflows and require adjustments from personnel.

Alternative Two: DERMS only; Implementing only the DERMS module is an option that presents the following considerations:

- Focused approach: Concentrates resources on the immediate challenge of DER integration and management, simplifying the project scope and timeline.

- Faster DER value realization: Quickly gain the ability to monitor, control, and optimize DERs to improve grid stability, increase hosting capacity, and potentially leverage DERs for grid services.
- Reduced initial investment: Lower upfront costs compared to implementing all modules simultaneously.
- Scalability: Provides a foundation for future expansion by adding other modules (SOM, VVO, FR) as needs and budget allow.
- Improved grid awareness for DER impacts: Gain valuable insights into how DERs are impacting the grid, enabling proactive mitigation of potential issues.
- Limited scope of benefits: Misses out on the full potential of a comprehensive ADMS upgrade, including optimized voltage control, automated switching, and improved outage management.
- Potential for suboptimal DER utilization: Without VVO and FR, the ability to fully optimize DERs for grid support may be limited.
- Missed synergies: The modules work best together and Hydro Ottawa will not realize the full benefit by adding DERMS alone.
- Increased future integration complexity: Integrating other modules later may be more complex and costly compared to a unified implementation.
- Potential for "siloed" approach: Focusing solely on DERMS may lead to a fragmented approach to grid management rather than a holistic one.

Alternative Three: Full implementation (Recommended); This option includes adding DERMS, SOM, VVO, and FR modules to Hydro Ottawa's ADMS platform, to achieve the full benefits available from this technology:

- Comprehensive Grid Modernization: Addresses multiple aspects of grid management simultaneously, leading to a more holistic and integrated approach to grid optimization.
- Enhanced DER Integration and Utilization: DERMS enables seamless integration of DERs, while VVO and FR optimize their use for grid support and increased hosting capacity.
- Improved Grid Efficiency and Reliability: VVO and FR minimize losses and improve voltage

profiles, while SOM enhances outage management and grid resilience.

- Increased Automation and Efficiency: Automated switching, voltage control, and feeder reconfiguration will streamline operations, reduce manual intervention, and improve workforce productivity.
- Enhanced Safety: SOM reduces switching errors and improves safety for field crews, while the overall ADMS platform enhances situational awareness and supports proactive decision-making.
- Cost Savings: Reduced energy losses, improved operational efficiency, and extended equipment life contribute to significant cost savings over time.
- Improved Customer Satisfaction: Increased reliability, reduced outages, and better power quality enhance customer satisfaction.
- Future-Ready Grid: Prepares the grid for future challenges and opportunities by providing a robust platform for managing increasing DER penetration and evolving grid requirements.
- Data-Driven Insights: The ADMS platform provides comprehensive data and analytics for informed decision-making and improved grid planning.
- High Upfront Investment: Implementing all modules simultaneously requires a significant initial investment in software, hardware, implementation, and training.
- Potential for Disruption: Implementation may disrupt existing workflows and require adjustments for personnel, potentially impacting operations during the transition.
- Resource Intensive: Requires dedicated resources and expertise for successful implementation and ongoing management of the ADMS platform.

7.6.2. Evaluation Criteria

Enabling The Energy Transition

This criterion assesses the ability to address the anticipated rise in electrification within the community, including the adoption of electric vehicles, heat pumps, renewables, and light rail transit. Increased densification and other demands on the electricity grid requires efficient data-driven decisions.

System Reliability

This criterion assesses Hydro Ottawa's ability to supply reliable electricity to customers in a dynamic evolving energy landscape.

7.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 7.6.1 - Alternatives Considered under the evaluation criteria of Section 7.6.2 - Evaluation Criteria.

The preferred alternative, the Recommended Approach, of incorporating DERMS, SOM, VVO, and FR ADMS modules was chosen over alternative approaches because it offers a comprehensive future-proof solution to the challenges and opportunities facing Hydro Ottawa's distribution network. While other options, such as standalone DERMS or piecemeal upgrades, might address immediate needs, they fall short in providing the integrated functionalities and long-term benefits this program delivers.

This comprehensive approach not only tackles the pressing need for effective DER integration but also optimizes grid operations, enhances reliability and resilience, improves safety, and unlocks cost savings through reduced losses and increased efficiency. By modernizing its grid with this integrated ADMS platform, Hydro Ottawa ensures it is well-equipped to handle increasing DER penetration, evolving customer demands, and the pursuit of a more sustainable and resilient energy future, ultimately maximizing the value of its grid assets and improving service for its customers.

7.7. PROGRAM EXECUTION AND RISK MITIGATION

7.7.1. Implementation Plan

The Control and Optimization Program is planned to be executed across the 2026-2030 rate period. Each module will be implemented in a phased approach, will have a different duration, and can overlap with other modules' implementation depending on the resources and systems involved. Table 25 shows the projects proposed for the 2026-2030 period under this program.

Table 25 - Proposed Projects under the Control and Optimization Program

Year	Proposed Projects
2026	• SOM ADMS Module
2027	• SOM ADMS Module • DERMS ADMS Module
2028	• DERMS ADMS Module
2029	• VVO ADMS Module • FR ADMS Module
2030	• VVO ADMS Module • FR ADMS Module

7.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Control and Optimization Program. Table 26 itemizes the key risks and corresponding mitigation strategies:

1 **Table 26 - Key Risks of Control and Optimization Program and Mitigation Strategies**

Category	Risk	Mitigation
Business Requirements and schedule	Changing business requirements or schedules can complicate project planning and increase costs.	Maintain flexibility in project designs and budgets. Regularly engage with business to anticipate and adjust for changes, ensuring resource availability and mitigating delays.
Financial Impact	Cost overruns or budget shortfalls may occur due to unexpected expenses.	Develop detailed budgets with contingencies and monitor financial performance closely throughout the project lifecycle.
Project Management	Poor project management could lead to delays or inefficiencies.	Utilize advanced project management tools to track progress, manage resources, and maintain timelines.
Resource Availability	Shortages in skilled labour may hinder project progress.	Plan resource needs well in advance and maintain strong relationships with suppliers and contractors to secure reliable access to critical resources.
User adoption and training challenges	Resistance to change or inadequate training could lead to low user adoption and hinder the realization of project benefits.	Involve users in the planning and implementation process. Provide comprehensive training programs and support materials. Communicate the benefits of the new system clearly. Encourage user feedback and address any concerns.
Vendor dependence	Over-reliance on a single vendor for the ADMS platform and historian could lead to limited flexibility and potential lock-in.	Negotiate favorable contract terms and service level agreements. Ensure close follow-up on items and tasks.

2

FIELD AREA NETWORK ASSESSMENT

BLACK & VEATCH PROJECT NO. 418910
BLACK & VEATCH FILE NO. 40.003

PREPARED FOR

HydroOttawa

11 JULY 2024

BLACK & VEATCH

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1.0 Project Background

Hydro Ottawa Holding Company (HOL), owned by the City of Ottawa, owns and operates four primary subsidiary companies: Hydro Ottawa Limited, Portage Power, Envari, and Hiboo Networks. HOL requested support from Black & Veatch to investigate Field Area Network (FAN) options. A Scope of Work was agreed to, and this document is the final deliverable for that original Scope of Work. This document will focus on the objectives and technical requirements for a FAN to support HOL field operations with use cases described below. Various FAN options will be described in this document. This document will make various FAN solution recommendations based on perceived HOL priorities, requirements, and budget. The recommended options will include potential public and private broadband networks. The goal of this effort is to capture an option for future HOL use that will fit within an appropriate budget. It is recognized that there is a specific focus on providing a FAN solution to support HOL's 2024 rate case submission. The ultimate decision may be based on additional information obtained in future design iterations and vendor negotiations.

1.1 Field Area Network (FAN) Report Scope

The HOL service territory to be covered is approximately 1110 km^2 in the Ottawa area and 5.4 km^2 in Casselman area. The main Ottawa service territory and Casselman service territory are physically separated by ~26 km on Highway 417.

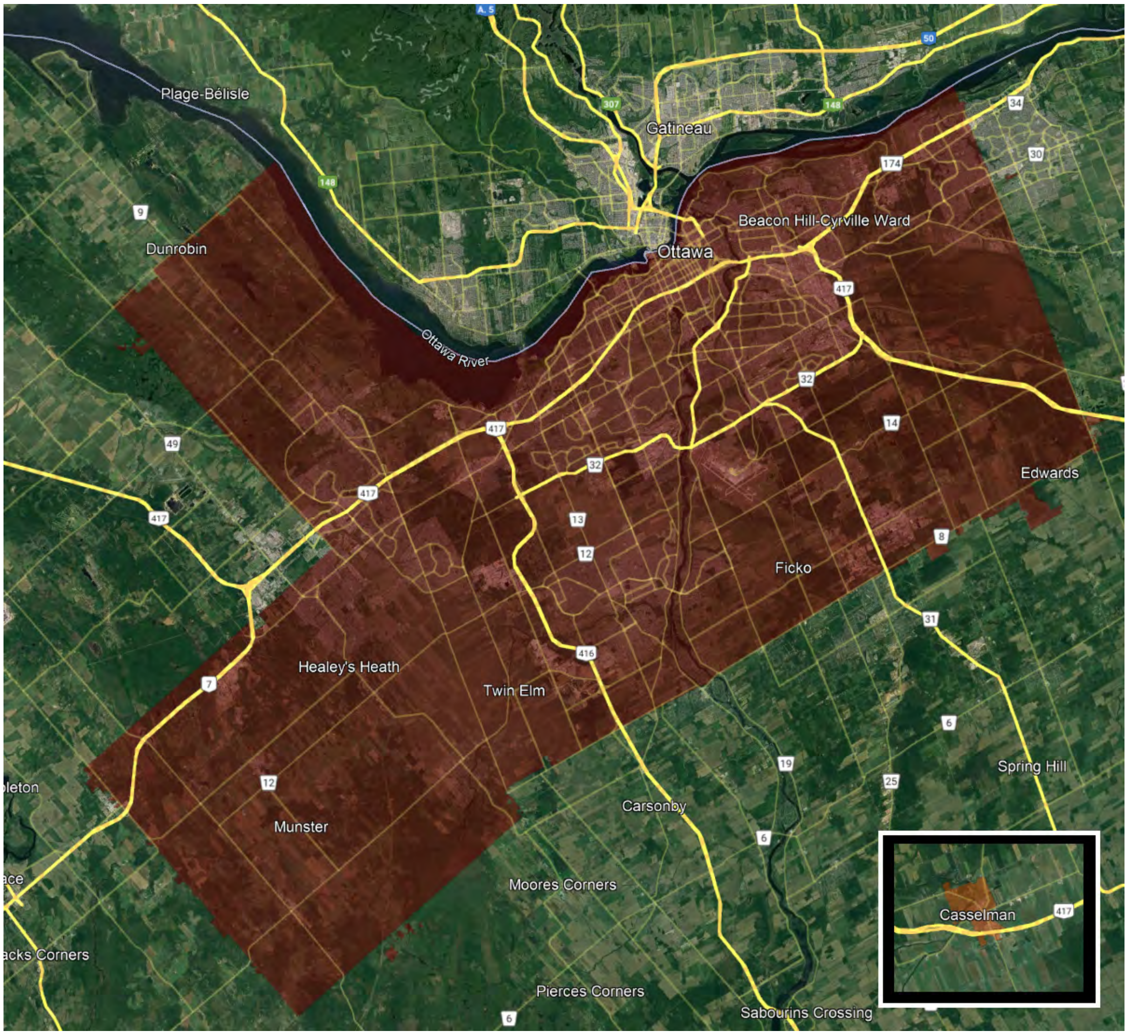


Figure 1 – Hydro Ottawa Service Territory (Casselman inset)

HOL has developed a reliable fibre infrastructure for a Wide Area Network (WAN) to provide secure, high availability, and bidirectional communications between the core grid, distribution control applications, substations, and control centres. The next step is to implement a FAN to enable reliable communications to grid devices not directly connected to HOL's fibre infrastructure to support current and future applications including but not limited to Smart Grid, Distributed Energy Resources, and next generation AMI. The FAN should also be able to support capacity growth for the long term needs of the proposed use cases.

The objective of the FAN is to provide broadband coverage across the entire service territory to enable high speed, low latency, reliable communication between HOL field assets and the two control centres. The existing assets include approximately 300 distributed automation devices and legacy AMI IP meters. The long term objectives include upgrade to almost 400k AMI 2.0 meters, future distributed energy and battery assets, and the supporting wireless communication network.

1.2 Field Area Network (FAN) Report Process

As a part of this process, Black & Veatch engaged HOL professionals in a series of stakeholder meetings including representation from Stations/Control, IT/Cybersecurity, AMI, and Assets/DSI teams. These stakeholder meetings were designed to facilitate a dialog with the project team to better align the objectives of HOL and the ultimate deliverables in support of the overarching analysis. Information gathered from the sessions feeds into the planning and assessment as a part of the gap analysis and rough order of magnitude (ROM) estimates. Additionally, the Black & Veatch project team leveraged experience from the HOL Telecom Master Plan, fibre network designs previously provided, and current involvement with the Advanced Distribution Management System.

2.0 Current State System Overview

2.1 Existing field devices

2.1.1 DA Assets

The HOL DA inventory was delivered to Black & Veatch via a layered KML inventory file which illustrated the 6 device types and counts in Table 1. Towers, future sites, and decommissioned sites included in the inventory were omitted for clarity. Local, non-communicating FCI's were also omitted. DA traffic to and from the field is distributed and collected by narrowband GE MDS radios (SD9). The models and software are at end of life or are discontinued. The northeast corner of the main service area was recently updated with newer GE MDS radios. The device prefixes in Table 1 come from the KML categories provided by HOL.

Table 1 – DA Device Summary

Device	Count
FC - Smart FCI	15
CS - Siemens Vector	2
CS - Scadamates	116
RX - Reclosers	35
SC - Automated Switchgear	32
44kv_switches	46
radio_towers	20
Sum	**266**

2.1.2 AMI Assets

Black & Veatch was also provided an inventory of AMI meters, of which approximately 360k are in use. The existing AMI meter inventory is overwhelmingly mesh backhaul, with some LTE backhaul IP meters and legacy POTs units. All of them are currently used exclusively for billing functions. 99.4% of the AMI meters are backhauled over the unlicensed 900MHz mesh network. There are small quantities (~0.6%) of IP meters and POTs meters combined. The IP devices (cellular modems) are backhauled via a Bell APN. The POTs meters (0.1%) were not discussed as they are also legacy devices. The backhaul methods and AMI meter types are summarized in Table 2.

Table 2 – AMI Device Summary

AMI Device	Count
900Mhz	356570
Cellular	1552
POTs	587
Total	358709

Meter Type	Comm Type	Count
A3 Collector	POTS	587
A3 Collector	IP (wireless)	1534
A3_ILN	900 Mhz (Mesh)	16714
REX	900 Mhz (Mesh)	273192
REX-D	900 Mhz (Mesh)	48647
REXU-EA	900 Mhz (Mesh)	17
	Total	358709

2.1.3 Fibre Assets

HOL has a modern, Nokia based, 10Gbps linked network which is broken up into four redundant quadrants with multiple links to the core loop. This network is built to be reliable and fault tolerant. Based on a GIS evaluation, Black & Veatch determined that the area contained within 1.6km of the existing fibre path makes up 43% of the main service territory. The Casselman service territory is not connected via HOL owned fibre.

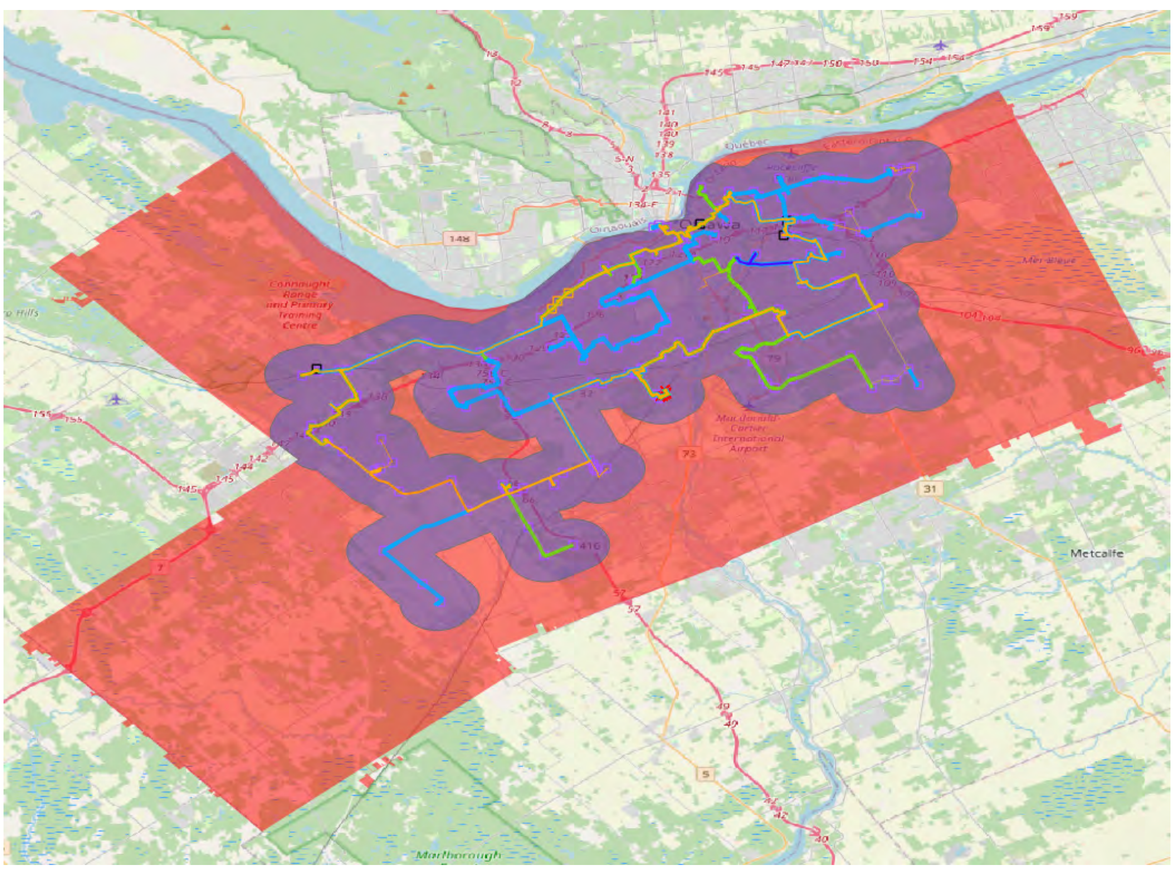


Figure 2 – HOL Fibre Extent + 1 mile buffer

2.1.4 RF Spectrum (ISED) Records and Public Cellular Utilization

Based on a survey of the ISED Spectrum database, HOL has eight licensed 900 MHz frequencies in service, four at 952MHz and four additional at 928MHz. A complete inventory is attached as an appendix. In addition, the fixed ISED database reveals that HOL has licensed 1.8125 GHz Ruggedcom Wi-Max radios at 10 locations in the HOL service territory but has never built the network. HOL does not own nor are there any existing plans or timeline to acquire 3GPP compatible LTE spectrum.

Public cellular is utilized for three applications in the HOL architecture; two are for data communications and one for voice communications. The dominant portion of devices are dedicated to AMI IP meters. Those ~1550 IP meters contain Bell SIMS which communicate with the Bell cellular network and are consolidated and delivered back to HOL over an APN. It is currently unknown if the APN is diverse across control centres. There are also ~40 active DA devices that are served by public cellular. It is our understanding that these devices have individual IP sec tunnels associated with them. The last public cellular category utilized by HOL is voice communications. HOL utilizes cell phones for field technical staff that are served by the Rogers Cellular network. The Stations stakeholder meeting indicated a preference for the Rogers Cellular network versus Bell due to its perceived superior coverage area.

2.1.5 Tower Assets

HOL has 19 towers documented in the KML drawings. Some of the centre lines have been correlated via the ISED database. There are a variety of transmitters on telephone poles which are not suitable as LTE base stations and thus are excluded from this summary. The tower assets Black & Veatch has identified are those that are suitable as LTE base stations for private use. A filtered inventory of the structures is attached as an appendix.

2.2 Existing Performance management

2.2.1 DA performance management

Some limited DA KPI's were provided by HOL via a "Previous Day RTU Stats Summary". Total DNP scans to successful scans ratio as well as ratios of uplink and downlink data volume rates for DA narrowband device were examined. Roughly 20% of the DA narrowband sites exhibit polling success rates at 95% or below, some as low as 30%. This is a single day and is therefore an insufficient data set with which to make long term assessments. Furthermore, these measurements were taken on a "sunny day" scenario. Inclement weather may erode these ratios.

For the cellular modem DA backhaul, there are available API methods via the Jasper portal for collecting and trending APN modem performance; however, these are not currently utilized by HOL. This inhibits a comparison of overall narrowband to cellular performance. Based on a Google Earth street level survey, it does not appear that external antennas are utilized for cellular links. This may inhibit higher level of performance and resiliency under adverse conditions. It may be that the photography is old and out of date, but if this practice of no external antennas is the standard, HOL is suffering much lower performance than is possible via public cellular networks.

2.2.2 AMI performance management

AMI polling metrics for the 900Mhz unlicensed network were not available and therefore not evaluated. It also does not appear that the cellular AMI backhaul success or latency is consistently measured or evaluated. There are methods to collect and assess this information via the cellular service provider such as via Jasper or Cisco Control centre. This depends on the current provider and contracted services as part of the APN.

AMI performance management, as it applies to 900 MHz and cellular backhaul, appears to be exclusively reactive in nature. Based on the selected vendor, a transition from mesh to cellular backhaul can be 1,500 meters or 60,000. Backhaul requirements would be impacted based on the topology selected. At the mesh level the performance is more based on endpoints and hop counts. With quantities of meters being smaller when meters hop from one to the other, bandwidth is less of an issue with a handful of meters.

There are two levels of performance management on an AMI network. At the meter reading level there is hop count, meter success rates, interactive command delay (like a real time disconnect command). At the backhaul level the performance factors are different. Packet delay, retry rates, speed are measurement factors considered to examine overall network performance.

2.2.3 General performance management practices

Polling success rates can be evaluated from the SCADA platform, which does provide end to end visibility but does not decompose the backhaul path into its constituent wired and wireless components. Wired networks are far more reliable for a variety of reasons and are likely carefully collected and monitored by the HOL IT team via SNMP. Performance management, as it applies to the RAN, is a process where the wireless aspect of a communication link is accounted for and evaluated on a device-by-device basis. This management process allows for high levels of visibility and helps the teams reliant in the incoming information to be proactive in terms of maintenance. The airlink can be subject to misconfiguration, RF noise, interference, and seasonality (foliage) to name a few. It is extremely important to differentiate the normal from the abnormal and a transient from a trend. This requires reliable data collection, data aggregation, and analysis by appropriately trained staff.

2.3 Distribution Automation

Upgrading from narrowband devices was discussed during the Stations and Control stakeholder meeting. There were specific comments relating to the uncertain reliability and high latency of the radio links at times. Upgrading to cellular devices from narrowband devices is generally not a difficult process. The key considerations are power consumption, physical form factor, interface capability, diversity antennas, and intelligent antenna placement. LTE has a rich set of manufacturers which support a broad range of form factors, interface types, port counts and temperature ranges. LTE chipsets also support a wide range of 3GPP frequencies and channel bandwidths to accommodate any of HOL’s current or near future requirements.

2.4 Automatic Metering Infrastructure

The existing HOL AMI 1.0 meters and collector network of almost 370,000 devices is unlikely to be compatible with the long-term reliability, latency, and remote intelligence needs. The 10-year estimate of the AMI meters is approximately 400,000 in total.

In addition to the basic billing function, the stated goals of the AMI 2.0 network are much higher sample rates and greater situational awareness promised by AMI 2.0 vendors. AMI interval changes can be accomplished with existing AMI 1.0 meters. Those will typically allow for consumption and interval reads where intervals can be more granular. Depending on meter type, there may be additional information provided by the AMI 1.0 meter. in addition to the consumption of the kilowatt hours and intervals, AMI 2.0 promises to deliver voltage, current, phase, transformer awareness and perhaps applications which run on the meter microcontroller. A defined HOL roadmap will drive the meter and/or application capability requirements. If a decentralized edge computing approach is sought, bandwidth requirements at the head end and wireless bandwidth use can be reduced. That said, the billing functions will likely stay centralized in the head end for head end to MDMS to billing data hand off, so some bandwidth is still needed for centralized activity.

Other factors to consider would be the calculation of certain parameters vs. actual reads from an AMI 2.0 meter. Power factor can be calculated or measured, but it could add to the meter data payload. If data is already provided from the meter, adding a measured power factor might add to the payload. It would likely be negligible but, if many parameters are added to the meter, it could significantly boost meter payload. In aggregate across the network, increments of 400,000 meters could require additional bandwidth on part or all of the network.

The question of centralization will contribute to awareness of how much additional data is transmitted. Again, there are many factors to consider that could/will affect overall FAN payload. Circuit loading may be done at the substation level. Localized meter data might be delivered to the substation for load accumulation calculations. From here, circuit loading could be reported to a D-SCADA system. This quasi-decentralized approach may increase bandwidth requirements across the network but decrease the bandwidth from a centralized collection point.

The specific AMI vendor and use cases have not yet been defined; however, we have estimates of the required functions and bandwidth requirements associated with each.

2.5 Distributed Energy Resources

HOL has indicated that there will be a need for reliable communications at future battery storage and DER locations. Battery storage and DER application capacity is assessed and estimated in Section 5.1.3.2. The monthly usage estimates appear manageable from a wireless LTE perspective; however, ensuring that coverage and capacity needs are met via site survey is recommended. Without specific siting locations, it is difficult to assess potential donor sites either public or private. In general terms, it is better to have these locations within the footprint of multiple cell sites hosting multiple frequencies for the sake of redundant and reliable communications for these assets.

3.0 Use Case Considerations

3.1 Use Case Matrix

The use case matrix in Table 3 is a tool for estimating wireless data volume that is a response when polled by HOL core assets. These devices are typically "outside the fence" and in the field; thus, the communications are typically wireless. The primary purpose of Table 3 is to sum up the data volume for each class of device, quantity of devices, volume per read and sample rate into a daily total and monthly data volume total. These totals are used to identify sim counts and data quantities per SIM card. The spreadsheet is particularly useful when using a public scenario and purchasing capacity from a public LTE carrier.

The table remains useful for a Private LTE scenario because it provides estimates of data volume over the air which will ultimately be processed and passed through the LTE core appliance. This helps size the server, license sizing and core NIC capacity. Much of these high-level estimates are represented in the propagation coverage estimates (hexagons) in Table 6 which summarizes data usage from AMI and DA on a per LTE base station basis. There are minor differences between the data volume on the two tables due to the device counts and Table 6 using approximate data volume, as opposed to building the data volume up from message size and sample rate. A copy of Table 3 is attached in the Appendices for customer customization and future growth estimates. Black & Veatch has included rows for devices that are potentially not in existence or have not been quantified yet but are being considered. This table builds up the sampled data volume based on data reads and sample intervals. These values are based on stakeholder conversations and may be modified to match the current HOL sample rates and devices to provide a more accurate prediction of data volume.

Table 3 – Wireless Use Case Matrix example

Device Type	Data Vol per read (kB)	Sample Rate (Secs)	data volume hour (MB)	Samples day	per device daily total (MB)	Device Quantity	data volume per day (MB)	data volume per Month (GB)
Reclosers	1.5	10	0.527	8640	12.66	35	443	13
Pad mount Switches	1.5	10	0.527	8640	12.66	50	633	19
Overhead Switches	1.5	10	0.527	8640	12.66	120	1519	44
EV Charging	1.5	10	0.527	8640	12.66	50	633	19
Solar Inverters	1.5	10	0.527	8640	12.66	0	0	0
Fault Indicators	1.5	10	0.527	8640	12.66	15	190	6
Capacitors	1.5	10	0.527	8640	12.66	0	0	0
Battery Storage	250	300	2.930	288	70.31	0	0	0
Solar Farm with Inverter	250	300	2.930	288	70.31	0	0	0
SCADA Totals						270	3417	100
AMI meter Totals					0.017	368509	6368	187

3.1.1 DA use cases

DA use cases are expected to require far less bandwidth than AMI 2.0 applications. This is largely due to the high volume of the AMI devices relative to DA. It is expected that high quality, optimally located antennas in tandem with LTE modems will contribute to lower latency, higher reliability, higher throughput and improved electrical distribution situational awareness.

3.1.2 AMI use cases

The AMI 2.0 use case has been described in the stakeholder meetings in general terms. Black & Veatch has performed a capacity analysis based upon vendor projections of the AMI 2.0 meter application. There are additional capabilities proposed by vendors including meter to meter interaction, source transformer awareness, waveform analysis and edge intelligence. Some or all these factors may contribute to the LTE network usage and loading. Vendor and model selection, along with use case testing validation in lab testing environment, would drastically improve the LTE capacity requirements.

AMI 2.0 or Next-gen AMI consists of edge-computing devices with advanced capabilities that enable a better understanding of how electricity is used or generated—in real time. This intelligence holds many potential benefits for consumers and utilities alike.

Next-gen AMI enables grid edge technologies that provide the consumer with improved power quality, access to appliance level energy use in real time, ability to participate in flexible rate programs, and better tracking and management of DERs and EV charging.

For utilities, AMI 2.0 will provide short- and long-term benefits that include better operability, performance, communication, security, and sustainability.

Black & Veatch's prior engagements with HOL recommended the four (4) key phases of an AMI roadmap below.

1. Capabilities that can be enabled with existing Honeywell AMI system (REX1/REX2 meters, existing mesh network nodes, existing backhaul, existing HES) but which require changes to the downstream systems.
2. Incremental investments in existing AMI system (selective replacement of existing meters or other low volume field devices, network collectors, backhaul, HES) to mitigate obsolescence risks and enable high value capabilities.
3. Investment in operational capabilities which may be enabled by the planned FAN network.
4. Re-investment in AMI replacement technology to enable benefits dependent on mass meter replacement or other endpoint deployments.

Within each phase, the desired and prioritized opportunities were discovered in workshops. These opportunities were further described as Business Releases and mapped to each of the four (4) phases.

The Phase 4 opportunities were based on the complete replacement of the AMI solution. This phase is dependent on the resolution of the HOL Telecom FAN plan. It was not pre-assumed that the next generation solution would be the existing vendor's technology or another vendor's solution. As such, the phase is preceded by a recommended vendor solution selection exercise, with the full understanding of the Telecom FAN solution.

The Phase 3 and 4 business releases in Figure 3 and Figure 4 below can be labeled as transformative consumer-facing and grid-facing initiatives that the utility needs to implement.

- Consumer-facing use cases – utilities have recognized consumer data analytics, consumer-targeting, rate recommendations and communications are some of the top use cases.
- Grid-facing use cases – utilities are required to rethink their power generation and distribution with the key priorities of resiliency, reliability, efficiency, and security.

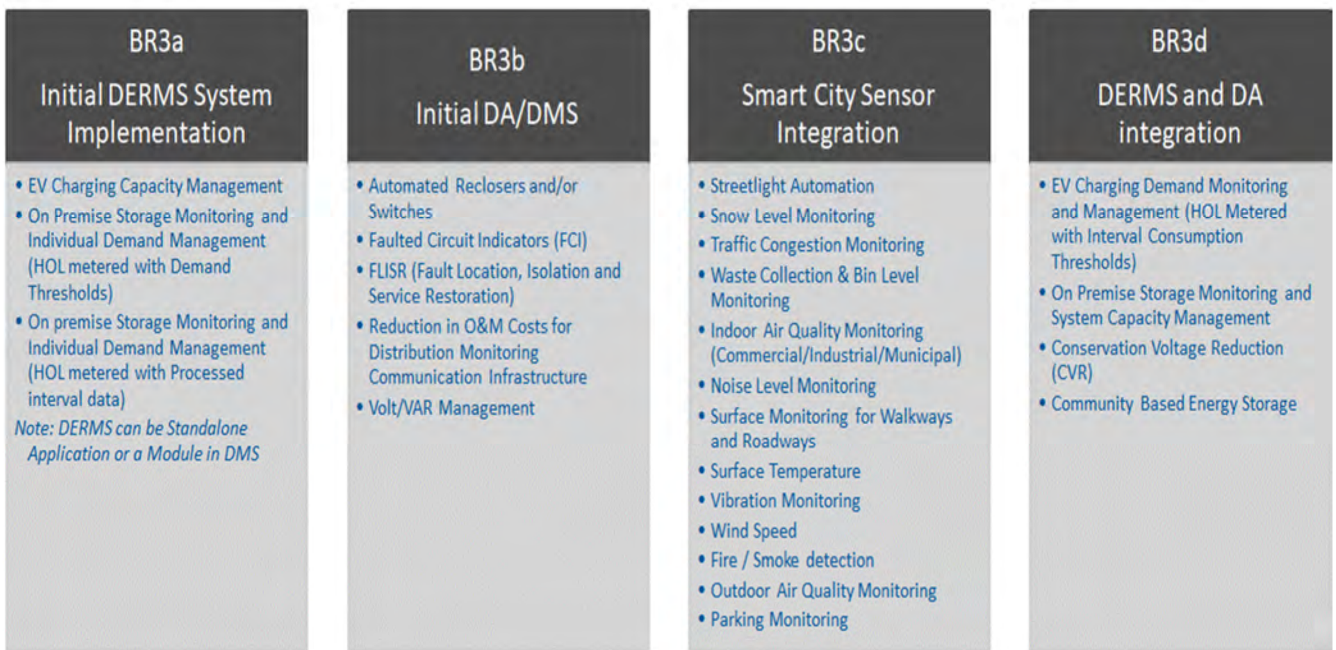


Figure 3 – Phase 3 Business Releases

Figure 4 – Phase 4 Business Releases

3.1.3 Use Cases – Latency and Bandwidth

All the example use cases in Table 3 could be recommended for use with 4G. They are all suitable for Public and Private scenarios and would improve the current system response times and reliability measurements. There are certain low latency use cases that could potentially be implemented, but they would require more detailed analysis and thoroughly defined architectures. The information in Table 3 is intended to quantify data volumes. Transfer trip is dependent on very low, ~5ms latency, which may be achieved with private on prem 5G architecture and QOS marking, but the 25-50ms latency for LTE is generally considered inadequate. The exact architecture and implementation would need to be assessed and tested to recommend any non TDM wireless for transfer trip. The vast majority of transfer trip is implemented on a low bandwidth TDM with 4 to 8ms latency. There are also other applications such as real time video and synchro phasors which can also be implemented over wireless, but they consume large quantities of wireless bandwidth and would need to be evaluated on a case-by-case basis within the RF coverage properties, spectral capacity or data volume limits.

4.0 LTE System Requirements and Network Security

All LTE systems, regardless of which option is chosen, must comply with a set of general requirements. Security, including SIM card authentication and encryption, must also be taken into account. The requirements and security information presented here will apply to any type of LTE system – private, public, or hybrid.

4.1 General LTE System Requirements

The following requirements are generally applicable to LTE systems.

- S1-U and S1-MME interfaces shall be capable of integrity checking and encryption over the air. Encryption and integrity checking will be ON for NAS and OFF for User plane.
- RF Coverage and channel quality: Downlink signal strength and CINR shall support a minimum of 5 Mbps at cell edge and no less than 50 Mbps peak per node to support the initial use cases.
- Radios shall support up to 40 MHz wide bandwidth in blocks of 5 MHz and carrier aggregation.
- Radios and antennas shall allow for all North American LTE bands.
    - New ISED bands may not be supported yet.
- Radios and antennas shall provide 2x2 MIMO operation at a minimum, 4x4 is preferred.
- Radios/eNodeBs shall support Interference mitigation techniques such as intelligent frequency block scheduling.
- The LTE EPS system shall support Quality of Service (QoS) and voice traffic prioritization for end to end for potential future use.
- EPC capacity must support an aggregate continuous throughput capacity of 2.0 Gbps.
- The EPC shall support segmentation and isolation or routing between APNs.
- The EPC shall support micro-segmentation security concept for isolating UEs from each other within an APN.
- The EPC shall be scalable to accommodate 10,000 dormant and 100 simultaneous active sessions.
- The EPC shall support sub 50ms RTT latency from a connected state.
- The LTE Infrastructure shall integrate with Hydro Ottawa's existing IP network access infrastructure and protocols.
- LTE RF Security features require demonstrated encryption, authentication, and access controls.
- The RF sites shall adhere to all RF safety protocols including power density calculations for RF safety signage.

4.2 Network Security

4.2.1 Device Authentication

The UICC or SIM card is one of the primary security methods for LTE. The SIM provides authentication via a shared key which is only known to the SIM and HSS. During the User Equipment (UE) attach process, the SIM is queried for a derivative of that key by the EPC in the AKA process. When the SIM authenticates properly, it is provided temporary identifiers to use in subsequent radio transactions, and it is allowed to attach to the LTE EPC and obtain an IP address. SIM's will be delivered to HOL, arranged by APN for distribution into the appropriate device types. Because the wireless network is intended to be private or virtually private, HOL will control the SIM cards and the devices in which they are installed. Hydro Ottawa therefore has complete control over which devices are allowed to authenticate and therefore utilize the LTE wireless network.

4.2.2 Air Interface Encryption

The S1-U and S1 MME interfaces shall be capable of integrity checking and over-the-air encryption. Assessments of the throughput costs will be tested and evaluated via iPerf within in a lab scenario or upon initial installation at the Hydro Ottawa site. At a minimum, the S1-MME link will be encrypted, and integrity checked. The user plane encryption and/or integrity checking capability will be implemented at HOL discretion. The Black & Veatch recommendation is to leave user plane encryption and/or integrity checking off to enhance throughput since the control plane is already encrypted. Optional services or optional managed services that can be obtained via equipment vendors or service providers include performance monitoring, software configuration, and management functions. These services are provided transparently to HOL in the existing Public LTE scenario since they do not own any of the LTE iinfrastructure. Both Rogers and Bell maintain the network in the background with compliance to a KPI standard. If HOL chooses to implement a private core and base stations, some internal or external team will have to maintain the LTE performance standards. If managing the private network is too burdensome, it will have to be contracted out in the Private or PVNO scenario. Managing the LTE network is typically supported by a carrier or equipment provider over a VPN as depicted in Figure 5.

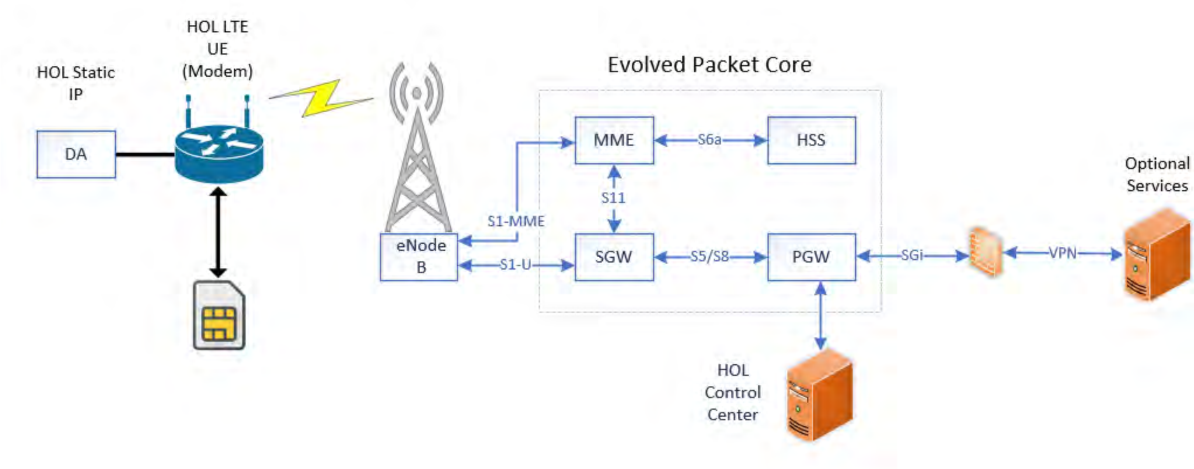


Figure 5 – LTE Detail Diagram

5.0 Private Network Option and Topology

A private network provides the flexibility and security of ownership of all network equipment and the spectrum that it uses. This comes at a cost, however, as HOL or its contractors would be responsible for the design, construction, testing, operation, and maintenance of every component of the network. There are many criteria to consider when selecting and designing a private network. In this section, network architecture, RF predictions, site placement and dimensioning, costs, and RF spectrum options are covered.

5.1 Private Network Architecture

An entirely private network is created where HOL owns the wireless radio spectrum, edge devices/user equipment (UE) and SIMs, radio access network (RAN), Enhanced Packet Core (EPC), and performs the day-to-day management and maintenance. The initial engineering to set up the selected equipment is typically performed with an OEM vendor. After integration with HOL assets and initial acceptance testing, it is turned up and optimized for a period of time. Following site by site testing and final acceptance, it is turned over to HOL to operate. There are also various managed service options available through different vendors.

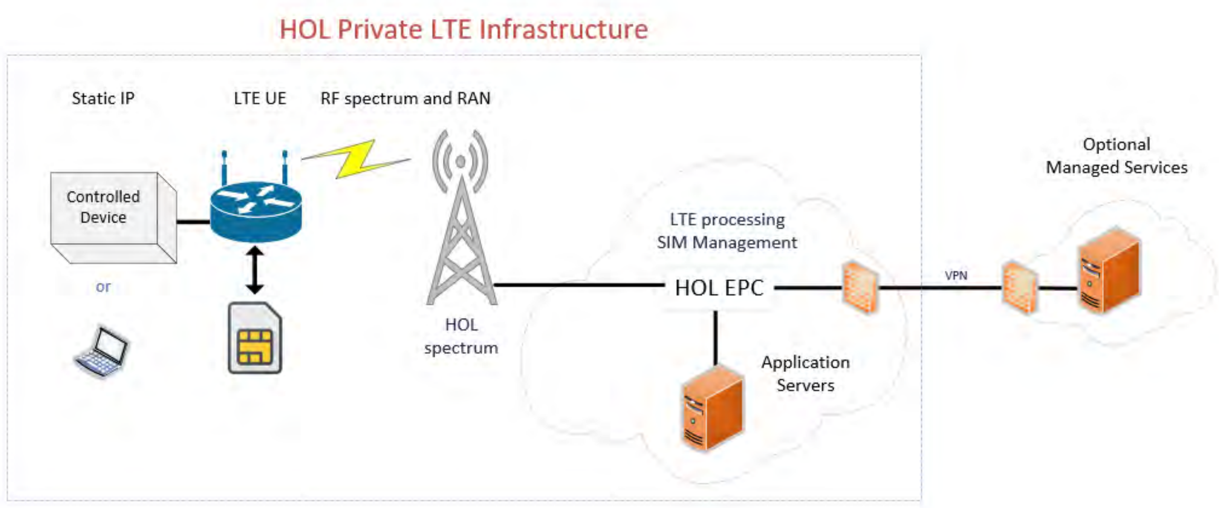


Figure 6 – Private Network Architecture

Some typical exceptions to a completely private scenario include co-location on existing cellular towers or rooftops and leasing backhaul where HOL lacks assets from a base station to HOL fibre. A private network can provide enhanced security and exclusive use of licensed spectrum with the attendant responsibilities and financial layouts.

5.1.1 Wireless Coverage Methodology

Black & Veatch inspected the HOL territory and performed a dimensioning analysis which yields a rough order of magnitude (ROM) cost estimate to build a private LTE network. This analysis was conducted using best practices and estimates by Black & Veatch senior engineers with multiple years of experience designing and deploying private LTE sites across North America. The following steps were involved in conducting this ROM analysis.

5.1.1.1 RF Predictions

Black & Veatch RF Design Engineers placed (2) two hypothetical sites within the HOL territory – one of them in rural morphology and the other in suburban morphology. These sites were chosen in a way as to provide a representation of the major portions of the HOL service area as shown in Figure 7. Both hypothetical sites were configured as 3-sectored LTE sites utilizing FDD in the 900MHz band. This configuration provides for 3MHz uplink and 3MHz downlink channels. Each site was configured with standard directional panel antennas with a 65-degree horizontal beamwidth. Once configured as standard LTE sites, coverage predictions for each site were modeled using an industry-wide accepted RF design tool. A transmit power of 38dBm (EIRP of 50.9dBm) was used in order to maintain compliance per the FCC rules governing the 900MHz Band 8 since Canada has not released any formal stipulations for this band yet.

Propagation studies were run at two representative antenna centre line heights of 23 metres and 38 metres See Figure 8 and Figure 9. The receiver height was defined at 5 metres above the ground level. This represents a typical height for AMI collectors. Based upon previous LTE designs, deployments, field testing, and engineering experience, a reference signal receive power (RSRP) of -118dBm was chosen as the cutoff for a usable signal. Receive Sensitivity is a property of the receiver; it is independent of antenna centre line. Raising the centre line can improve performance due to improved downlink receive signal strength and improving uplink line of site to the serving tower. Adding to the centre line collects more signal since it rises above the clutter which attenuates and diffracts the desired signals.

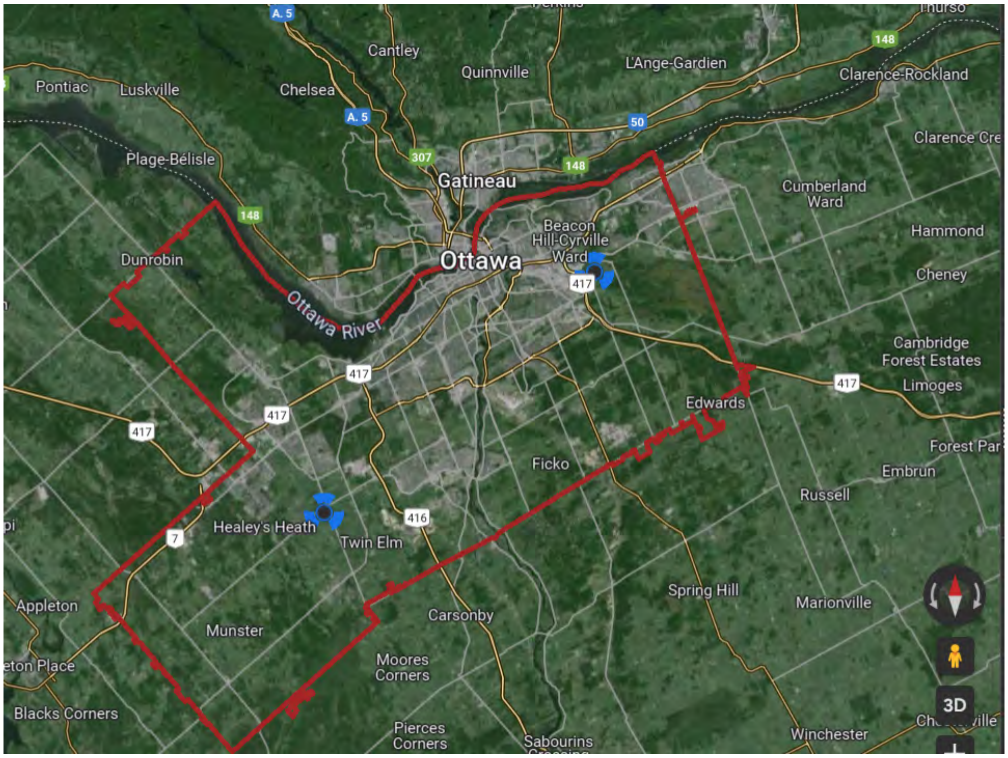


Figure 7 – Coverage Prediction locations

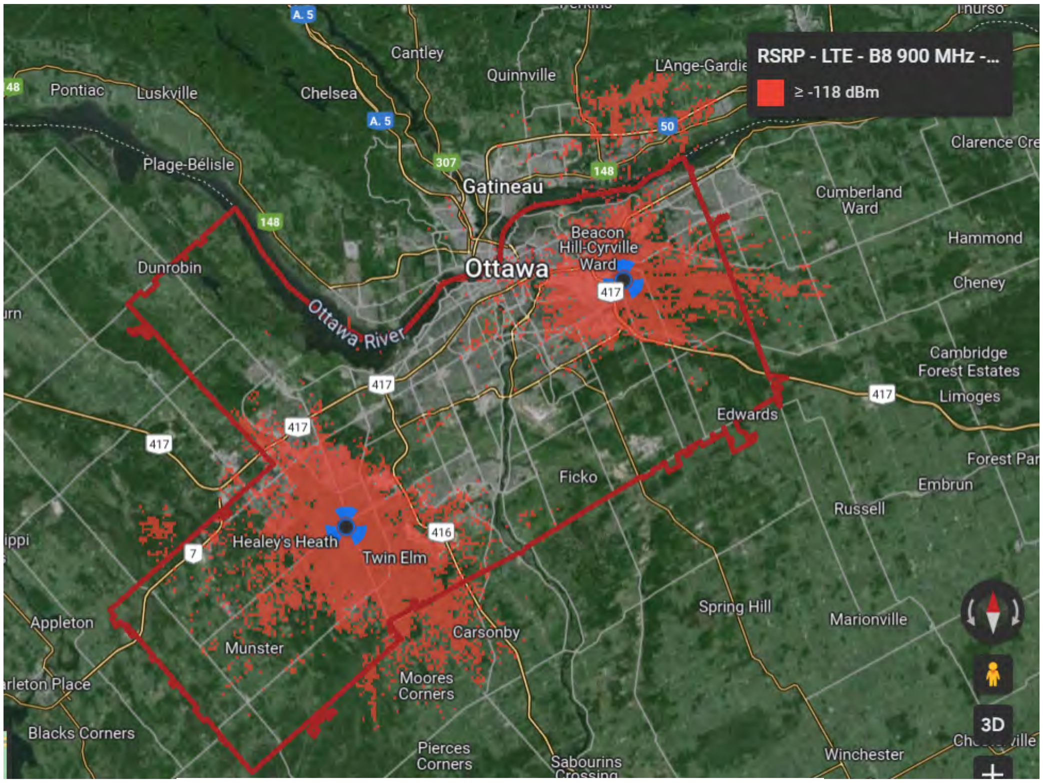


Figure 8 – Coverage Prediction at 23-metre antenna centre line

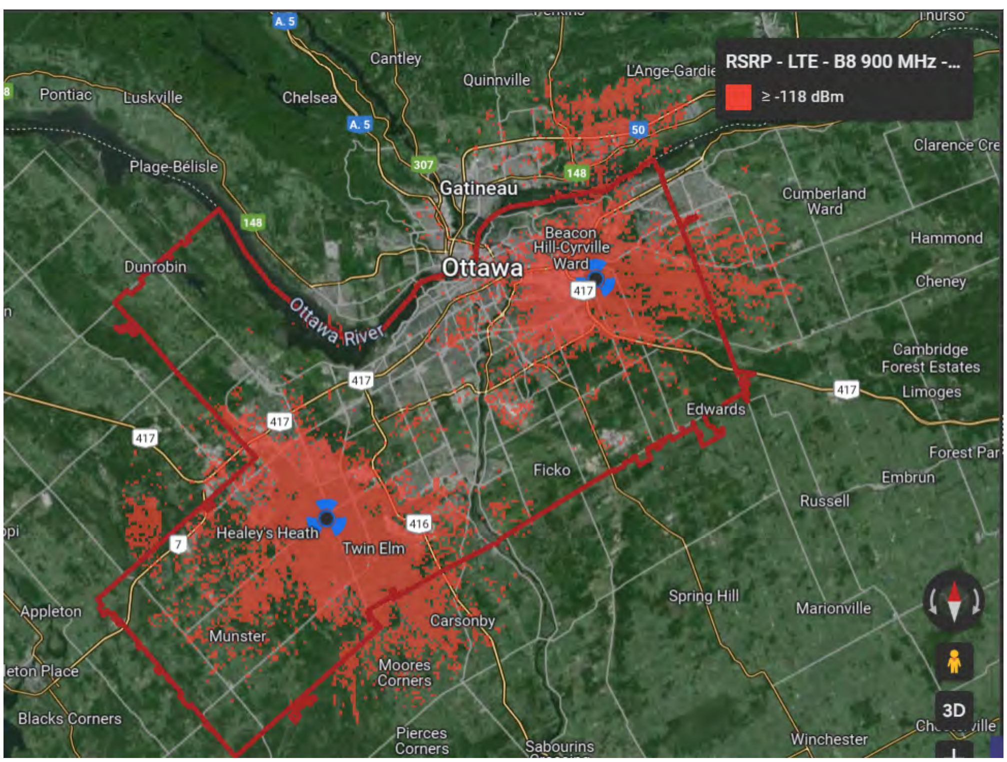


Figure 9 – Coverage Prediction at 38-metre antenna centre line

5.1.1.2 Site Dimensioning

The approximate area covered by these two sites at each of the two heights was obtained using RF propagation study software. The resulting area covered was used to approximate the total number of sites required to cover the entire HOL service area. For each height (23 metres and 38 metres), a +30% adjustment was made to each site to account for coverage overlap between the sites and for non-ideal site location in a real-world scenario. Site placement can be affected or influenced by multiple items including zoning restrictions, willing or non-willing landowners, geographic restrictions, air space restrictions, and many others. Black & Veatch has determined, through multiple LTE designs and deployments, that a +30% overlap adjustment best represents the impact of site placement on initial site counts. This model has been used by Black & Veatch on several projects with a high degree of accuracy for forecasting preliminary site counts as well as for budgetary purposes. The dimensioning results are shown in Table 4 below.

Table 4 – Site Count Estimation

Total Service Area			**1,113 km^2**				
Rural	724 km^2		**Sub-urban/urban**	390 km^2			
Frequency	**Tower/Antenna Height**		**Site 1 (Rural) Approx Coverage Radius**	**Site 2 (Sub-urban) Approx Coverage Radius**	**Approx Coverage area (Rural)**	**Approx Coverage area (Sub-Urban)**	**Number of sites required**
900 MHz	75 ft	22.9 m	7.0 km	5.5 km	153.9 km^2	95.0 km^2	12
900 MHz	125 ft	38.1 m	7.6 km	6.0 km	181.4 km^2	113.0 km^2	10

5.1.1.3 Site Placement

Once dimensioning is completed, a representative hexagonal cell is created in a GIS tool to approximate the placement of the sites and confirm the initial site count. This cell must correspond to the approximate coverage radius determined during RF predictions. In this case, a 23-metre rural cell was found to cover a radius of approximately 7km. Therefore, the hexagonal cell should be created with side length of 7km or a radius of 14km. These hexagons are arranged in a way that maximizes coverage while minimizing overlap. The resultant placement is shown in Figure 10. When utilizing a 23-metre rural site, we see that the initial estimate was 12 sites (Table 4). Given a 30% correction factor, this closely matches the site placement estimate of 14. The predictions rely on a low band LTE frequency that propagates effectively through and around clutter and foliage. Access to a lower LTE operating frequency minimizes the number of cells required to cover the service territory. As the LTE coverage frequency increases, additional power will be needed to achieve coverage parity with the low band, or else the grid must become more densely packed, and the site density will increase. There is no guarantee that any of the approximated locations are viable options; this process is meant to evaluate the potential number of sites to cover the service territory. In addition to the main Ottawa service territory area, the adjacent Casselman will require one additional site to cover those HOL AMI and DA assets.

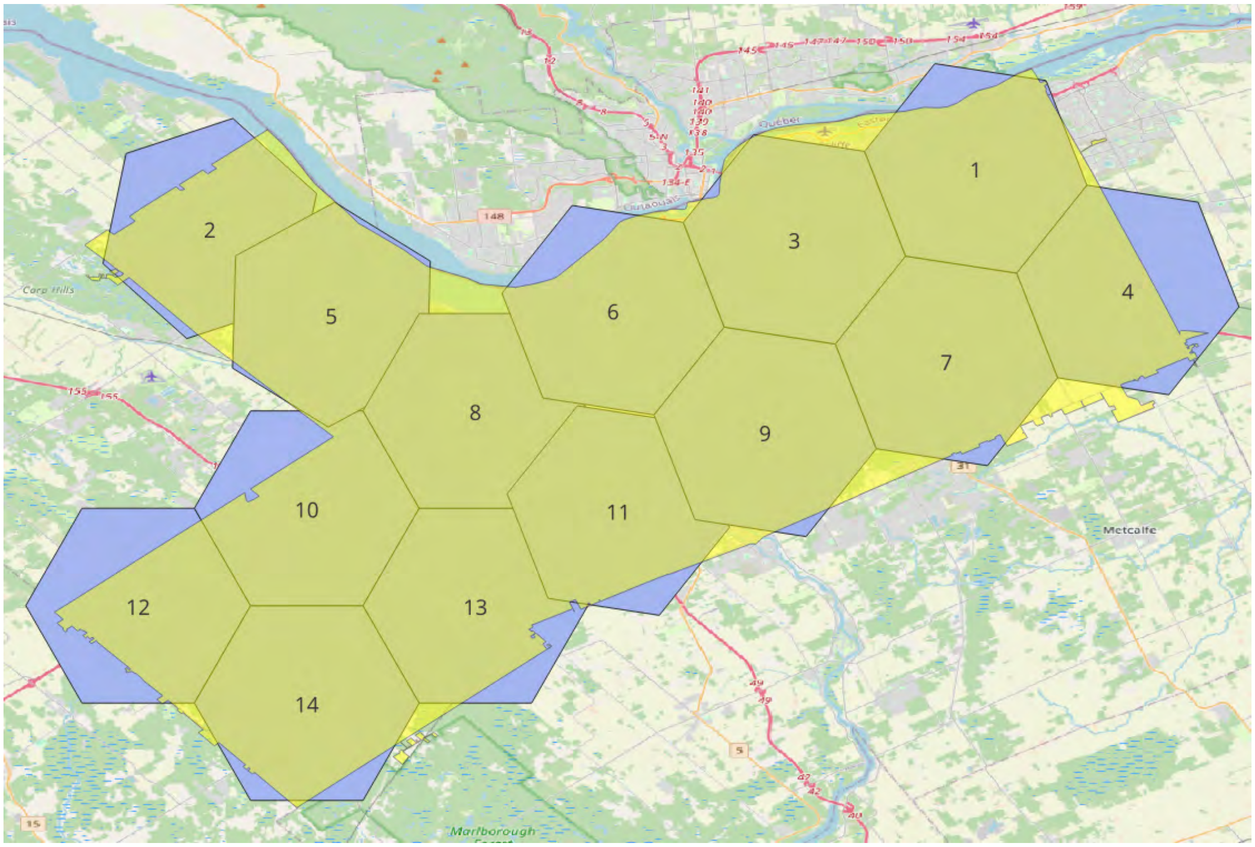


Figure 10 – Hexagonal Cell Placement

5.1.2 RF Capacity Planning discussion

The following per cell capacity estimates are based on securing spectrum and tower centre lines capable of projecting the hexagonal cell footprints described in the Coverage Methodology. The HOL geolocated DA and AMI assets were divided into the hexagonal cells by their relative location. The capacity required per cell will be estimated based on AMI 2.0 and DA traffic estimates.

5.1.2.1 DA

A GIS analysis was conducted to count the amount of DA objects in the service territory which resulted in the division of the existing DA into each hexagonal site. In Figure 11, the red number represents the assigned number of the cell site, and the yellow number represents the number DA objects (modems) occurring in that cell footprint.

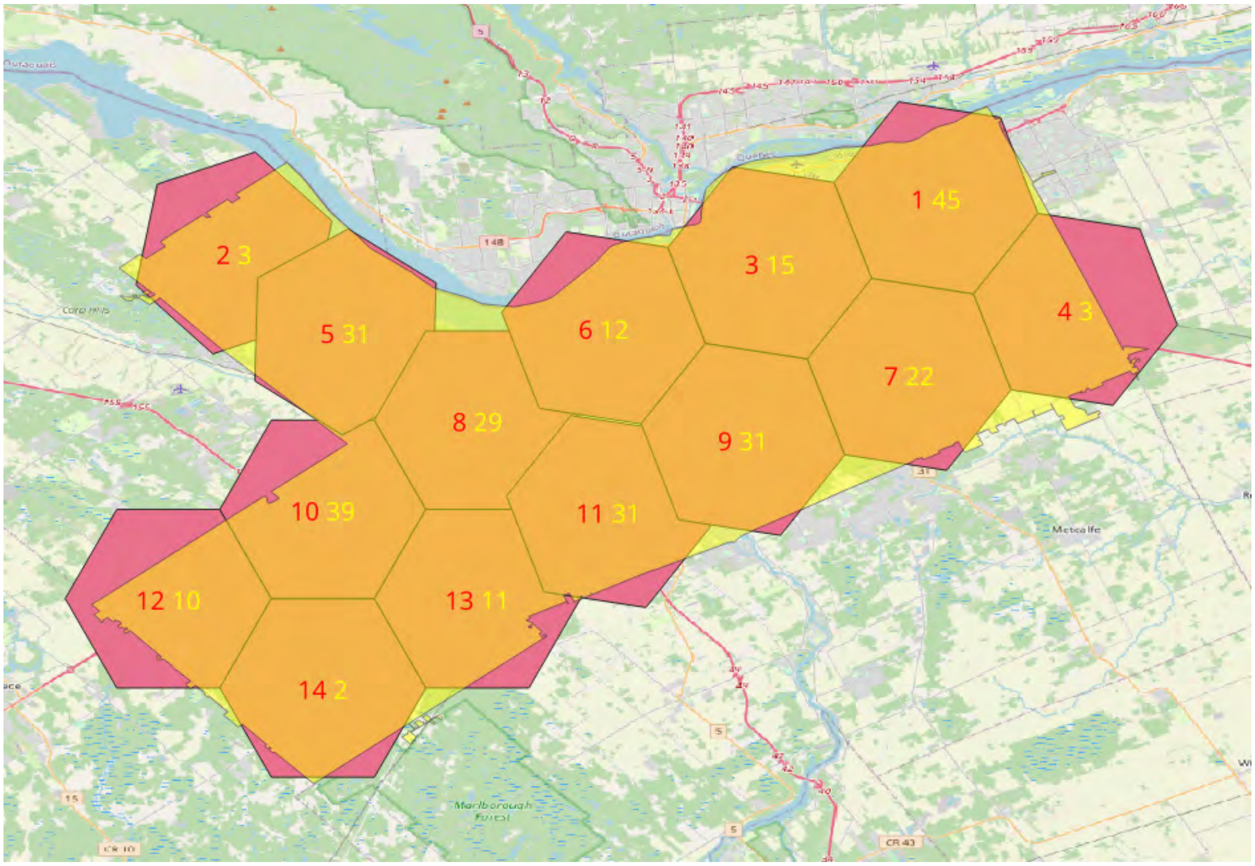


Figure 11 – predicted DA assets per hexagonal cell

DA device bandwidth requirements are determined by the sampling rate and the complexity of DNP points list brought back to the SCADA headend. While this varies between utilities, a 5kB response is a reasonable approximation for each poll response. Assuming 5-minute samples:

Estimate:
12 samples/hour * 24hrs/day * 30 days/month= **8640** samples over a month
5kB/poll * 8640 = **43.2 MB**/month for SIM sizing (MRC)
Cell loading = 50 DA per cell(worst case) * 5kB/poll= 250KB/300sec polling= ~**1kB/sec**

Actual volume of "X_CS" devices with >95% success rates:
Previous Day RTU Stats Summary showed and average of **500KB/day** per device or ~ ½ the estimated value.

5.1.3 AMI

A GIS analysis was conducted to approximate the number of AMI collectors in a geographic area which resulted in the division of the existing AMI meters into the hexagonal cell approximations. In Figure 12, the red number represents the number of the cell site, and the yellow number represents the number Aps or collectors at 1000:1 ratio required in that cell footprint. Table 5 includes the projected total number of required AMI Aps per cell rounded the next whole number.

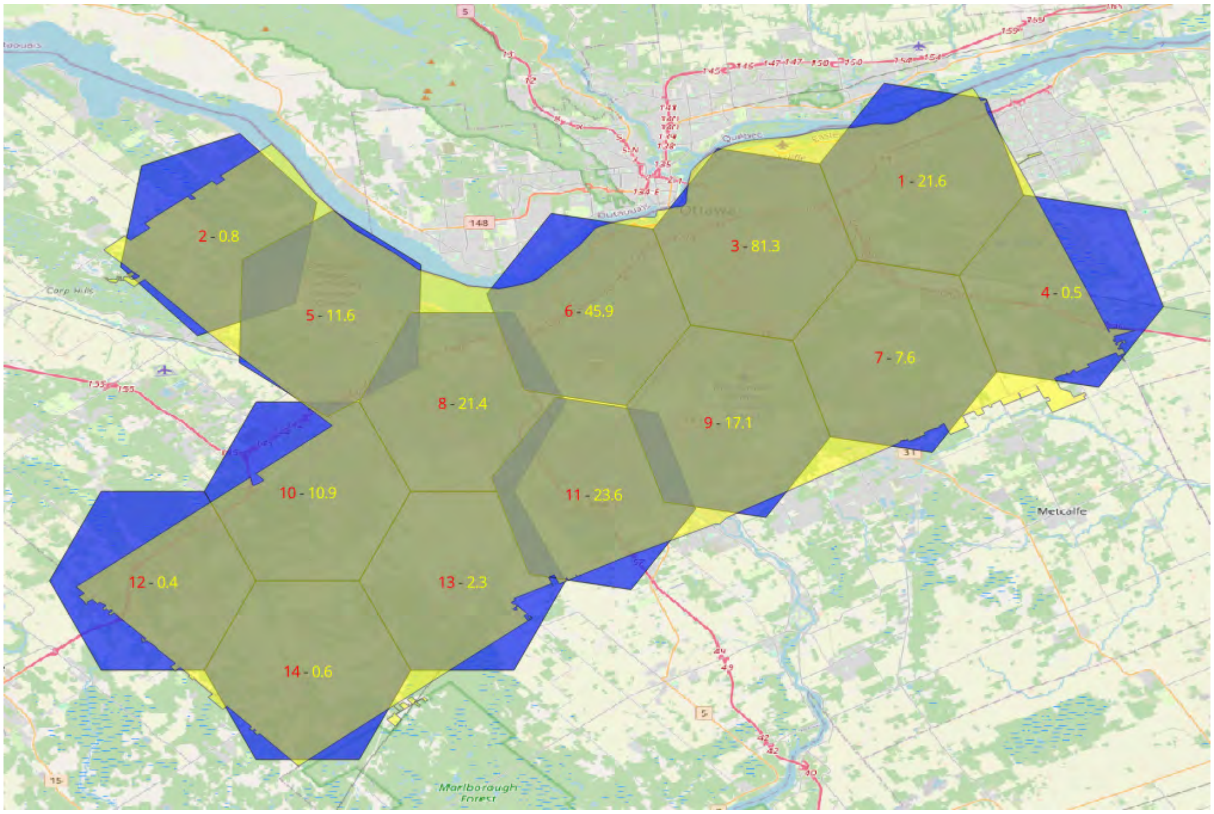


Figure 12 – AMI AP's per cell

When planning specific collector locations, it will be important to ensure that there is site diversity and preferably frequency diversity to decrease the risk of backhaul failures should a cell site/sector fail or undergo maintenance. The projected capacity need of AMI over cellular has been estimated using a Landis and Gyr load profile table that defines ~10 transaction types from firmware upgrades to various read types to last gasp communication. See Table 5.

Table 5 – L and G Load Profile Options

Cellular Data Volume Usage

Commercial	Landis+Gyr Payload Size	Periodicity	Daily with 4 LP @ 1 minute	Daily with 16 LP @ 1 minute	Daily with 4 LP @ 5 minute	Daily with 16 LP @ 5 minute	Daily with 4 LP @ 15 minute	Daily with 16 LP @ 15 minute	Landis+Gyr Payload Size	Periodicity
Load Profile			25,920	103,680	5,184	20,736	1,728	6,912		
Landis+Gyr Meter Firmware Upgrade	1MB	6 months							1MB	6 months
Landis+Gyr Module Firmware Upgrade	1MB	6 months							1MB	6 months
Modem Firmware Upgrade	1MB	18-24 months							1MB	18-24 months
Disconnect	~30B								~30B	
Load Control	~30B								~30B	
On-Demand Read	<1kB								<1kB	
Snap Read	200B	24 hours	200	200	200	200	200	200	200B	24 hours
Event Log	~5kB	24 hours	5000	5000	5000	5000	5000	5000	~5kB	24 hours
Meter Reconfiguration	~5kB								~5kB	
Last Gasp	100B								100B	
Heartbeat	34B		9,792	9,792	9,792	9,792	9,792	9,792	34B	
Total Daily Bytes			40,912	118,672	20,176	35,728	16,720	21,904		
Per month			1,227,360	3,560,160	605,280	1,071,840	501,600	657,120		
In MB			**1.23**	**3.56**	**0.61**	**1.07**	**0.50**	**0.66**		

The L & G meter will store data within the meter at the cadence specified in the load profile above. The rate at which it is picked up by the AMI server is based on how often the AMI meter is polled. The rate at which the AMI meters can be polled and successfully respond depends on the speed of the AMI response. This analysis assumes meters can be polled successfully every 15 minutes, which will likely require few mesh connections and many LTE connections. AMI sample rates can be sampled and stored by the meters and picked up at a rate which the communications support. Some of the variables include the LTE interface (CAT-M) and the depth of unlicensed mesh required prior to getting to an LTE exit point.

Based on stakeholder feedback, 15-minute 4-channel meter channel measurements were selected for the data volume (5th column in Table 6). Additional types of surveys and data rates are possible but based on the volume of the standard configuration (4LP @15 mins), it is unlikely to dramatically skew the expected aggregate data volume for the entire AMI 2.0 meter population. Based on the red highlighted column in Table 5, that sample rate results in the following projection of traffic per site for all collectors. An all P2P network would have LTE interfaces on all AMI devices; however, this does not guarantee that all AMI LTE meters would be in good coverage. Thus, all meters would also require mesh interfaces as well as LTE. The latency performance of the AMI polling would be dependent on the penetration of the LTE signals.

Table 6 – Data Volume Projection

Hex Cell ID	AMI per cell	Count of AP: 1000 to 1	Count of AP: 1500 to 1	4LP @ 15 min Data Volume per Month (MB)	AP (SIM) Volume (MB/month)	AP (SIM) Volume (MB/day)	DA per cell	DA Data Volume (MB/day)	DA Data Volume (MB/month)
1	32389	32	22	0.5	16194.5	540	45	22.5	675
2	1264	1	1	0.5	632	21	3	1.5	45
3	122014	122	81	0.5	61007	2034	15	7.5	225
4	703	1	0	0.5	351.5	12	3	1.5	45
5	17354	17	12	0.5	8677	289	31	15.5	465
6	68878	69	46	0.5	34439	1148	12	6	180
7	11467	11	8	0.5	5733.5	191	22	11	330
8	32122	32	21	0.5	16061	535	29	14.5	435
9	25592	26	17	0.5	12796	427	31	15.5	465
10	16377	16	11	0.5	8188.5	273	39	19.5	585
11	35340	35	24	0.5	17670	589	31	15.5	465
12	630	1	0	0.5	315	11	10	5	150
13	3406	3	2	0.5	1703	57	11	5.5	165
14	973	1	1	0.5	486.5	16	2	1	30
Totals	**368509**	**367**	**246**		**184254.5**	**6142**	**284**	**142**	**4260**

The aggregate expected monthly data traffic between the AMI and the DA is roughly 6.3GB per day and projected to just short of 190GB per month. That capacity will be divided across ~600 LTE devices. Approximately 246 modems and SIMs will be in service providing backhaul for smaller mesh networks of 1500 meters to 1 collector. This can be divided down for the to 1000 to 1 ratio which results in ~370 modems and SIMs. The higher the number of AP's, the lower the meter latency should become. The complexity becomes the number of SIMs and IP's that need to be managed and assigned respectively. Again, accurate recordkeeping and strong SIM process controls will prevent problems. Does HOL have a good handle in its current SIM inventory? Can HOL provide a current inventory of all active SIMs, their individual data usage, and assurances that there is no fraud? If the answer is no, that process should start soon. This is a sample of the traditional point to multipoint scenario with LTE backhaul. This could be over private or public LTE. If it is private, HOL will possibly have to extend fibre to reach the HOL WAN. If it is public, it will aggregate on the LTE carriers network and be returned to HOL over an APN.

The next scenario is a point-to-point AMI network. The point-to-point network has ~367k SIMs and IP addresses. This is where a good process related to SIM management and awareness become essential, as numerous authentications and sessions will have to be hosted on an appliance (server) based LTE core HSS and MME. LTE generally scales easily to this size, but the correct sizing considerations must be evaluated by the core OEM vendor. The other consideration is that mesh solves problems with RF coverage by routing traffic to the node that is closest or has the best RF channel to the AP. A network that is point to point everywhere will likely require some mesh component since LTE may not reach all meter locations. The mesh will allow for the poll to reach the mesh connected meter to communicate. The AMI 2.0 meter should have intelligence that allows for mesh where LTE is unavailable. Well considered planning will locate the APs in good coverage with multiple potential servers and multiple frequencies in service. In a public scenario, this AP planning process could be surveyed for coverage and planned now since the commercial cellular networks are on the air and operational. For a private scenario, HOL would first need to secure the spectrum and clear it, secure the tower locations and centre lines, secure backhaul if it is not on the HOL fibre, select and order all the equipment, and train the staff. Then, HOL would initiate site construction, backhaul, and cores, followed by RF testing and optimization. Once this is completed, all of the remote resources and anything else in the field can be added to the network.

5.1.3.1 Future Battery

Stakeholder meetings indicated that battery usage could exceed 10Gbps/month with polling occurring every minute. The capacity demands are calculated as follows.

> 1 sample/min * 60 mins/hour. * 24hrs/day * 30 days/month= **43200** samples over a month
> 10Gb month/43200 = ~**250kb** per read.

250kb is a relatively conservative throughput number for a LTE base station, depending on the spectral bandwidth available. The battery management interface (BMI) devices may need to be placed in a defined SIM data plan since they far exceed the volume of data expected from the DA and AMI devices. It is likely that the BMI located SIM(s) will require an unlimited data plan. In addition, it is strongly recommended to ensure that there is LTE site diversity and frequency diversity, and potentially LTE carrier diversity at these locations so that in the event of a sector radio fail, an antenna sector fail, or a complete site failure, there is still RF diversity to respond back to the monitoring status query. Facilitating the recommended site diversity requirements requires an LTE site survey prior to planning the locations of these battery storage assets. The site survey will find all the available LTE carriers, the bands, signal strengths, and related parameters to provide a higher degree of confidence in the reliability of RF backhaul. Battery and diesel generator backup at those locations would also be advisable.

5.1.3.2 Distributed Energy Resources (DER)

Distributed Energy Resources (DER) can be large isolated solar farms, commercial building rooftops, or even residential homes. The stakeholder meeting alluded to the need for monitoring and control of these applications. Exact sampling and throughput values have yet to be determined, but current estimate is ~50 Mb/month of data volume per station.

> 6 samples/hour * 24hrs/day * 30 days/month= **4320** samples over a month
> 10kB/poll * 4320 = 43.2 MB/month

5.2 RF Spectrum Options

Black & Veatch has researched the various frequency spectrum options that are available for HOL. Each band has specific licensing requirements, and each has advantages, disadvantages, and restrictions. For each band, the band plan, licensing rules, other requirements, restrictions, and potential risks are provided.

Below is a list of the spectrum options under consideration with bandwidth and maximum theoretical throughput (downlink/uplink).

- 700 MHz, Band 14, public safety broadband network
  - 10 MHz x 10MHz FDD – 75Mbps/25Mbps
- 900 MHz ISM
  - 10 MHz x 10 MHz
- Band 8 FDD option (Anterix)
  - 3 MHz x 3MHz FDD – 22.5Mbps/7.5Mbps
- 1800 MHz
  - 10 Blocks of 5MHz x 5MHz FDD – 37.5Mbps/12.5Mbps
  - 1 Block of 15MHz x 15MHz – 112.5Mbps/37.5Mbps
- Globalstar 2400 MHz – Low power
  - 10MHz TDD* – 18.4Mbps/15.5Mbps
- 3900 MHz
  - 10MHz TDD* – 18.4Mbps/15.5Mbps
- Subordinated Licensing

* TDD throughput assumes frame configuration 0 (2x2 MIMO radio, 64QAM/16QAM for DL/UL modulation)

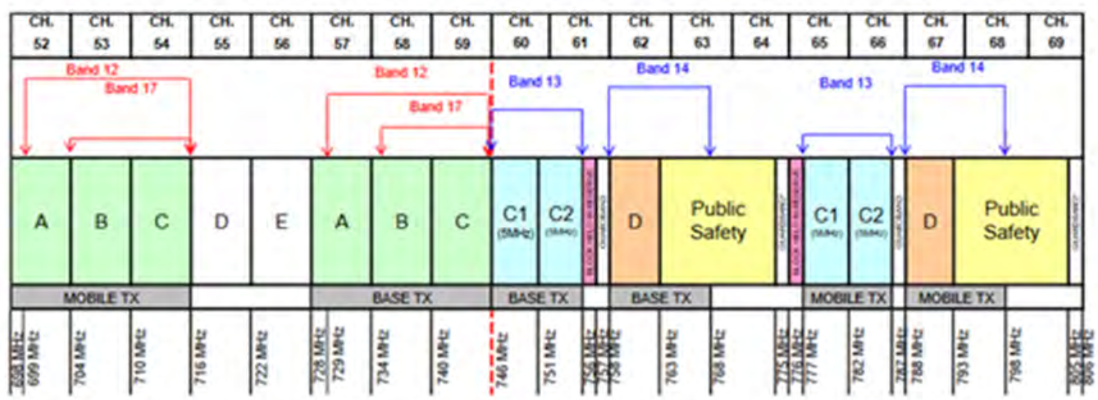
Spectrum licensing services can be found at the following link: [Spectrum Licensing Services (canada.ca)](). Here, it is possible to browse existing and available licences and to apply for licences.

5.2.1 700MHz - Band 14:

This band has excellent propagation characteristics and is expected to have excess capacity, so it would appear to be a viable option. However, public safety entities have priority over this band, so this excess capacity might not be guaranteed over the long term. As a utility with ownership of critical infrastructure, HOL could potentially qualify for priority access to Band 14 for certain purposes. Regulations for this band have not been finalized, and the current and near future availability of licences is uncertain. For further information, contact ISED Eastern and Northern Ontario District Office, 1-855-465-6307 or spectrumenod-spectredeno@ised-isde.gc.ca.

Band Plan:

- ISED has allocated 20MHz (10 MHz UL & 10 MHz DL) of 700MHz spectrum for spectrum licences to one or more public safety network entities. The 700MHz band gives excellent propagation characteristics. See Figure 13.
- The primary spectrum of the Public Safety Broadband Network (PSBN) is Band 14, but it could include other bands where capacity is available and it is economically feasible.
- It is expected that PSBN allocated spectrum will have significant surplus capacity. Otherwise, PSBN users must have priority and the ability to pre-empt commercial users as and when needed.



*In Canada, the bands 775-776 MHz and 805-806 MHz are designated for public safety.

Figure 13 – 3GPP Technical Specifications for equipment operating in 700MHz band with Block C subdivided into two separate blocks

<u>Licensing:</u>

- ISED will establish the Band 14 conditions of licence and award spectrum.
- Spectrum will not be auctioned.
- The current licensing framework on its own is not sufficient and should be supported by additional governance.
- The Temporary National Coordination Office (TNCO) recommends that the PSBN be implemented using a shared network approach.

<u>Spectrum Utilization Model:</u>

The TNCO considered three broad models of spectrum utilization for the implementation of a PSBN in Canada:

1. **Public Safety Exclusive Dedicated Network:** A dedicated public safety network used exclusively by public safety users (using 700 MHz Public Safety Broadband).
2. **Shared Public Safety-Commercial Network:** A network that supports both public safety and commercial usage (with distinct public safety and commercial cores), with priority access and pre-emption rights for public safety use during emergencies and other times of need.
3. **Commercial Network:** The public safety community obtains services from one or multiple commercial carriers using that carrier's existing network spectrum and/or acquired Band 14 spectrum.

A dedicated network is not preferred due to the low likelihood of satisfying the principles of coverage, sustainability, affordability, and efficient use of spectrum.

<u>Strategic Partnerships</u>

Under mutually beneficial agreements, infrastructure owners could choose to share some of their infrastructure for installation of new equipment for the PSBN or could become a regional PSBN operator, depending on the circumstance. This should start with clarification on regulatory completion and adoption of ISED directives regarding 700MHz spectrum. Developing relationships with the Ottawa public safety entities, specifically those which maintain and operate the existing radio networks, will promote insight regarding the Ottawa Public Safety 700 MHz LTE adoption and implementation roadmap. The local LTE carriers will also have some insight as to the disposition of the spectrum. Black & Veatch recommends hosting a call with one or more of the local LTE carriers along with HOL.

5.2.2 900 MHz – Unlicensed Industrial, Scientific, and Medical (ISM) Bands

The Industrial, Scientific, and Medical (ISM) frequency bands are designated radio frequency bands as defined by the ITU Radio Regulations. These frequency bands were set aside for RF use for purposes other than telecommunications. Hence, using the ISM bands for telecommunications is possible, but telecommunications devices using these frequencies must be able to withstand interference from other RF and microwave technologies, such as microwave ovens, RF heating, and other potentially electromagnetic interference (EMI) producing devices. This band has the advantage of not requiring licensing, but its potential for interference makes it a risky solution.

Various wireless services operate in the 900 MHz band. These services include utilities, railroads, and other private land mobile radio services. The 900 MHz frequency band can be used for land mobile, paging, multipoint communications systems, narrowband-PCS, and fixed services. Equipment availability could be a risk here. Equipment options will require further research. This band is not suitable for large scale LTE deployments, but there could be specific applications in which it might be considered.

Band Plan:

- 902-928 MHz is designated for industrial, scientific, and medical (ISM) applications.
- Stations operating on this band must accept harmful interference.
- Being first to deploy a system in this band does not grant any rights to continued operation without interference.

Licensing:

- 902-928Mhz is a licence-exempt band.
- Radio equipment operating in this band must be ISM certified.

5.2.3 900 MHz / BAND 8 FDD – Anterix Band

This is a licensed band that is likely to have some capacity available, but it is limited to rural and remote areas, and railways are making heavy use of it, but if capacity is available inside of HOL's service area, it may be an option.

Band Plan:

- This band was for 3/3 MHz for broadband services in the range 897.5-900.5 and 936.5-939.5 MHz portion (US Band 8). The 3/3 was also supported by multiple respondents during the commenting period.
- ISED will make access radio licences available in the rural and remote Tier 5 service areas.
- ISED will allow fixed and mobile use under access radio licence.
- First come first service with a licence fee.
- The railway industry has a significant deployment of radios which would need to be protected regardless of which band plan is utilized.

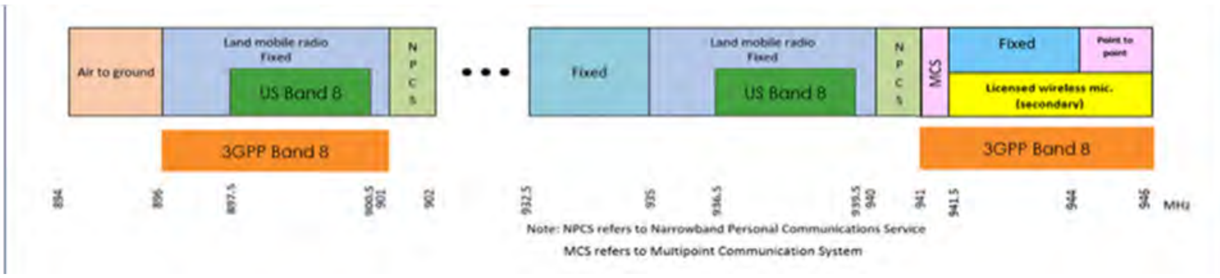


Figure 14 – Proposed Band Plans for 900MHz Radio Access Licensing

Licensing:

- ISED typically releases spectrum using a first come first serve (FCFS) licensing approach where the demand for spectrum is not expected to exceed the supply and a competitive process is not required.
- ISED will determine the rural and remote areas where there is unused spectrum on a band-by-band basis.
- Access licences will be made available where ISED has determined there is unused spectrum, defined by the Tier 5 service area categories.
- Access spectrum licences will have a term of 3 years and cannot be transferred or subordinated.

Additional details are available at

https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/spectrum-allocation/decision-new-access-licensing-framework-changes-subordinate-licensing-and-white-space-support-rural

5.2.4 1800 MHz

This is a licensed band that currently has older, non-standard systems, but new, standardized requirements have come online. This band could be an option if spectrum is available in the HOL service area. This band will require a higher density of sites than the 700 MHz or 900 MHz bands.

Licensing process:

- Existing radio systems in 1700-1710 MHz and 1780-1850 MHz bands remain standard.
- Requests to extend or expand existing systems reviewed case-by-case by ISED.
- New systems in these bands must comply with SRSP requirements.

Systems Originally Licensed on a Non-Standard Basis:

- Non-standard licensed systems may require modification, replacement, or removal to comply with SRSP or SP/RP at a later date.
- A two-year notice will be given unless Regional Executive Director determines shorter notice period is warranted.
- The five-year protection and two-year warning rule don't apply to systems initially licensed as non-standard.

Systems Authorized on a Secondary Basis:

- Secondary system licensees must relinquish their assignment if the frequency is needed for primary service growth.
- Non-standard and 5- and 2-year rule provisions don't apply.
- Regional Executive Director may grant up to 2 years notice before relinquishing the frequency for primary service use, depending on local circumstances.

Band Plan:

- The bands 1850-1915 and 1930-1995 MHz are divided into two sub-bands: the lower sub-band (1850-1915 MHz) and the upper sub-band (1930-1995 MHz). These sub-bands are further divided into 11 paired blocks with a frequency separation of 80 MHz: 10 blocks of 10 MHz (5 + 5) and one block of 30 MHz (15 + 15) as seen in Figure 15.

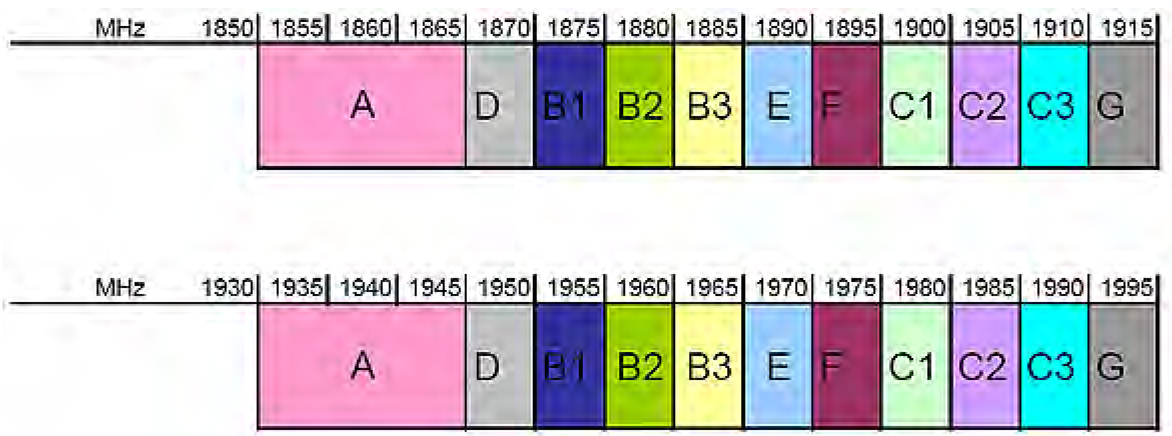


Figure 15 – 1800MHz Band Plan

5.2.5 2400 MHz

Globalstar Canada has applied to operate in this band, and they have the option to subordinate their licence. The details of this arrangement and requirements for this band follow.

Band Plan:

- Globalstar Canada's ATC application outlines plan for deploying low-power time division duplex (TDD) LTE systems in "downlink duplex mode" (also known as "non-forward-band mode") in a small cell configuration within its MSS downlink spectrum (2483.5-2500 MHz).
- ISED proposes to permit this mode of operation and adopt similar technical rules as in the U.S., including power limitations, the use of a Network Operating System (NOS) for base station control, and unwanted emission limits to address harmful interference concerns.
- Although Globalstar Canada's ATC application covers the 2483.5-2500 MHz band, ISED notes that in the U.S., Globalstar was authorized to operate its low-power ATC system only in the 2483.5-2495 MHz band.
- ISED will authorize Globalstar Canada to operate only low-power ATC in the 2.4 GHz band through a spectrum licence, subject to specific technical, policy, and licence conditions.
- Globalstar Canada may choose to subordinate the spectrum to a major mobile carrier.

- A 10MHz TDD channel could operate at low power in the downlink section of this band. It would provide both uplink and downlink to the deployed network. See Section 5.2.

Technical and operational requirements:

- Equipment shall operate in the 2483.5-2495 MHz frequency band.
- The transmitted signal shall be digitally modulated.
- The 6 dB bandwidth shall be at least 500 kHz.
- Transmitter output power shall not exceed 0 dBW.
- The maximum equivalent isotropically radiated power (e.i.r.p.) shall not exceed 6 dBW.
- The equipment's maximum power spectral density conducted to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.
- Compliance with this limit may be based on the use of a measurement resolution bandwidth of at least 1% of the occupied bandwidth. If 1% of the occupied bandwidth is less than 1 MHz, the power measured shall be integrated over the required measurement bandwidth of 1 MHz.
- The 2.4 GHz low-power ATC system meeting the technical requirements in this section may operate in non-forward-band mode.
- The 2.4 GHz low-power ATC system meeting the technical requirements in this section is not required to use dual-mode user equipment.
- The ATC licensee shall utilize a Network Operating System (NOS), consisting of a network management system located at an operations centre or centres. The NOS shall have the technical capability to address and resolve interference issues related to the licensee's network operations by:
  - reducing operational power
  - adjusting operational frequencies
  - shutting off operations
  - any other appropriate means
- The NOS shall also have the ability to resolve interference from the terrestrial low-power network to the licensee's MSS operations and to authorize access points to the network, which in turn may authorize access to the network by end-user devices. The NOS operations centre shall have a point of contact in Canada available 24 hours a day, seven days a week, with a phone number and address made publicly available by the licensee.
- All access points operating in the 2483.5-2495 MHz band shall only operate when authorized by the ATC licensee's NOS, and all client devices operating in the 2483.5-2495 MHz band shall only operate when under the control of such access points.

Spectrum Licences and Fees:

- Spectrum licences will be issued for Ancillary Terrestrial Components (ATC) systems and will be subject to spectrum licence fees.
- The specific fees will be established through a separate public process.
- Innovation, Science and Economic Development Canada (ISED) indicated that the fee for each assigned transmit or receive frequency "channel" would be $41 per "channel."
- For a transmitter and receiver using the same frequency channel, the current annual fee would be $82.
- Licensees are required to pay the applicable annual licence fee on or before March 31 of each year for the subsequent year (April 1 to March 31).
- Innovation, Science and Economic Development Canada (ISED) will mandate Ancillary Terrestrial Components (ATC) Licensees to apply for and maintain a radio licence under the Radiocommunication Regulations for each operating site.

- Once a spectrum licence fee is established, ISED plans to amend the provision requiring radio licences and authorize equipment operation through the spectrum licence.
- Annual spectrum licence fees will be required to be paid at that time.
- The spectrum licence is non-transferable and indivisible, except in cases of internal reorganization of the Licensee or its affiliate.
- In such cases, the Licensee may apply to the Minister of Innovation, Science and Industry for authorization for a transfer, following the procedures outlined in the Client Procedures Circular.

5.2.6 3900-3980 MHz

This band is licensed under a first come, first served approach, and an auction for licences is scheduled for April 2024. Subordination is not permitted. It offers eight 10 MHz blocks, and it is intended for multiple licensees to coexist, so there is potential for interference. At higher frequencies, such as this band, a higher density of sites is required, resulting in higher cost.

Band Plan:

- The 3900-3980 MHz band offers frequency blocks for licensing, primarily for time division duplexing (TDD) systems.
- The band is divided into eight unpaired blocks (Figure 16 below), each spanning 10 MHz.
- Adjacent 20 MHz guard band in 3980-4000 MHz
- Frequency blocks can be aggregated.

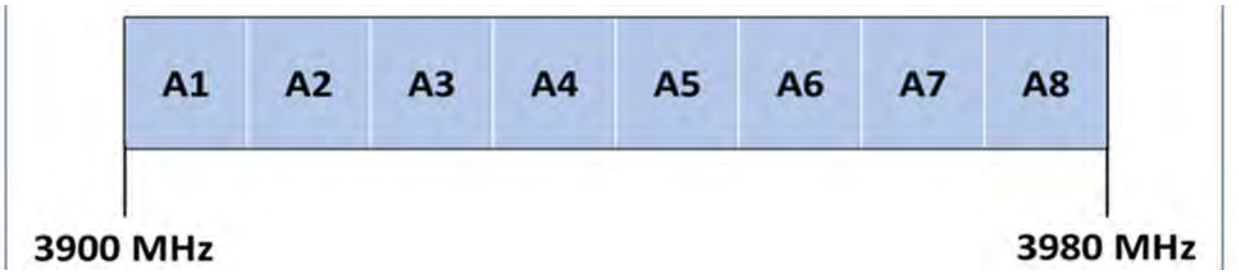


Figure 16 – 3900MHz NCL Licensing Band Plan

Licensing:

- Innovation, Science and Economic Development Canada (ISED) will oversee access to the 3900 MHz band via an automated Non-Competitive Local (NCL) licensing system, subject to potential modifications.
- The automated system aims to enable coexistence among licensees sharing the same frequency block.
- Subordinations will not be permitted in this licensing framework.

Coexistence with other radio services:

- The automated Non-Competitive Local (NCL) licensing system will aid in coexistence between NCL licensed systems and other systems.
- Innovation, Science and Economic Development Canada (ISED) will utilize planning parameters and technical assumptions outlined in Annex A of the automated NCL licensing system to

establish appropriate separation distances from NCL licensed representative base stations to other systems.

- In cases of harmful interference conflicts, licensees are responsible for resolving conflicts through mutual arrangements after consultation and coordination.
- If conflicts persist and cannot be resolved promptly, affected parties shall notify ISED. ISED will then determine the necessary course of action following consultations with involved parties.

Certification requirements:

- Equipment operating in the 3900-3980 MHz band under NCL licences must be certified according to the latest version of Radio Standards Specification RSS-198.
- This equipment falls under Category I and requires certification.
- Certification can be obtained through a technical acceptance certificate (TAC) from ISED's Certification and Engineering Bureau (CEB) or a certificate from a recognized certification body (CB), such as the American Certification Body, Inc. (CAB Identifier: US0101).
- Equipment under this standard fall under Category I and must be certified.
- Certification can be obtained through a technical acceptance certificate (TAC) from ISED's Certification and Engineering Bureau (CEB) or a certificate from a recognized certification body (CB).
- The Standard Radio System Plan (SRSP) aligns with current and future technologies for non-competitive local (NCL) licensed systems in Canada.
- NCL licensees must ensure their fixed and base stations are professionally installed to meet SRSP compliance standards.

Fee Order for Non-Competitive Local Licences: (3.9 GHz)

- First come first served (FCFS) licensing approach.
- Fees for these licences are based on the amount of spectrum authorized in MHz, and the geographic size of the licence area in km^2, multiplied by a base fee rate.
- The fees take effect as of April 1, 2024 and are applicable to all non-competitive local spectrum licences in accordance with the conditions of each licence. Licences are valid for 1 year.
- Deploy within 2 years of acquiring the licence.
- No subordinations

Spectrum Licence fee for Non-Competitive Local Licences at Frequencies below 10 GHz

For non-competitive local spectrum licences at frequencies below 10 GHz, the annual fee payable is the total assigned spectrum, multiplied by the licence area, multiplied by the base rate specified below ($/MHz/km^2), for the assigned frequency band(s).

- $1.80 per MHz per km^2 for non-competitive local spectrum licences in metropolitan and urban areas
- $0.45 per MHz per km^2 for non-competitive local spectrum licences in rural areas
- $0.01 per MHz per km^2 for non-competitive local licences in remote areas

5.2.7 Subordinated Licensing

A subordinate licence allows for more efficient use of spectrum by permitting licensees to enter into agreements that allow another party to operate within the licence area, using the licensed spectrum or a portion of their frequency or geographic area without having to completely transfer their spectrum licence(s).

- A subordinate licence enables licensees to efficiently utilize spectrum by allowing other parties to operate within the licensed area.
- It permits licensees to enter agreements for another party to use the spectrum without transferring the entire licence.
- Primary licensees can jointly apply with another party to request a subordinate licence.
- ISED reviews the application, and if satisfied, approves the request, and issues a subordinate licence to the third party.
- The subordinate licence includes a subset of the primary licence conditions and additional terms.
- Both primary and subordinate licences exist simultaneously.
- Commercial mobile spectrum subordinate licence requests are subject to specific requirements outlined below.
- Requests for subordinate licences in these bands must address criteria as outlined below.
- ISED maintains a publicly accessible database listing all licences.

In general, the issuance of a subordinate licence will be subject to, but not limited to, the following conditions and guidelines.

- The subordinate licence term can be for a term of less than or equal to the duration of the primary licence. The term for which a subordinate licence is being sought must be clearly specified in the application.
- Subordinate licences are not divisible or transferable.
- Where implementation of spectrum usage requirements exists, the responsibility for being in compliance rests with the primary licensee. Implementation by the subordinate licensee will count toward meeting the primary licensee's responsibilities and should be reported accordingly to ISED.
- Where a displacement and transition policy exists, either the primary licensee or the subordinate licensee may invoke the transition policy provisions; however, a subordinate licensee must notify the primary licensee of any displacement request submitted to ISED.
- ISED's approval is required for all proposed subordinate licences.
- ISED will contact the primary licensee directly for non-compliance issues of the primary licence conditions and the subordinate licensee directly for non-compliance issues of the subordinate licence conditions. ISED also has the authority to contact either the primary or the subordinate licensee regarding compliance issues and, if necessary, to revoke or suspend the primary licence and/or the subordinate licence, in accordance with the Radiocommunication Act.
- Access licensing should be a secondary option to subordination and only be granted if an applicant attempted to receive a subordination and was denied.
- Subordination will normally be completed within 12 weeks from the time of receipt of all required information.
- Primary licensees may apply to ISED jointly with another party in order to request a subordinate licence. The request would then be reviewed and, subject to ISED's satisfaction with the application, the request would be approved and the third party would be issued a subordinate licence.

- The subordinate licence would include a subset of the primary licence conditions, as well as additional terms and conditions that may vary from those of the primary licence.
- The primary licence and subordinate licence would both exist at the same time.

5.3 Cost Estimate

Black & Veatch used a standard 3-sectored site Bill of Material (BOM) (Table 7) to estimate the total cost to build the network for the above number of forecasted sites. This BOM includes estimates of both labour and materials. Backhaul is not included in this estimate since it is unique and may vary depending on the location. SIMs would be an additional cost and can be acquired from a variety of vendors. An MNC can be obtained by registering for it.

Table 7 – Private Network ROM cost estimate

pLTE Bill of Material			
Line Item	**Qty**	**Unit Cost**	**Total Cost**
Site Specific Costs	**$**		**438,175.00**
Valmont 100' Monopole	1.00	$ 80,000.00	$ 80,000.00
Tower Install (foundation, etc)	1.00	$ 55,000.00	$ 55,000.00
Sector frame for monopole tower	1.00	$ 4,750.00	$ 4,750.00
Pipe Mounts (one per antenna)	3.00	$ 225.00	$ 675.00
Generic Sector Antenna (single band 900)	3.00	$ 750.00	$ 2,250.00
Generic Sector Antenna (dual band 900/PCS or CBRS)	3.00	$ 1,000.00	$ 3,000.00
Raycap box	1.00	$ 2,500.00	$ 2,500.00
Misc hardware (Jumpers, grounding, coax, etc.)	1.00	$ 5,000.00	$ 5,000.00
Shelter/Cabinet Cost	1.00	$ 40,000.00	$ 40,000.00
Site Survey, Construction Drawings, etc	1.00	$ 45,000.00	$ 45,000.00
Site selection, zoning, permitting, etc	1.00	$ 15,000.00	$ 15,000.00
Site preparation (Power, fiber, grading, etc)	1.00	$ 60,000.00	$ 60,000.00
Install Lines, Antennas, etc	1.00	$ 20,000.00	$ 20,000.00
Install Shelter/Cabinet	1.00	$ 30,000.00	$ 30,000.00
Engineering, PMO, CM	1.00	$ 75,000.00	$ 75,000.00
Base Station Equipment	**$**		**466,346.33**
Nokia RRH, BBU and Hybrid Cable	3.00	$ 129,624.67	$ 388,874.00
Base Station integration and setup	1.00	$ 15,500.00	$ 15,500.00
Licensing (Base Station) per year	1.00	$ 61,972.33	$ 61,972.33
TOTAL PER SITE			**$ 904,521.33**
Core Equipment	**$**		**1,353,217.67**
CMU Core Hardware	2.00	$ 432,039.00	$ 864,078.00
CMU Software Load and RTU (Hypervisor, licensing, etc) per year	2.00	$ 57,443.67	$ 114,887.33
Network Management	1.00	$ 319,398.00	$ 319,398.00
Network Management License per year	1.00	$ 26,354.33	$ 26,354.33
Questionaire and Integration (IP planning, QOS, SIM imports, Acceptance testing)	1.00	$ 28,500.00	$ 28,500.00
Spectrum Costs per year	**$**		**5,000,000.00**
Estimated	1.00	$ 5,000,000.00	$ 5,000,000.00
TOTAL Network Cost 900MHz (14 sites + Redundant Core)	**$**		**19,016,516.33**
900MHz Yearly recurring costs	$		6,008,854.33
TOTAL Network Cost 1.8GHz (35 sites + Redundant Core)	**$**		**38,011,464.33**
1.8GHz Yearly recurring costs	$		7,310,273.33
TOTAL Network Cost 3.9GHz (88 sites + Redundant Core)	**$**		**85,951,095.00**
3.9GHz Yearly recurring costs	$		10,594,807.00

5.4 Conclusion

A private network offers exceptional flexibility and security. Having control over the entire network is certainly advantageous, but it comes with a high degree of complexity and responsibility. All aspects of design and construction must be overseen and executed by HOL and its subcontractors, and the choice of spectrum may require detailed trade studies accounting for cost, licensing, competition with other entities for capacity, interference, and other risks. However, the complexity and risks associated with this approach can be managed, and a robust and secure private network is a potentially feasible option.

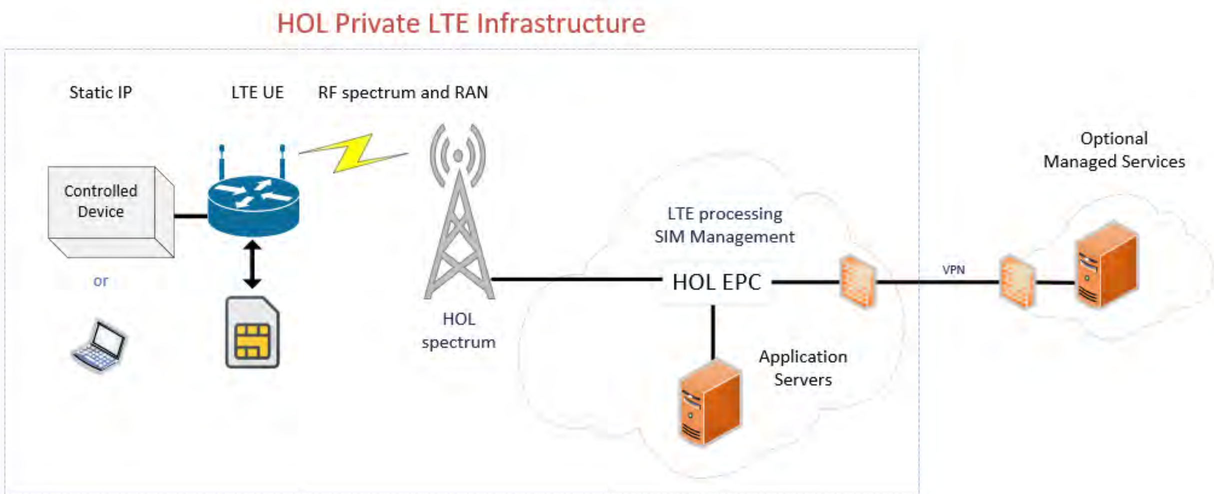


Figure 17 – Private LTE Architecture

<u>Managed Services</u>

HOL could construct an entirely private network with private spectrum, individual base stations exclusive to HOL, and a private core. While this is buildable, it needs to be manageable. Currently, HOL does not have the staffing, tools, or training to support such a network. It could be engineered, configured, lab tested, and constructed by one of the Local LTE service providers or equipment providers. In addition to the implementation there is the day-to-day operation, monitoring, and performance management. These so-called managed services include real-time monitoring within the terms of a service level agreement (SLA), software patching, coordinated change controls, trouble ticket resolution, SIM management, and other functions. These managed services can help HOL bridge the knowledge gap until appropriate staffing can be acquired or trained to support the system internally. There may need to be a combination of internal and external services for the lifespan of the equipment. Existing HOL field technicians could potentially be trained to serve as cell technicians, IT staff could be trained to support the EPC cores and collect and review KPI's.

6.0 Public LTE Network utilizing an APN

Utilizing a public network would allow HOL to avoid many of the complexities of a fully private network. The RF spectrum and the radio access network (RAN) are owned, operated, and maintained by a public carrier, and HOL leases capacity on this network. This solution eliminates the cost and complexity associated with the design, construction, operation, and maintenance of the private network, but it adds the recurring cost of leasing capacity. Furthermore, this solution creates a dependency on the public carrier's network, so risks of unexpected cost increases, future capacity reductions, and security concerns must be considered. This section covers the basic architecture, management considerations, and costs associated with this solution.

6.1 Architecture

In the Public option, edge devices/user equipment (UE) and SIMS are owned by HOL. SIM management can be performed via web Portal by Jasper or equivalent. Jasper provides the customer an interface to evaluate the radio links and to selectively enable or disable SIMs. The wireless radio spectrum, radio access network (RAN), backhaul, and core (EPC) are owned and maintained by the public wireless LTE carrier. This may be Rogers, Bell, Tellus or any other LTE carrier. Public is the simplest scenario for the customer to adopt since it does not require specific knowledge of LTE nor specialized staffing. Effectively utilizing the public LTE infrastructure can improve operational improvements for HOL in a short period of time at relatively low cost. It may provide an important transition period to develop operational and monitoring expertise prior to operating a Hybrid (PVNO) or Private network.

The Public APN arrangement depicted in Figure 18 allows HOL to simply attach to the wireless network assets of the public carrier and quickly leverage their resources without having all the overhead of operating the network. Some of these requirements include purchasing spectrum, securing tower space and leases, purchasing, and maintaining equipment, upgrading software, troubleshooting, understanding LTE protocols, troubleshooting PIM or interference, and managing on premises LTE Core infrastructure assets. Except for SIM distribution, DA field modem and AMI Aps/collectors, most all responsibilities belong to the carrier. As depicted below, HOL can connect to the Bell and/or Rogers Network wherever they have coverage including in Casselman. The carriers provide Jasper/Control centre or an equivalent to test the RF link for each modem. There are also APIs to collect and database performance information to track/trend the integrity/reliability of the wireless network. Jasper also allows grouping of SIMs, looking at aggregate usage and selectively enabling or disabling SIMs to manage expenses and prevent fraud.

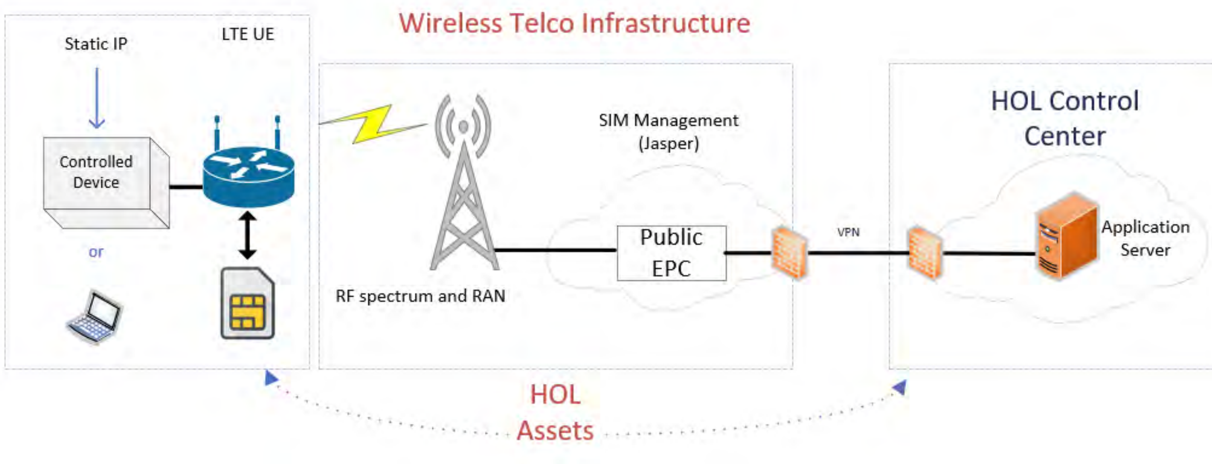


Figure 18 – Public APN Architecture

The stakeholder meetings revealed that the AMI network utilizes a Bell APN. That APN could be reevaluated and grown to support the DA infrastructure. Swapping narrowband modems and antennas for LTE modems and antennas could be planned and accomplished quickly depending on the APN dimensions and IP's currently allocated. In most cases, site reliability via sector, polarity, and frequency diversity would be enhanced, with lower latency and higher throughput than the performance provided by the existing narrowband network does today. All the traffic would be delivered over the APN and easily routed to HOL control and monitoring systems. During the stakeholder meetings, it was not known if any QOS has been applied to the Bell APN SIMs, but in the event of busy cells, QOS can prioritize traffic and avoid signaling delay.

6.2 Management Considerations

SIM and IP management responsibilities would still belong to HOL. Well organized and disciplined IP control, SIM distribution, and related documentation are essential to success and will remain so in any scenario. There are various methods for keeping modem configurations consistent and software/firmware up to date and patched. As the numbers of devices and SIMs increase over time, robust automated methods save time and allow staff to focus on HOL power delivery as opposed to struggling with wireless reliability and management.

6.3 Rogers Budgetary APN build

In Table 8, the three gray rows show the cost of the appropriate SIM pool size per month based on usage, 10MB, 100MB and 1GB. Top and bottom lines of the monthly recurring costs (MRC) table are MRC fees, and the gray lines are data volume allowances per SIM. One SIM size would be selected per device; the preliminary forecast indicates that 1GB would be appropriate for all DA devices and AMI collectors. Black & Veatch is also working to establish bulk pricing with data pool sizes of 200, 300, and 400 GB tiers of aggregate data volume for all devices. This simplifies SIM distribution and decreases the need for per SIM data volume management. Table 9 represents the non-recurring (NRC) setup charge to build the APN and preconfigure the SIMS in the HSS. Ruggedized SIMs are optional.

Both the MRC and NRC are negotiable; terms improve as the volume increases.

Table 8 – (MRC) Monthy Recurring Costs

Product	Qty	Unit	List Price	Monthly Recurring Charges (MRC)	Term
IoT Data Connectivity Rate Card Platform Fee	1	Per **ACTIVE** SIM Monthly	$0.50	$0.50	60
CC - IoT Data Connectivity **Rate Card 10 MB Per SIM** - CDN LTE Data for IoT, Pooled, CC Advantage platform, Month to Month (**Overage $0.75 / MB**)	1	Each	$3.75	$4.15	60
CC - IoT Data Connectivity **Rate Card 100 MB Per SIM** - CDN LTE Data for IoT, Pooled, CC Advantage platform, Month to Month (**Overage $0.15 / MB**)	1	Each	$6.00	$5.40	60
CC - IoT Data Connectivity **Rate Card 1 GB Per SIM** - CDN LTE Data IoT, Pooled, CC Advantage platform, Month to Month (**Overage $7.50 / GB**)	1	Each	$12.00	$10.80	60
CC - IoT Data Connectivity Rate Card Custom **APN** Monthly Fee	1	Each	$500.00	$500.00	60
			IOT MRC	**Sums Depend SIM quantities: See Table 12 and Table 13.**	

Table 9 – (NRC) One Time Costs

Product	Qty	Unit	List Price	Non-Recurring Charges (NRC)	
CC - IoT Data Connectivity Rate Card CC IoT SIM Card (2FF, 3FF, 4FF) pack of 20 SIMs	100	Each	$40.00	$4,000.00	
CC - IoT Data Connectivity Rate Card CC Rugged IoT SIM Card (2FF) pack of 20 SIMs	1	Each	$80.00	$80.00	
CC - IoT Data - Connectivity Rate Card Custom APN Set up Fee	1	Each	$5,000.	$5,000.00	
			IOT NRC	**$9,080.00**	

Table 10 – Public LTE Cost Estimate - AMI

Hex Cell ID	AMI per cell	Count of AP: 1000 to 1	Count of AP: 1500 to 1	4LP @ 15 min Data Volume per Month (MB)	Total AP (SIM) Volume (MB/month)	Each SIM data Vol 1000:1	Each SIM data Vol 1500:1	AMI AP Cost per hexagon per month	AMI AP Cost per hexagon per year	AMI AP Cost per hexagon per 5 yr. term
1	32389	33	22	0.5	16195	491	737	495	5940	29700
2	1264	2	1	0.5	632	316	632	22.5	270	1350
3	122014	123	82	0.5	61007	496	744	1845	22140	110700
4	703	1	1	0.5	352	352	352	22.5	270	1350
5	17354	18	12	0.5	8677	483	724	270	3240	16200
6	68878	69	46	0.5	34439	500	749	1035	12420	62100
7	11467	12	8	0.5	5734	478	717	180	2160	10800
8	32122	33	22	0.5	16061	487	731	495	5940	29700
9	25592	26	18	0.5	12796	493	711	405	4860	24300
10	16377	17	11	0.5	8189	482	745	247.5	2970	14850
11	35340	36	24	0.5	17670	491	737	540	6480	32400
12	630	1	1	0.5	315	315	315	22.5	270	1350
13	3406	4	3	0.5	1703	426	568	67.5	810	4050
14	973	1	1	0.5	487	487	487	22.5	270	1350
Totals	**368509**	**367**	**246**		**184254.5**	**6297**	**8949**	**$ 5,535**	**$ 68,040**	**$ 340,200**

Table 11 – Public LTE Cost Estimate - DA

Hex Cell ID	DA per cell	DA Data Volume (MB/day)	DA Data Volume (MB/month)	DA Cost per hexagon per month	DA Cost per hexagon per year	DA Cost per hexagon per 5 yr. term
1	45	22.5	675	1012.5	12150	60750
2	3	1.5	45	67.5	810	4050
3	15	7.5	225	337.5	4050	20250
4	3	1.5	45	67.5	810	4050
5	31	15.5	465	697.5	8370	41850
6	12	6	180	270	3240	16200
7	22	11	330	495	5940	29700
8	29	14.5	435	652.5	7830	39150
9	31	15.5	465	697.5	8370	41850
10	39	19.5	585	877.5	10530	52650
11	31	15.5	465	697.5	8370	41850
12	10	5	150	225	2700	13500
13	11	5.5	165	247.5	2970	14850
14	2	1	30	45	540	2700
Totals	**284**	**142**	**4260**	**$6,390**	**$76,680**	**$383,400**

6.4 Private vs. Public Budgetary Comparison

When comparing the costs presented above for Private vs Public wireless network options, several factors come into play. To understand the overall financial implications of each, both capital and operational expenses should be considered.

Private networks require a higher upfront cost. Physical infrastructure such as towers, monopoles, shelters, and real estate may be required. Base stations, redundant cores, software licenses, configuration, and installation add additional costs to deploy and optimize a private network. Ongoing expenses include maintenance, training, upgrades and repair. Initial deployment cost is estimated to be $19,016,516 with additional yearly recurring licensing of approximately $6,008,854 for software and network management subscriptions. Total cost over 5 years for a private network is roughly $49,060,788.

Using a public network, capital expenses are greatly reduced; however, recurring fees are higher. As shown in Table 12, initial NRC (600 SIM's + APN setup) would total $6200. The MRC cost for the SIMs, data usage and APN is ~$6500. The five year usage projection is approximately $400k; this does not yet include the cost of LTE DA devices or AMI collectors.

Table 12 – Public LTE usage cost projections (Mesh scenario 1500:1 LTE)

AMI SIMs	DA SIMs	Total SIMs	Jasper MRC	MRC SIMs	MRC 1GB SIM	MRC data	MRC APN	MRC Monthly	Term Months	5 year Total
246	284	530	0.5	$265.00	$10.80	$5,724	$500	$6,489	60	$389,340

Table 13 – Public LTE usage cost projections (P2P scenario - based on Table 8)

AMI SIMs	DA SIMs	Total SIMs	Jasper MRC	MRC SIMs	MRC SIM	MRC data	MRC APN	MRC Monthly	Term Months	5 year Total
0	284	284	0.5	$142.00	$10.80	$3,067	$500	$3,709	60	$222,552
370000	0	370000	0.5	$185,000.00	$4.05	$1,498,500	$500	$1,684,000	60	$101,040,000

6.5 Conclusion

A public network is simpler to implement than a private network, but a public network must work within the carrier's system and is therefore less flexible. There are many aspects to security, including physical and network, that must be managed as work proceeds. Table 12 represents recurring costs of leased LTE capacity (Mesh AMI) over the lifetime of the system, which will be significant, but this will be offset by lower capital cost. Table 13 represents the potential burden of opting for LTE P2P everywhere.

7.0 Hybrid Network (PVNO)

Hybrid private/public solutions can be considered if fully private or public options do not satisfy all of HOL's requirements. Wireless private networks have multiple implementation options which are partially private and partially public depending on how the network is envisioned, engineered, and implemented. The Private and Public options are described in Sections 5.0 and 6.0, respectively. This section covers the basic architecture of the Private Virtual Network Operator (PVNO) solution and advantages and challenges associated with this option. Much of the PVNO architecture will depend on what the carrier will accept and how existing PVNO networks are designed. Since there are many variations in how a PVNO solution can be implemented, a detailed solution cannot be presented here and would be negotiated with the carrier.

7.1 Shared Architecture

In a Hybrid option there are multiple different scenarios. The Hybrid option usually moves the EPC within the customer's infrastructure. This scenario can improve call processing speed and improve control. There are variations on how it the EPC is configured; this can be entirely private, or it may peer with one or more LTE Carriers to facilitate seamless roaming. This configuration is complex, and an appliance (consolidated) grade EPC may be insufficient. The terms, requirements and costs of this scenario have yet to be determined since there are so many options in scenarios. In the PVNO scenario, which is a hybrid option, HOL would appear as its own entity since it will have a distinct mobile network code (MNC). To support this arrangement, carrier grade infrastructure may be required.

The hybrid scenario also allows for the customer to own its own spectrum and radio access network. If the spectrum acquired is 3GPP compatible, there are typically multiple vendors which will support those frequencies. If the radio spectrum is not 3GPP compatible or not widely used throughout the world, it can be difficult, if not impossible to secure appropriate equipment.

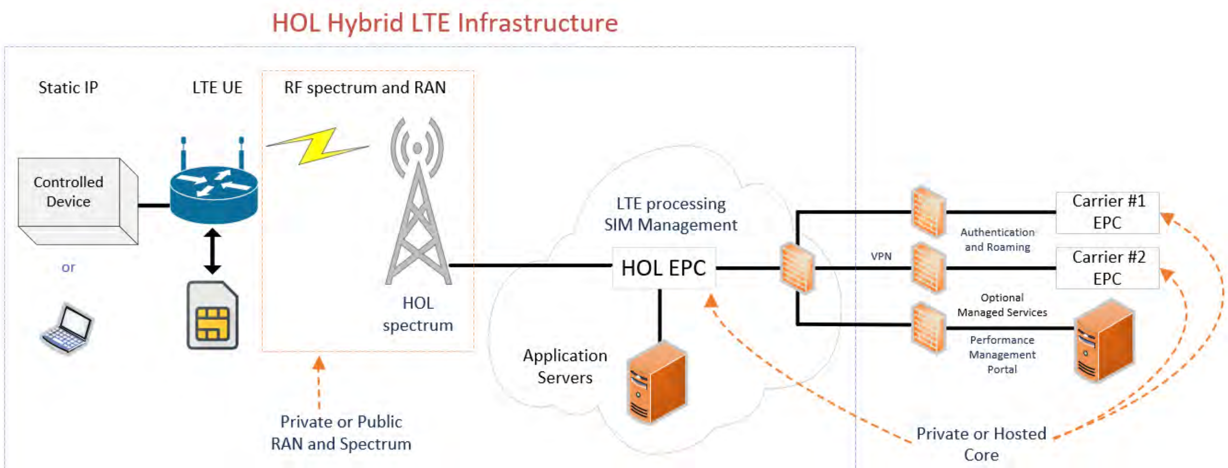


Figure 19 – Hybrid Network Architecture

The scenario that seems most preferable to HOL is private EPC, which facilitates roaming with multiple carriers and a public RAN. Based on stakeholder meetings, it appears that this arrangement is being pursued by Hydro Quebec. The details of the proposed Hydro Quebec architecture, the equipment vendors, LTE carriers, costs, and maintenance arrangements have not been obtained by HOL or Black & Veatch. PVNO architecture appears to provide desirable benefits to HOL; however, initial discussions with carriers reveal that substantial expenses from EPC hardware selection, peering to the LTE carriers, and related business agreements may be very expensive. Carrier grade equipment and licensing volumes, as opposed to consolidated appliance EPC such as provided by Nokia, are likely required.

7.2 Hybrid Considerations

A Private Virtual Network Operator (PVNO) is a network connectivity option that can provide utilities some of the advantages of a fully private field area network (FAN) without the necessity to build out every physical component of the network. It is a customizable solution, but it is also relatively new, and there is currently no single, standardized approach. This solution allows for the use of the networks of multiple cellular carriers, providing redundancy, and it allows for more privacy due to HOL's ownership of MNC, as opposed to using the carrier's MCC-MNC.

In a PVNO, the utility owns and operates the core functions of the network but leases the RAN (radio access network) from one or more carriers in the form of bulk wholesale capacity. Customized interface devices and SIM cards form the boundary between the utility's network equipment and the carrier's RAN. This system provides flexibility on matters such as security and network configuration. Furthermore, it can rely on the networks of multiple carriers, potentially providing coverage equivalent to the full cellular phone network, but it may not be suitable for all areas since there are holes and regions of poor reception in the cellular network. For any implementation, an evaluation of coverage in the region is necessary. Typically, this will be less of a problem in urban areas than in remote rural areas.

Given the increase in needs for highly distributed, low bandwidth monitoring and control, a PVNO is potentially useful for applications such as rooftop solar, electric vehicle charging, line monitoring and control, and use cases specific to certain industries, including existing and emerging high tech, in addition to common existing applications such as SCADA and metering.

Though the PVNO concept has been used in other industries, it is relatively new for utilities, and architecture could be evolving until there is wider adoption among utilities and some standard configurations are developed.

When considering PVNO as an option, cost/benefit and risk analyses are necessary. The cost of bulk leased capacity should be compared to the capital and maintenance costs of a private RAN over the useful lifetime of the equipment. Risks associated with changing costs of leased capacity and reductions in available network capacity should also be considered. Costs may also be incurred due to training and other activities associated with the shift in operation. Additional risks to be analyzed include security, availability of standard and custom equipment, reliability of equipment, SIM card management and security, and interfaces between the PVNO and the utility's network.

Coverage may be a concern with a PVNO. If the PVNO does not cover the entire required area or if capacity is limited in some areas, a gap filler solution, such as a fully private FAN or services from another carrier, might be required.

7.3 Conclusion

A hybrid network is a complex approach that will have to be tailored carefully to HOL's needs. Though it presents risks due to security, equipment availability, and a lack of experience with this approach in the utility sector, it may be necessary to consider a hybrid approach if neither a fully public nor a fully private option satisfies all requirements. Depending on the results of cost/benefit and risk analyses and on the specific use cases, a PVNO can be a viable solution for utilities willing and able to be relatively early adopters of this approach.

8.0 Gap Analysis

HOL's existing systems have gaps in tower coverage and provision of backhaul that will have to be addressed. Depending on the option chosen (private, public, or hybrid network), new tower sites may be necessary, and extensions of backhaul coverage, including new fibre runs and microwave installations, may have to be constructed.

8.1 Tower gap assessment

HOL has approximately 19 "tower" locations with narrowband 900 MHz radio antennas within the Ottawa service territory. These towers will require individual assessment to ensure that they can support typical LTE site infrastructure, which typically includes one or two 6' cross polarized antennas along with a fibre feed radio per sector. By visual KML street inspection of the tower types, is it unlikely that any of HOL's current towers are capable of supporting a sectored LTE site with panels and the corresponding LTE radios per face. It is possible to place the amplifiers on the ground rather than on the tower, but that can decrease performance and add the complexity of multiple coaxial cable runs.

In addition to the HOL towers there is a large variety of cell sites exceeding 25 metres within the service territory. That inventory, which is depicted in Figure 20, creates the option of colocation in a private or hybrid scenario. The hexagons that are likely to be a colocation challenge are numbers 2, 13 and 14 due to the lack of adequate height at the centre of the hexagon. It is also assumed that the hexagons with sites of adequate heights near the centre of the hexagon also have available centre lines with sufficient RF isolation. There is also the possibility that some towers may have very high centre lines that could cover the extent of the hexagon without being centred or sufficiently covering the DA/AMI/Battery/DER in that service territory.

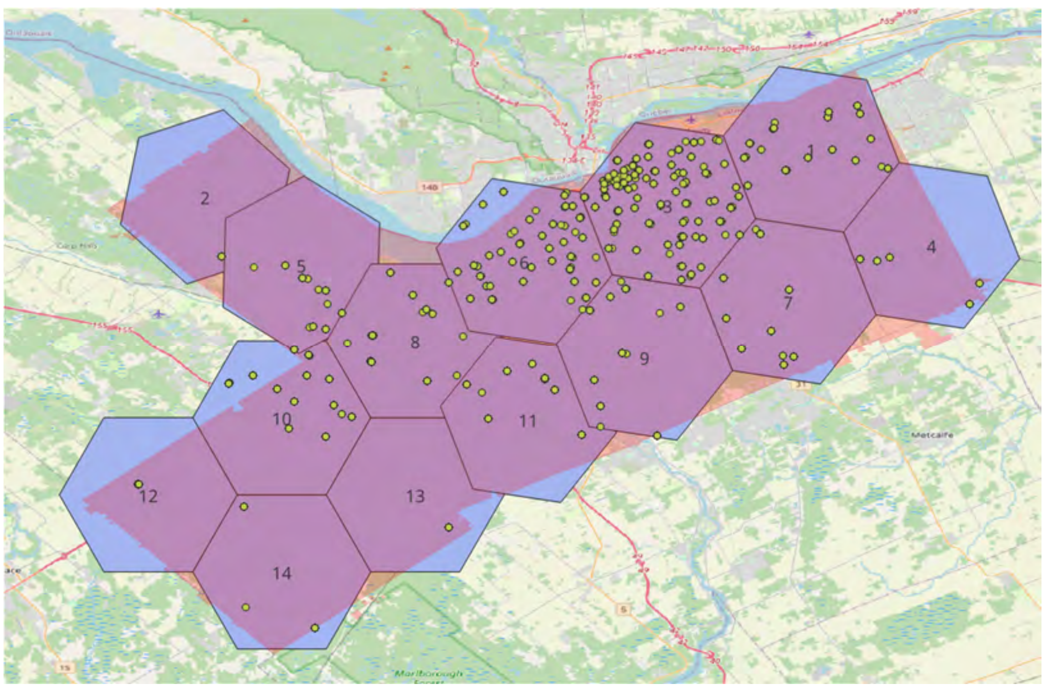


Figure 20 – Possible colocation opportunity locations (>25m heights)

8.2 Backhaul gap assessment

As was considered in Section 2.1.3, Adding a 1.6km buffer around the existing fibre assets provides 43% reach within the main service territory. This leaves a substantial void in the potential for economical backhaul coverage outside that buffer. In some locations, it may be economical to extend fibre to provide backhaul coverage, but where this is not economical, other options, including microwave and public carrier solutions, can be considered.

8.3 Microwave Backhaul Alternative

Line of sight microwave paths can provide options for redundancy or for primary access to locations where it is not practical or cost effective to run fibre. A microwave path requires a clear line of sight, free of obstructions such as tall trees, buildings, or towers, so this solution will only be practical for places where a tower can be built to a height sufficient to meet this requirement.

The microwave backhaul planning process follows a number of steps, beginning with a search for candidate sites and culminating in preliminary designs for sites and paths. During the initial site search and identification phase, the first step is to list all sites for which backhaul is required and for which fibre or other methods do not provide the required access, bandwidth, or redundancy. Additionally, nearby sites that have sufficient backhaul capacity and might be reached via a microwave link are identified.

Next, candidate frequency bands are identified. As a general rule, lower frequencies, typically in the 6GHz and 11GHz bands, are used for paths longer than approximately 7km, while higher frequencies, such as the 18GHz and 23GHz bands, are used for shorter paths. In urban areas, spectrum availability might be limited, so the spectrum licensing agency or a consultant should be contacted to determine availability.

Once the candidate sites and frequencies are chosen, possible microwave paths are checked for obstructions using GIS tools and/or a microwave path design tool such as Pathloss with appropriate terrain and clutter data. The antenna heights required to clear the obstructions are calculated, and candidate paths for which antennas heights are excessive are eliminated. Note that for paths longer than approximately 15km, space diversity (two antennas on each end mounted at different heights) is likely to be required to counteract multipath interference.

For those paths where existing mounting structures are available and those where towers can be constructed, site surveys, path surveys, and tower location studies can proceed. Site surveys and path surveys may be required at this point or during the previous activity, especially if the paths are crossing congested urban areas, if tall structures are close to the paths, or if tree clearance appears tight. For new towers, locations within the site will be narrowed down at this point. Sometimes, the optimal location is unclear, and two or three alternatives will be identified, leaving the final decision for the detailed design phase. Geotechnical analysis may be required at this point or later for new tower sites, and preliminary structural analysis may be required at this point for existing towers that appear to be high risk.

Cost estimations and trade studies are performed for the candidate paths that remain. Capital and recurring costs associated with the microwave paths are compiled. These include towers or other mounting structures, antennas, radios, cables/waveguides, building or tower modifications, and any other necessary equipment. If microwave is being considered in competition with other possible solutions, such as fibre or leased services, a trade study comparing these costs and other concerns, including reliability, is performed.

A preliminary design will result from this process. If microwave is chosen, detailed design can proceed. Microwave backhaul will not be suitable or even possible for all situations, but where it is possible, it can be a cost effective and reliable backhaul solution, and it can be useful for providing redundancy, so it should be considered among other options.

9.0 Roadmap

The existing DA use cases have sufficient capacity on the narrowband network; however, the performance and reliability of that narrowband network was described as lacking at times. The existing 900 AMI mesh has been previously described as slow to complete all the required meter billing reads. The narrowband network could be improved and expanded, but it will always suffer due to the use of unlicensed frequencies, lack of diversity and the inherent SD9 duplexing method. Narrowband communications impose bandwidth and latency performance limitations which conflict with many proposed future use cases. Future widespread uses of narrowband unlicensed communication are therefore not recommended, but licensed narrowband may be useful in specific situations where LTE coverage is unavailable or for mission critical equipment.

A broadband LTE Network, if properly planned, engineered, implemented and maintained, has the ability to serve Hydro Ottawa operations decades into the future. These three LTE design options, private, public and hybrid, must be carefully considered to ensure the selected path achieves an appropriate balance among manageability, capacity, reliability, and cost.

The **private** option will require private broadband spectrum. Black & Veatch researched a variety of spectrum options. The most important consideration is frequency and the coverage that follows. In order to build a lower density grid, a low frequency band is required; for Hydro Ottawa, the recommended spectrum is the PSBN 700 block. ISED makes specific provisions allowing for commercial traffic coexisting with public safety traffic. Public safety does have priority and can preempt commercial traffic; however, the available bandwidth makes this unlikely. Furthermore, it is in the public's best interests to have a robust and reliable communications capability in order to restore power. Acquiring access to PSBN spectrum will require partnerships with public safety entities to gain access and monitor performance and usage parity. A secondary option may be to partner with an LTE carrier to subordinate a portion of their low-band spectrum in the event that it is underutilized or not in service. Underutilized spectrum could be allocated and used as a test bed via a public APN scenario. At this time, it is unclear what the wireless carriers are obligated by ISED to accept or willing to accept if not obligated.

Beyond the spectrum portion, there are choices to be made regarding the location of the LTE core resources, in particular if HOL prefers an owned physical core to a core hosted and managed by the selected carrier. The owned core would be implemented in a private and likely a hybrid scenario, where the hosted core would be implemented in a public scenario. The spectrum will impact the RAN architecture, which may be a long lead time item. The subordination conversations with LTE carriers should be planned and undertaken in tandem with the PSBN spectrum negotiations to establish the most economical and advantageous path forward.

HOL currently operates a **public** APN. This arrangement serves ~1500 AMI SIMs through the Bell LTE network. Hydro Ottawa could reevaluate the terms of its existing Bell APN contract for expansion and consolidation of additional ~40 individual DA IP SEC tunnels. Depending on the existing configuration, an additional IP range could be allocated to the APN to move existing DA assets on to the Bell cellular APN.

Narrowband DA assets could be configured, lab tested, and migrated to LTE. Those assets will likely experience substantial reliability, latency, and performance improvements at relatively low cost. LTE performance schemes could be developed and implemented, which will begin to develop staff competencies for any future LTE scenario. The preceding steps will lead to public expansion and potentially long-term adoption if that is what HOL prefers. These upgrade and public LTE consolidation efforts are also not pointless efforts since, at a minimum, DA performance and reliability will improve. Expanding the public LTE scope will enhance understanding of LTE and allow for development of performance schemes and staff expertise over time. The public option can easily be rehomed or migrated to private assets at a later time. APN negotiations with Rogers may serve to improve Bell pricing terms, extend contract length, and combine professional services offers. These conversations serve to refine cost in terms of CAPEX and OPEX and illustrate what an alternate network and professional service team offers.

The last option is hybrid or PVNO. This is a bit more complex to evaluate since there are many uncertainties related to EPC core equipment requirements, the interfacing requirements with commercial LTE providers, each of which may have different terms and requirements, and 3GPP standards related to this arrangement. The PVNO would also almost certainly require one or more highly trained and experienced core engineers to manage and maintain the LTE carrier interfaces. At a minimum, considering PVNO will require further discussions with both the incumbent LTE service providers and EPC core equipment manufacturers to consider costs, necessary hardware for the required capabilities. The business agreements with each of the LTE providers may also prove challenging.

Appendix A. Equipment Reliability Standards

The LTE EPCs and BBU's shall be engineered to provide 99.995% reliability.
Individual LTE radios shall provide 99.9% reliability.
Table 14 is an industry standard for describing system reliability.
Table 15 presents recommended general high level LTE KPI's.

Table 14 – Availability Percentage

Availability %	Downtime per year	Downtime per quarter	Downtime per month	Downtime per week	Downtime per day (24 hours)
99.5% ("two nines five")	1.83 days	10.98 hours	3.65 hours	50.40 minutes	7.20 minutes
99.8% ("two nines eight")	17.53 hours	4.38 hours	87.66 minutes	20.16 minutes	2.88 minutes
99.9% ("three nines")	8.77 hours	2.19 hours	43.83 minutes	10.08 minutes	1.44 minutes
99.95% ("three nines five")	4.38 hours	65.7 minutes	21.92 minutes	5.04 minutes	43.20 seconds
99.99% ("four nines")	52.60 minutes	13.15 minutes	4.38 minutes	1.01 minutes	8.64 seconds
99.995% ("four nines five")	26.30 minutes	6.57 minutes	2.19 minutes	30.24 seconds	4.32 seconds
99.999% ("five nines")	5.26 minutes	1.31 minutes	26.30 seconds	6.05 seconds	864.00 milliseconds

Table 15 - RAN KPI

KPI Type	KPI Name	Target
ACCESSIBILITY	E-UTRAN E-RAB Setup Success Ratio	99.40%
ACCESSIBILITY	E-UTRAN Initial E-RAB Accessibility	98.50%
ACCESSIBILITY	E-UTRAN Initial E-RAB Setup Success Ratio	99%
ACCESSIBILITY	E-UTRAN E-RAB Setup Attempt	Count
ACCESSIBILITY	E-UTRAN RACH Setup Completion Success Rate	95%
ACCESSIBILITY	Total E-UTRAN RRC Connection Setup Success Ratio	99%
RETAINABILITY	E-UTRAN E-RAB Drop Ratio, User Perspective	2%
RETAINABILITY	E-UTRAN E-RAB Drop Ratio, RAN View	0.50%
RETAINABILITY	E-UTRAN Total HO Success Ratio, intra eNB	97.50%
MOBILITY	E-UTRAN HO Success Ratio, S1	95%

Table 16 - EPC KPI

EPC KPI	Target
Memory and CPU loading	<50%
MME Paging Success Rates	>98%
SGW-PGW Active Bearers	Count
SGW-PGW Idle Bearers	Count
PGW Attach Failure Rate	1%<
PGW UL Volume (MB)	Volume (MB)
PGW DL Volume (MB)	Volume (MB)

Appendix B. Lexicon

Term	Description
3GPP	3rd Generation Partnership Project
AKA	Authentication and Key Agreement
AWS	Advanced Wireless Services
BBU	Baseband unit
CAPEX	Capital Expenditure
CPRI	Common Public Radio Interface
DER	Distributed Energy Resources
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
HSS	Home Subscriber Server
LTE	Long Term Evolution
MME	Mobility Management Entity
MPE	Maximum permissible exposure, an RF power density (mw/cm2)
MRC	Monthly recurring cost
NMS	Network Management System
OPEX	Operational Expenditure
OTT	Over the top, voice and video delivered with no prioritization
PAPR	Peak to Average Power Ratio
PCRF	Policing and Charging Rules Function
PGW	Packet Gateway
PS	Packet Switched
QoS	Quality of Service
RAN	Radio Access Network
SAE	System Architecture Evolution
SC-FDMA	Single Carrier Frequency Division Multiple Access
SGW	Serving Gateway
TDD	Time Division Duplex
TOR	Top of Rack switch to allow for enhanced I/O for the EPC
TTI	Transmission Time Interval
UE	User Equipment
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network

Appendix C. Attachments

Document	
Example Use Case Matrix	HOL_Use_Case_Matrix.xlsx

GENERAL PLANT INVESTMENTS

1. SUMMARY

Hydro Ottawa's planned General Plant Capital Investments for 2026-2030 total $121.2M (net), comprising ten key programs focused on maintaining and advancing Hydro Ottawa's infrastructure, operational capabilities, and customer service excellence. These investments address areas such as critical infrastructure reliability, fleet renewal, customer engagement, and IT and cyber security infrastructure. Hydro Ottawa's plans include two cloud-based software solutions, which are considered operations, maintenance and administration (OM&A) costs under current International Financial Accounting Standards and are discussed in Attachment 4-1-1(A) - Transition to Cloud Computing, which should be read in conjunction with this schedule. All together, these programs ensure Hydro Ottawa remains well-equipped to meet evolving industry demands, regulatory requirements, and customer expectations.

General Plant Capital Programs:

Section 2. Meter to Cash ($8.9M - CAPEX)

This program supports critical business functions such as billing, meter reading, collections, and reporting. Upcoming upgrades to systems like Oracle's Customer Care & Billing (CC&B) and Advanced Metering Infrastructure (AMI) aim to ensure compliance, improve customer self-service options, and address end of life infrastructure.

Section 3. Customer Engagement Platform ($2.5M - CAPEX, $4.3M - OM&A)

This program encompasses tools such as MyAccount, outage communication systems, Hydro Ottawa's website, and energy management tools platforms. It prioritizes enabling intuitive self-service, delivering detailed energy insights, and enhancing customer satisfaction through seamless digital experiences. Furthermore, these digital platforms enable Hydro Ottawa to gather valuable customer insights that can also be used to enhance customer experience, inform grid planning, and identify opportunities for future NWSs and customer programming. By supporting scalability, it addresses the increasing demand for electrification and distributed energy resource (DER) integration, empowering customers with actionable data to make informed energy decisions.

Section 4. Enterprise Solutions ($1.4M - CAPEX, $0.6M - OM&A)

This program focuses on maintaining and upgrading applications such as Enterprise Resource Planning (ERP) and IT Service Management systems. These enhancements ensure business continuity, streamline workflows, and reduce cyber security risks. Over the rate period, the program includes business continuity software and expanding self-service HR capabilities.

Section 5. Data and System Integrations ($3.5M - CAPEX, $0.5M - OM&A)

This program consolidates fragmented data systems to create an integrated, reliable, and efficient framework. It aims to reduce manual interventions, enable real-time decision-making, and ensure compatibility across platforms to support both operational and strategic initiatives.

Section 6. Grid Technology ($4.3M - CAPEX, $1.5M - OM&A)

This program addresses the maintenance and upgrade of tools and software that support modernization of grid operations, integrate new technologies like DERs and support grid planning. The program focuses on network visualization and management, data collection and network modelling and simulation.

Section 7. CCRA - Connection Cost Recovery Agreement ($45.9M - CAPEX)

The CCRA program funds Hydro Ottawa's share of transmission infrastructure upgrades, determined through system capacity assessments. These upgrades include connections for new and upgraded stations and addressing equipment limitations at Hydro One Networks Inc. (Hydro One)-owned stations. Hydro Ottawa contributes to the costs of these upgrades, ensuring grid reliability and supporting growth. Key projects include new stations (Hydro Road, Mer Bleue, Kanata North, Greenbank) and upgrades to existing stations (Cyrville, Bronson, Carling, King Edward, Hinchey). This investment will increase station capacity by over 811MVA, improving DER hosting capacity and reliability, and supporting customer growth. Driven by the need to address capacity constraints, the CCRA program responds to load requests and, without these investments, Hydro Ottawa may not be able to meet future demand.

Section 8. Infrastructure & Cyber Security ($11.9M - CAPEX, $1.0M - OM&A)

This program invests in strengthening IT systems to protect against cyber threats, maintain data integrity, and support business continuity. The program aims to ensure systems are secure, scalable, and aligned with industry best practices to safeguard critical infrastructure.

Section 9. Tools Replacement ($4.9M)

This program updates and replaces outdated equipment and tools to enhance operational efficiency, support field staff, and improve safety. The program ensures workforce readiness and aligns with modern operational standards.

Section 10. Buildings - Facilities ($6.6M)

This program focuses on maintaining and upgrading office and operational facilities to support workforce needs, improving energy efficiency, and providing a safe working environment. These investments also align with Hydro Ottawa's sustainability goals and level of organizational growth.

Section 11. Fleet Replacement ($40.6M)

This program plans for additional vehicles required for increased staffing needs as well as to replace aging vehicles with modern, efficient alternatives that support safety and operational needs and reduce carbon emissions.

2. METER TO CASH

2.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $3.6M

2026-2030: $8.9M

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Operational Efficiencies, Regulatory Compliance, Customer Experience

Outcomes: Operational Effectiveness, Customer Focus

The Meter-To-Cash (MTC) program enables vital business capabilities such as accurate customer billing for electricity revenue, meter reading, customer relationship management, collections, related financial reporting and more. The MTC technology landscape includes a Customer Information System (CIS), applications to support Automated Metering Infrastructure (AMI) and Commercial Billing & Settlement System (CBSS), all of which are tightly integrated internally and externally to provincial regulatory systems. MTC is responsible for supporting all technology components used in the billing process that is critical to Hydro Ottawa's revenue stream.

Hydro Ottawa's CIS uses Oracle's Customer Care & Billing (CC&B) platform to provide core billing services critical to the MTC process for the entire customer base of approximately 364,000 customers. As any typical software shelf life at Hydro Ottawa, the CIS platform is upgraded every five to seven years and the current version of CC&B platform was last upgraded in June 2020. The CC&B platform requires a technical version upgrade - planned for 2028 - to version 25A to ensure continued vendor support and system reliability. The timing of these upgrades coincides with the expiration of the managed services contract (held by IBM, a long-time Oracle partner) at the end of 2027.

Hydro Ottawa will perform technology upgrades to its AMI head end systems which collect meter data and serve as the foundation of billing and reporting for its customer base. This includes both Honeywell Connexo and Itron MV90 systems. These systems must remain up-to-date in order to be eligible for vendor support and to minimize the risks of not being able to accurately track meter reads and/or bill its customers.

Continuous technology investments are planned to unlock efficiencies through automation of internal business processes, achieve regulatory compliance, simplify system maintenance and create self-serve options to improve the customer experience. Hydro Ottawa recognizes the industry shift in the energy sector and these investments will help to support customer demands for decarbonization, electrification and grid modernization that may impact future regulatory requirements. Funds will be allocated annually to implement the changes outlined in Section 2.7.1 - Implementation Plan, subheading Regulatory Compliance and Operational Enhancements.

2.2. PERFORMANCE TARGETS AND OBJECTIVES

Table 1 outlines the performance targets and objectives that will be achieved via the Meter to Cash Program.

Table 1 - Performance Outcomes for Meter to Cash

Performance Outcome	Target
Operational Effectiveness	• Upgrade to a "Cloud ready" version of CC&B in preparation for the transition to a Software as a Service (SaaS) solution in the 2031-2035 rate period.
	• Maintain Regulatory compliance.
	• Improve internal workflows to drive operational efficiencies.
	• Reduce the risk of rising operational costs associated with outdated systems by investing in upgrades and enhancements that improve efficiency, security, and the overall performance of customer engagement platforms.
	• Keep critical metering systems on fully supported platforms.
Customer Focus	• Reduce volume of calls and call handling times.
	• Provide best-in-class customer service/experience to be measured via surveys and focus groups.
	• Enhance Hydro Ottawa brand image and reputation.

2.3. PROGRAM DRIVERS AND NEED

2.3.1. Main and Secondary Drivers

Primary Driver: Business Operations Support

Secondary Drivers:

- Business growth and scalability; prepare for increasing billing complexity and higher transaction volumes
- Customer Experience and Satisfaction: Improve self-service and reduce cycle times transacting with Hydro Ottawa on a modernized billing platform
- Operational Efficiency and Productivity: More automation and integration with other systems, new and modernized functionality and a reduction of custom / legacy code
- Regulatory Compliance: Meet all applicable OEB compliance obligations

- Technology Advancements: Utilize Application Programming Interfaces (API) architecture and emerging artificial intelligence to simplify integrations, which will achieve better interoperability and productivity

2.3.2. Current Issues

Technical Upgrades

Hydro Ottawa's current CIS infrastructure components, including the Oracle CC&B application, are reaching end of life and must be upgraded to avoid being out of vendor support. Similar upgrades are required for existing AMI head end systems critical for tracking energy consumption, in-depth reporting and the production of bills. Being on an unsupported platform for critical systems such as its CIS and AMI is risky as there would be limited vendor support in the event of software issues, added security risk of unpatched vulnerabilities, and no access to new features. This will limit Hydro Ottawa being able to expand its offering to its customers and keeping up-to-date with newer technologies.

Regulatory Compliance and Operational Enhancements

In order to maintain a high level of service to its customer base, Hydro Ottawa must make annual updates to:

- Maintain Regulatory Compliance;
- Provide customers with self-serve options for answering common questions; and
- Automate time-consuming manual processes, allowing staff to focus on higher-value activities.

2.4. PROGRAM BENEFITS

2.4.1. Reliability and Aging Infrastructure

Upgrades to the CIS system and AMI headends allows Hydro Ottawa to keep pace with technology, mitigate risks and ensure sustained operational excellence.

2.4.2. Resilience and Climate Change Adaptation

Enable Hydro Ottawa to respond to and implement regulatory changes related to electrification.

2.4.3. Customer Experience

Accommodate more customers, more complexity and increased transaction volume on modernized technology stacks, allowing the business to scale efficiently. Enhance customer experience and loyalty by providing easily accessible self-serve options rather than having to make a call to its call center.

2.4.4. Grid Modernization and DERs

Upgraded metering infrastructure to support the demands of grid modernization and increase in data flows and frequency. Enable Hydro Ottawa to respond and implement regulatory changes related to DERs and associated billing impacts

2.4.5. Workforce Planning and Renewal

Automation of manual processes and leveraging base functionality will free up time for staff to focus on more meaningful work.

2.4.6. Productivity and Innovation

An upgraded CIS system will ease adoption of future regulatory and business requirements through configuration changes instead of developing code.

Increased cooperation and sharing of best practices among Ontario LDCs who are also on CC&B (Toronto Hydro, Alectra & Enova Power), leading to cost savings and improvements in customer service.

Introduce more automation and self-serve options and take advantage of new features and functionality such as AI to improve productivity

2.5. PROGRAM COSTS

Table 2 details the historical, bridge and test year spending for the MTC Program.

Table 2 - Historical, Bridge, and Test Year MTC Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 0.5	$ 1.4	$ 1.1	$ 0.3	$ 0.4	$ 0.3	$ 1.0	$ 6.8	$ 0.4	$ 0.4
ANNUAL TOTAL	**$ 0.5**	**$ 1.4**	**$ 1.1**	**$ 0.3**	**$ 0.4**	**$ 0.3**	**$ 1.0**	**$ 6.8**	**$ 0.4**	**$ 0.4**
5-YEAR TOTAL					**$ 3.6**					**$ 8.9**

2.5.1. Cost Factors

Program costs reflect regulatory and operational enhancements over the term, system upgrades to AMI head ends in 2027, and system upgrades to CIS in 2028. Hydro Ottawa has received preliminary quotations for the technical upgrades and has used knowledge of past projects to estimate the expected costs.

2.6. ALTERNATIVES EVALUATION

Hydro Ottawa is committed to growing and providing best-in-class customer service while remaining regulatory-compliant. Investments are required to improve existing services and to meet yearly regulatory obligations as set forth by the OEB.

2.6.1. Alternatives Considered

Hydro Ottawa's existing AMI infrastructure and CIS systems are critical to servicing and billing its customers, so it is important to avoid unnecessary risk and to remain on a well-supported platform with modernized technology. These systems must be upgraded every five years to avoid technology obsolescence.

Deferral or "doing nothing" would negatively impact Hydro Ottawa and customers in the following ways:

- Increased OM&A costs for both licensing and managed services for end-of-life technology.
- Business risk with limited vendor support available in the event of software error or failure.
- Increased cyber security risk if vulnerabilities are found by malicious actors and the vendor is no longer producing security patches.
- Limited ability to implement technology and process innovations (e.g. AMI 2.0) due to an aged system.
- Negatively impact collaboration across the LDC community as systems would be incompatible with peers.
- Regulatory requests are non-discretionary and must be implemented by Hydro Ottawa, but may not be possible if systems are not kept current.
- Restricts ability to execute operational enhancements (e.g. continuous improvement) by streamlining internal processes and/or improving the customer experience.

2.6.2. Evaluation Criteria

The evaluation criteria for these initiatives are:

- Regulatory requirements must be fulfilled by all LDCs in Ontario, including Hydro Ottawa.
- Technical upgrades are required to sustain operations with its current support vendors.
- Existing CIS and AMI implementation partners are best positioned to perform system upgrades.

2.6.3. Preferred Alternative

Upgrading the CIS and AMI systems are preferred to allowing the systems to fall out of date.

2.7. PROGRAM EXECUTION AND RISK MITIGATION

2.7.1. Implementation Plan

CIS Upgrade

In 2028, Hydro Ottawa will initiate a 10-month project to perform a technical upgrade of CC&B from version 2.7.0.3 to 25A (new version numbering). This will include a full refresh of the infrastructure and bring Hydro Ottawa to the most up-to-date functionality of the CC&B

application.

AMI Head End Upgrades

The existing Honeywell Connexo and Itron MV90 AMI head ends were last upgraded in 2022 with an expected life of five years. A technology upgrade and infrastructure refresh will be required during the 2026-2030 rate period as these are critical systems in the MTC process. The target timeline to upgrade both systems is 2027 to align with the implementation of the AMI 2.0 system, which requires these upgrades to read the AMI 2.0 meters.

Regulatory Compliance and Operational Enhancements

The scope of these enhancements is to improve operational efficiencies while staying regulatory-compliant. Hydro Ottawa reserves funds each year to implement changes from the OEB, such as new rate options, as well as automate manual, intensive processes in order to allow staff focus on value-added work. Among other projects, Hydro Ottawa plans to address the following known regulatory changes, enhancements and process automations over the rate period:

- New EV rate for low-utilization EV charging stations (due January 1, 2026)
- Potential for new future rate options
- Revamp Incremental Synchronization process with the provincial Meter Data Management/Repository (MDM/R) to resolve synchronization issues
- Rate reclassification automation
- Equal Monthly Payment Plan (EMPP) process automations
- Introduce self-serve automation for collection processes via Hydro Ottawa's MyAccount portal

2.7.2. Risks to Completion and Risk Mitigation Strategies

Table 3 - Key Risks to Completion for MTC Program and Mitigation Strategies

Risk to completion	Mitigation
Resources	Resources allocation will be performed to ensure Hydro Ottawa delivers on the projects set to complete.
Prioritizing projects	Projects will be prioritized based on customer and financial impacts.
Large Regulatory Initiative	Projects will need to consider Regulatory initiative deadlines and allocate the proper cycles to meet the timelines.

2.7.3. Other Factors

The following identify key factors influencing the timing and costs:

- Aging infrastructure (Operating system, application, hardware and database)
- Product obsolescence dates and vendor support ending
- CIS Managed Services contract ending in 2027 (Hosting, Infrastructure and Support)
- OEB deadlines for regulatory changes

3. CUSTOMER ENGAGEMENT PLATFORMS

3.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $7.1M (CAPEX)

2026-2030: $2.5M (CAPEX) $4.3M (OM&A)

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Scalability and Adaptability, Cost Effectiveness, Regulatory Compliance, Risk Mitigation, Data-Driven Decisions

Outcomes: Operational Effectiveness, Customer Focus, Public Policy Responsiveness

Hydro Ottawa's digital engagement tools are the primary platform for daily customer interaction, shaping Hydro Ottawa's brand and online reputation. These tools are crucial for delivering essential information, new programs, billing and usage insights, self-serve options, energy decision making tools and outage communications.

To enhance customer experience and meet evolving needs, Hydro Ottawa is investing in a Customer Engagement Platform Program. This program will continue to modernize Hydro Ottawa's digital platforms, making them more scalable and user-friendly. The enhancements to these platforms will improve the customer experience, drive operational efficiencies and equip customers to better navigate the complexities of the evolving energy landscape as described Schedule 1-4-1 - Customer Engagement Ongoing, Attachment 1-4-1(B) - Customer Experience Strategy.

Key areas of focus over the 2026-2030 rate period include:

MyAccount - This platform, available online and via mobile app, has become an increasingly important point of access for customers to a widening range of information and services such as billing, energy usage, rate plan options, and outage information. Hydro Ottawa will continue to refine and improve the MyAccount platform, ensuring it remains a primary personalized point of access for customers to manage their accounts, access information and services, and receive tailored support. This includes adapting to new interactive billing technologies and energy management tools to meet evolving customer expectations, while addressing legacy technology issues. Hydro Ottawa will leverage data analytics and disaggregation[1] to empower customers to make better informed energy choices to save money, while providing Hydro Ottawa with valuable data on behind-the-meter insights to inform planning, improve grid management, and develop and amplify customer energy efficiency, demand response and DER programs as Non-Wires Solutions (NWSs).

Hydro Ottawa (.com) - Hydro Ottawa's website will undergo a redesign to improve visual appeal, optimize for mobile devices, and enhance usability for all customer types.

24/7 Chat Support - Hydro Ottawa will integrate an AI-powered chatbot to provide customers with 24/7 assistance for common inquiries and personalized responses, with seamless hand-off to a live agent when needed.

Outage Communications - Hydro Ottawa will build on previous outage communication enhancements by integrating planned outage information into the outage map and automating planned outage notifications to customers.

[1] Hydro Ottawa previously used Behind the Meter load disaggregation technology to provide customers with Home Energy Reports and appliance specific energy usage data as a CDM initiative. This practice was discontinued due to various factors (e.g. CDM program funding, MyAccount redesign, etc.). However, Hydro Ottawa intends to reintroduce disaggregation and data analytics capabilities as part of future updates to its MyAccount platform.

3.2. PERFORMANCE OBJECTIVES AND TARGETS

Table 4 describes the expected performance targets of the Customer Engagement Platform Program.

1 **Table 4 - Performance Outcomes for Customer Engagement Platform**

Performance Outcome	Target
Operational Effectiveness	● Improve grid planning and grid management with data-driven decision-making capabilities using insights gained from customer meter data analytics tools, including consumption patterns, and the identification of behind-the-meter DERs (such as battery storage, EVs and heat pumps). These will inform opportunities for NWSs & demand-side management programs that increase grid flexibility and reliability.
	● Increase customer self-service adoption by offering intuitive and user-friendly online and mobile platforms, integrating automated processes that optimize resource allocation and enable staff to focus on higher-value, more complex activities.
	● Reduce manual processing to minimize errors and improve processing times.
	● Achieve cost savings through: ○ 24/7 access to virtual assistants (chatbot), self-serve options and online support resources that will reduce call center volumes. ○ automation of common customer service inquiries such as bill payments, account updates, payment reporting, rate selection and outage reporting.
	● Mitigate the risk of increased operational costs by proactively modernizing customer engagement platforms so that they remain efficient, secure, and scalable to meet evolving customer needs and industry standards.
	● Ensure regulatory compliance by implementing and maintaining secure and privacy-compliant customer engagement platforms.
Customer Focus	● Enhance customer engagement with expanded energy management tools, including interactive digital bills within MyAccount that provide access to detailed energy use data. These tools will give customers personalized insights into energy consumption, identify opportunities for enhanced energy efficiency and cost savings, and enable greater control over energy use and billing management.
	● Provide 24/7 customer support through a chatbot, allowing timely responses to customer inquiries outside of business hours.
	● Enhance outage communication capabilities to provide timely and accurate information across all channels, including planned outages, ensuring clarity and facilitating efficient customer support.
	● Empower customers with expanded, flexible self-service options available 24/7, enabling them to resolve issues, submit requests, and manage their accounts at their convenience.
	● Contribute to increased customer satisfaction by providing a modern, user-friendly online experience and expanding self-service options.
Public Policy Responsiveness	● Support the OEB's expectation that utilities incorporate consideration of NWSs into the distribution system planning process. This will be informed through gaining deeper insights into customer-owned DERs from meter data to identify opportunities for Customer NWSs Programs.

3.3. PROGRAM DRIVERS AND NEED

3.3.1. Main and Secondary Drivers

Primary Driver: Business Operations Support

Hydro Ottawa's investment in digital customer engagement platforms is driven by a commitment to both enhance the customer experience and achieve operational excellence. Investing in this digital-first approach aligns with Hydro Ottawa's overarching strategy to empower customers through touchpoint improvements, self-service, personalized interactions, and higher levels of understanding, control, and management of their energy use.

By investing in user-friendly tools like the website, MyAccount portal, and a chatbot, Hydro Ottawa aims to make it effortless for customers to obtain immediate assistance, manage their accounts, understand their energy use, and make informed choices. Outage communications, for example, ensure customers receive timely and accurate updates during power disruptions to help them prepare and make informed decisions. This, in turn, improves operational efficiencies by streamlining core business processes, automating tasks, and reducing manual workloads, ultimately increasing efficiency and cost savings. Furthermore, these digital platforms enable Hydro Ottawa to gather valuable insights that can also be used to enhance customer experience, inform grid planning, and identify opportunities for future NWSs and customer programming.

Secondary Drivers:

- Scalability and Adaptability: Ensure services are available and evolving to meet customer demand.
- Cost Effectiveness: Realize efficiencies in automation, reliability, lifespan and preventative maintenance.
- Regulatory Compliance: Meet and exceed mandated requirements and service obligations.
- Risk Mitigation: Stay current with technology to mitigate the risks associated with obsolescence.

- Data Driven Decisions: Better understand and analyze customer choices, channel usage, service issues and energy usage.

3.3.2. Current Issues

MyAccount

Significant progress has been made with the redevelopment of MyAccount in recent years, but there remains legacy technology underpinning some components, opportunities in self-service options to leverage, automation potential, and an absence of advanced insights for customer-driven energy decisions. As the main platform for customer account management, MyAccount requires ongoing updates to meet evolving technology and customer expectations.

Hydro Ottawa can enhance the MyAccount experience and transform how customers interact with their billing information by transitioning to interactive digital bills. The bill is the most frequent touchpoint with customers, playing a crucial role in their understanding of energy usage and costs and their comfort in managing their accounts. Static traditional bills can lead to confusion due to increasing complexity and limited detail regarding rates, charges, energy usage, payment plans, services and programs. A digital bill presented through MyAccount will provide customers with clear, personalized information, allowing them to interactively delve into the specific details relevant to their needs.

At present, Hydro Ottawa customers lack the detailed energy insights needed to understand and lower their energy footprint using existing self-serve tools. Customers have no line of sight to granular electricity usage broken down by appliance or device, making it harder to track consumption patterns and adopt energy-saving measures. With growing EV use, electrification, and new energy sources, the grid and customers are becoming more interconnected. Customers should have better "behind-the-meter" energy intelligence to gain insights and make informed choices. Energy analytics tools, using meter data, can visually identify which devices or end-uses (e.g. EV charging or heating/cooling) consume the most electricity. These tools create opportunities for customers to prioritize energy efficiency, pinpoint savings, and analyze rate options.

Hydro Ottawa also lacks visibility into behind-the-meter DERs and customer electrification trends. Having greater visibility into DERs, and large and/or controllable loads like heat pumps and EV usage, would aid with load forecasting, grid planning, and grid management by uncovering opportunities for NWSs programs and engaging customers to participate in them. Refer to Section 9.2 of Schedule 2-5-4 - Asset Management Process for additional detail.

Providing these tools to customers and accessing behind-the-meter data at a more granular level will support the transition to a smarter, more flexible grid, strengthening customer engagement and empowerment.

Hydro Ottawa has also identified opportunities to expand self-service capabilities within MyAccount for high-volume interactions like collections activities. Currently, customers must contact Hydro Ottawa's contact center to report payments or set up payment plans. This requirement contributes to longer wait times, limited to business hours, and can lead to miscommunication or a lack of clarity regarding payment details. Customers may feel rushed or unable to fully process the information during a phone call, hindering their ability to review options and obligations at their own pace. Automating these routine interactions presents an opportunity to improve both customer experience and contact center efficiency.

Hydro Ottawa (.com)

Hydro Ottawa's website was last significantly redesigned in 2019 to modernize its technology and content management system (CMS). While the site's underlying technology has proven reliable and robust, particularly during periods of high traffic and emergencies, the front-end design is out-dated and the navigation makes it difficult for different customer types to access essential information and services efficiently. Some areas for improvement include updating the visual design and structural elements to align with current standards, updating and enriching the content, and enhancing usability for different customer types, all with the goal of improving the overall user experience and adapting to changing customer expectations.

24/7 Chat Support

Hydro Ottawa is committed to proactively enhancing the customer experience and optimizing operational efficiency. The current customer support model, with limited live chat availability and reliance on traditional service channels such as phone and email, presents an opportunity for improvement. By implementing a 24/7 AI-powered chatbot, Hydro Ottawa can offer a more accessible and convenient support option, streamline processes, and enable customer service agents to focus on more complex issues, ultimately improving the overall customer experience.

Outage Communications

The 2023 shift to a new outage communications solution, including a new map and individual outbound customer notifications via SMS and email, has elevated the reliability and scalability of Hydro Ottawa's ability to provide accurate information to customers when they need it most. Following this work, communication gaps around planned outages still remain. Currently, planned outages are not visible on the outage map in advance, and planned outage notifications rely on a labor-intensive manual process. Hydro Ottawa will continue to evolve its outage communication tools and processes to address these gaps and meet the changing needs of its customers and its operations.

Implementing "unplanned" regulatory requirements within its customer engagement platforms

Hydro Ottawa is committed to providing customers with accessible, up-to-date, and accurate information in response to any specific guidance and expectations by the OEB. An example of this is the electricity load capacity map - phase 1 work which Hydro Ottawa completed and posted to its website by the OEB's March 3, 2025 deadline. It is anticipated that other ongoing consultations by the OEB will lead to other enhancements to Hydro Ottawa's customer engagement platforms that benefit customers.

3.4. PROGRAM BENEFITS

The benefits associated with the proposed Customer Engagement Platform Program are detailed below.

3.4.1. Reliability and Aging Infrastructure

By investing in cutting-edge technology, Hydro Ottawa can provide its customers with best-in-class self-service options through a secure, intuitive, and modern interface. This empowers them to access support via their preferred channels, such as Hydro Ottawa websites, mobile applications, or other digital platforms.

Benefits of Upgrading Technology

- **Enhanced User Experience:** Modern interfaces prioritize user-friendliness, making it easier for customers to navigate and find the information they need.
- **Improved Accessibility:** Upgraded systems can be optimized for accessibility, ensuring that all customers, regardless of their abilities, can use self-service options.
- **Increased Efficiency:** Streamlined processes and automation reduce the time it takes for customers to resolve issues or access information.
- **Enhanced Security:** Modern technologies come with advanced security features, protecting customer data and ensuring privacy.

Informed Decision-Making

By equipping customers with the right tools and information, Hydro Ottawa enables them to make informed decisions. This reduces their reliance on direct inquiries, minimizing delays and uncertainties during critical situations like outages.

Security and Privacy as a Priority

As Hydro Ottawa upgrades its systems and processes for greater efficiency, it prioritizes security and privacy. Each step of the modernization process involves a thorough examination of security measures, ensuring that customer data is protected at all times.

3.4.2. Customer

Hydro Ottawa's investments in customer engagement platforms and customer service technologies will deliver an improved customer experience, ensuring convenient access to the information and tools customers need, when they need them, with enhanced reliability and scalability.

These benefits will be delivered through enhancements to the redesigned MyAccount portal, improving customers' online experience. The work will include transitioning to interactive digital bills combined with energy management tools that will offer a more dynamic and user-friendly billing experience. By leveraging meter data and AI, Hydro Ottawa can deliver more detailed usage data, enhanced visualizations, and targeted communications through digital billing that improve comprehension, promote informed energy decisions and increase customer engagement. The enhancements will simplify bill management and provide personalized insights, especially as energy information and billing become increasingly complex. It will also facilitate the exploration of new service offerings and empower customers to manage their accounts with greater ease and efficiency, while building in platform reliability and scalability to ensure 24/7 access to all necessary information and tools.

Hydro Ottawa is committed to empowering customers to manage their energy use effectively. Interactive digital bills will incorporate new energy management tools that will leverage disaggregation technology to provide detailed insights into electricity usage and identify which end-uses such as appliances, lights, heating and cooling, and EV chargers are using the most electricity. This increase in transparency gives customers greater control over their energy consumption, so they can identify efficiency opportunities or cost savings measures such as load shifting or assessing the impact of different rate options.

Hydro Ottawa envisions MyAccount as a platform where customers can easily track their energy usage and generation, accessing detailed breakdowns of energy use by appliance, understand rate structures, compare costs, and receive personalized insights. All these features contribute to a more transparent, engaging, and satisfying customer experience. The flexibility of a digital platform allows for adaption to evolving customer needs and seamless integration of new services and offerings, creating a future-proof solution. This initiative offers an opportunity to increase customer satisfaction and operational efficiency by providing enhanced self-service options, which will, in turn, reduce customer inquiries.

Expanding self-service options for high-volume interactions, including collections activities, provides customers with greater convenience and control. Online tools for reporting payments and setting up payment plans offer an alternative to phone calls, giving customers 24/7 access and the ability to manage their accounts on their own terms. This self-service approach also facilitates a full understanding of options and obligations by presenting clear, concise payment details that customers can review at their own pace, minimizing the risk of miscommunication.

Hydro Ottawa's website will be refreshed with a visually appealing design, improved mobile responsiveness, and streamlined customer journeys. By enhancing usability for different customer types, it will be easier for customers to find the information they need and access essential services. This will enable customers to self-serve more solutions, and reduce customer inquiries, improving the customer experience.

Customers will benefit from improved communication and support. Communication regarding planned outages will be timely and accurate, minimizing disruption and inconvenience. These outages will be integrated into the outage map to provide a comprehensive view of all service disruptions. Additionally, an AI-powered chatbot will provide 24/7 assistance, offering immediate answers to common questions and enabling customers to complete tasks at any time. This allows customer service agents to dedicate more time to complex issues, ensuring faster and more personalized service.

3.4.3. Grid Modernization and DERs

Utilizing behind-the-meter load disaggregation tools to detect appliances and DERs and collect consumption and generation data enables Hydro Ottawa to put this data in front of customers in the form of improved self-serve tools to make better decisions about their energy usage, identify issues and promote a conservation mindset. These tools also help to better forecast power needs across the grid by gaining a better understanding of behind-the-meter loads, identifying trends, and opportunities to take advantage of new DERs emerging on its system for grid planning and management.

3.4.4. Productivity and Innovation

Optimization and automation of internal processes, including the integration of self-serve capabilities and additional inquiry resolution tools like the 24/7 chatbot, intuitive website information, and detailed insights on energy usage, will reduce manual workload, increase efficiency, and decrease call volume. This will create a more effortless experience for customers, reducing inquiries, delays, disputes and costs.

3.4.5. Digitization and Technology Evolution

Provides Hydro Ottawa's customers with improved options and services while further developing a platform and infrastructure of applications and data that is designed to meet the continuous evolution of technology and the expectations it sets for customers.

3.5. PROGRAM COSTS

The proposed Customer Engagement Platform expansion, evolution and maintenance is anticipated to cost $2.5M (CAPEX) and $4.3M (OM&A) over the 2026-2030 rate period. The shift from capital to OM&A costs is largely due to the move to cloud-based solutions and completion of the MyAccount Redesign capital project in 2022-2024. Further enhancements to MyAccount and the Hydro Ottawa (.com) redesign are capital solutions, while the remainder of the program is based on cloud solutions and OM&A spend. For additional information on cloud computing in general refer to Attachment 4-1-1(A) - Transition to Cloud Computing.

Table 5 - Customer Engagement Platform Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 0.2	$ 1.1	$ 2.2	$ 2.6	$ 1.0	$ 0.9	$ 0.7	$ 0.3	$ 0.3	$ 0.3
OM&A	-	-	-	-	-	$ 1.0	$ 0.8	$ 0.8	$ 0.8	$ 0.8
ANNUAL TOTAL	**$ 0.2**	**$ 1.1**	**$ 2.2**	**$ 2.6**	**$ 1.0**	**$ 1.9**	**$ 1.5**	**$ 1.1**	**$ 1.1**	**$ 1.2**
5-YEAR TOTAL					**$ 7.1**					**$ 6.8**

3.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations from vendors to inform the expected costs of the program, including:

- Purchase of licenses and subscriptions
- Vendor services to implement and/or develop software
- Internal labor costs
- Annual support for each part of the platform

3.6. ALTERNATIVES EVALUATION

3.6.1. Alternatives Considered

Alternative One - Do Nothing: This approach represents a complete cessation of any further development or improvement to the existing platforms. This would immediately freeze the current state of customer knowledge and account management tools, preventing any future enhancements and contributing to an increasingly outdated customer experience.

Alternative Two - Limited Enhancement: This approach, while acknowledging the need for some improvements, would selectively defer or eliminate key projects, including an interactive digital bill, energy management tools, and additional self-serve functionality. While this approach might offer short-term cost savings, it would limit the potential of these platforms, hindering Hydro Ottawa's ability to meet evolving customer expectations for modern digital experiences and self-service capabilities.

Alternative Three - Recommended approach: Implement the program as described above in Section 3.1 - Program Summary.

Risks associated with Alternatives One and Two, and their direct impact, are further detailed in Table 6.

1 **Table 6 - Customer Engagement Platform Program Alternatives Risks and Impacts**

Risk Category	Risk	Impact
Customer Satisfaction	Declining Information Accessibility Across Channels	Customers will experience increasing difficulty accessing necessary information on their preferred device or channel, leading to frustration, increased call volumes to customer service, and confusion.
Operational	Ongoing Reliance on Manual Processes	Continued reliance on manual processes will perpetuate inefficient resource allocation and accumulate technical debt, eventually leading to support issues and an inability to adapt to evolving technology and customer expectations.
Customer Satisfaction / Operational	Limited Self-Service Evolution	Customers will face restricted options, increased reliance on customer service support, and delays due to manual processes. This will also contribute to accumulating technical debt, creating future support challenges and hindering adaptability to technological advancements and changing customer needs.
Customer Satisfaction	Limited 24/7 support options	While customers can access information through MyAccount, the absence of 24/7 live agent chat support limits their ability to resolve issues and receive personalized guidance outside of business hours.
Customer Satisfaction / Operational	Limited adaptability of Outage Communications	Outage Communications will continue to have limitations and exceptions around different outage scenarios and the customer's communication channel of choice. Not continuing the expansion of Hydro Ottawa's outage communications capabilities will detract from the customer experience and may require the continuation of inefficient and manual processes.
Customer Satisfaction / Operational / Financial	Limited Energy Insights for Customers and Hydro Ottawa	Customers will have limited access to data-driven insights at the appliance level and will have limited knowledge and tools to take control of their energy usage without disaggregation. Hydro Ottawa will have limited insight into how consumer energy is being used and changing with DER adoption which hinders informed load forecasting in grid planning, customer engagement, and opportunities for targeted program design.

3.6.2. Evaluation Criteria

Customer Engagement and touchpoint improvements: Convenient and easy-to-use tools and touchpoints across multiple channels to enhance customer engagement.

Personalization and Self Service: Personalized self-service options to empower customers with choice and control over their accounts.

Energy Enablement: Effective tools and resources to enable customers to understand, control, and manage their energy consumption.

Productivity & Operational Effectiveness: Automation and system integration for increased productivity, streamlined operations, and reduced costs.

Reliable scalability: Ensure reliable handling of increased traffic and customer inquiries during periods of high demand.

3.6.3. Preferred Alternative

Alternative Three: Implement the program as described above in Section 3.1 - Program Summary

3.7. PROGRAM EXECUTION AND RISK MITIGATION

3.7.1. Implementation Plan

The various initiatives and activities that are planned for the Customer Engagement Platform Program are coordinated with other programs and projects over the course of the 2026-2030 rate period. Additionally, each year there is allocation for ongoing enhancements for several of the platform's pillars to ensure they meet customer needs, are kept updated, are secure, and put customer experience and privacy on the forefront.

Table 7 - Proposed Projects under the Customer Engagement Platform Program

Year	Proposed Projects
2026	• MyAccount Enhancements and Projects ○ Interactive Digital Bill & Energy Management Tools • Implementation of Hydro Ottawa (.com) Redesign • Outage Communications Enhancements
2027	• 24/7 Chatbot • Outage Communications Enhancements • MyAccount Enhancements • Hydro Ottawa (.com) Enhancements
2028	• Outage Communications Enhancements • MyAccount Enhancements • Hydro Ottawa (.com) Enhancements
2029	• MyAccount Enhancements and Projects ○ Collections Self-serve Automation • Outage Communications Enhancements • MyAccount Enhancements and Projects • Hydro Ottawa (.com) Enhancements
2030	• Outage Communications Enhancements • MyAccount Enhancements and Projects • Hydro Ottawa (.com) Enhancements

3.7.2. Risks to Completion and Risk Mitigation Strategies

The risks to completion and mitigation strategies for the Customer Engagement Platform Program are outlined in Table 8.

Table 8 - Key Risks of Customer Engagement Platform Program and Mitigation Strategies

Risk	Mitigation
Planning and scope definition	Develop a comprehensive set of project plans with clear objectives, deliverables, timelines, and a risk management strategy.
Data Design and Availability	Plan for data availability, transformation and integration challenges early in the project and allocate sufficient resources to address them.
Resourcing	Ensure that the project team has the necessary technical and functional expertise to support project deliverables and ongoing support.
Level of change for employees and customers	Implement change management strategies to address employee responsibilities to ensure smooth transition of customers to new features and functionality.
Executive Support and Stakeholder Engagement	Maintain open communication with champions, stakeholders and steering committees to address concerns promptly.
Vendor Management	Selection and renewal of vendors with proven track records and establish clear expectations within contractual agreements.

A risk to completion of initiatives across the platform is the availability of internal and external resources to support the implementations. Each project within the plan will require internal expertise and support to ensure its successful completion. Limitations on internal resources due to competing projects, general availability, and any potential labor disruptions could impact the initial delivery timelines. Unforeseen major weather events and unexpected regulatory requirements may also have an impact should they occur within an individual project's development timelines. As each major endeavor of the Customer Engagement Platform is also dependent on external vendors, Hydro Ottawa will require that they are able to demonstrate their own redundancy capabilities through procurement processes.

Mitigating the availability of resources can be accomplished through careful planning and coordination of projects, ensuring that there is a backup for each role and working with vendors to plan for any unexpected delays caused by unforeseen events.

4. ENTERPRISE SOLUTIONS

4.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $5.7M (CAPEX)

2026-2030: $1.4M (CAPEX) $0.6M (OM&A)

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Efficiency and Productivity Improvements, Risk Mitigation Cost-Effectiveness, Enhanced Performance

Outcomes: Operational Effectiveness, Financial Performance

Hydro Ottawa's Enterprise Solutions team is responsible for the management of approximately 40 corporate business applications, including commercial-off-the-shelf, in-house developed, and cloud-based solutions. Central to the application portfolio is a large JD Edwards Enterprise Resource Planning (ERP) system providing core back-office functions such as Finance, Supply Chain, Job Costing, and Capital Asset Management. The ERP is heavily integrated with Workday Human Capital Management (HCM) which provides core HR, time management, and payroll services.

Annual investments are required to maintain these systems and deliver improvements by way of application upgrades, system enhancements, integration developments, and technology advancements. Remaining current with technology is imperative to secure vendor support, gain access to software upgrades and mitigate cyber security vulnerabilities. Additionally, Hydro Ottawa intends to implement business continuity management software, evolve Workday HCM with more self-service options and expand the IT Service Management solution. Together, these investments will enable Hydro Ottawa to optimize daily operations, streamline processes through reengineering, and bolster system resilience to mitigate risk and promote continuous improvement.

4.2. PERFORMANCE OBJECTIVES AND TARGETS

Modernizing applications within the Enterprise Solutions portfolio will accelerate progress toward the following objectives, as shown in Table 9:

Table 9 - Performance Objectives and Targets

Performance Outcome	Target
Operational Effectiveness	● Upgrading and enhancing applications will ensure its systems remain functional and relevant, supporting continuous operations and reliability.
	● Enhancements to applications will facilitate process efficiencies, optimize resource utilization, and enhance overall performance, effectively meeting organizational objectives.
	● Establish seamless communication and data consistency between applications through robust system integrations and workflows.
	● Strengthen cyber security defenses and safeguard sensitive information from threats and vulnerabilities.
Financial Performance	● Enable cost-effectiveness associated with prolonged support, break-fix scenarios, and emergency repairs by proactive upgrades.
	● Streamline IT infrastructure, optimize resource utilization, and enhance system agility by reducing the footprint of legacy applications.

4.3. PROGRAM DRIVERS AND NEED

4.3.1. Main and Secondary Drivers

Primary Driver: Business Operations Support

Secondary Drivers:

- Efficiency and Productivity Improvements: Upgrades will unlock new functionalities and capabilities, driving incremental improvement across the organization.
- Risk Mitigation: Modernize aging infrastructure and applications to improve reliability, business continuity, and disaster recovery. Maintain a solid cyber security posture by

minimizing vulnerabilities, safeguarding information and critical software assets.

- Cost-Effectiveness: Enable automation and integrations between new and existing systems to improve information flows and reduce manual effort. Modernized technology will simplify support requirements, allowing resources to be redirected to higher value activities.
- Enhanced Performance: Ensures that systems and operations are optimized, supporting a well-planned and capable workforce. Upgraded systems enable faster processing speeds, smoother multitasking, and improved application performance.

4.3.2. Current Issues

Modernizing and Replacing Outdated Systems

Addressing the retirement or technological obsolescence of legacy systems requires upgrades and/or migrations to new platforms

Adopting and Evolving Technologies

Keeping pace with industry advancements and meeting organizational needs through the adoption and evolution of new and existing technologies.

Process Gaps

Addressing inefficiencies in current processes is a significant challenge due to fragmented systems and silos, which leads to disconnected data flows and manual interventions.

Reliance on Manual Processes

Moving away from reliance on spreadsheets, ad hoc databases, and manual processes to more streamlined, automated solutions to enhance accuracy, reliability, and efficiency.

4.4. PROGRAM BENEFITS

4.4.1. Reliability and Aging Infrastructure

Proactively upgrading and modernizing technology will enable Hydro Ottawa to mitigate risks associated with cyber security, performance, cost-effectiveness, and business continuity.

4.4.2. Customer

Transform operations and enable more intuitive, user-friendly, and personalized experiences that improve customer satisfaction and engagement.

4.4.3. Digitization and Technology Evolution

Moving away from manual processes reliant on spreadsheets, ad hoc databases, and manual processes to more streamlined, automated solutions will minimize human error risk and improve collaboration.

4.4.4. Workforce Planning and Renewal

Enhanced self-service will empower employees to access and update their own information, increasing engagement. Access to real-time data allows for more agile and responsive workforce planning, allowing Hydro Ottawa to adapt quickly to changing needs.

4.4.5. Productivity and Innovation

- Unlock new features and functionality to drive innovation and process improvements.
- Modernized technology will allow Hydro Ottawa to automate more tasks, eliminate redundancies, and optimize workflows, creating significant gains in efficiency and productivity.
- Modern applications are designed to integrate seamlessly with other systems and technologies, facilitating better data exchange and collaboration.

4.5. PROGRAM COSTS

The Enterprise Solutions program will see a total investment of $1.4M (CAPEX) and $0.6M (OM&A) over the 2026-2030 rate period.

Table 10 - Enterprise Solutions Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 1.0	$ 1.2	$ 1.8	$ 1.0	$ 0.7	$ 0.2	$ 0.1	$ 0.9	$ 0.1	$ 0.1
OM&A	-	-	-	-	-	$ 0.1	$ 0.1	$ 0.2	$ 0.1	$ 0.2
ANNUAL TOTAL	**$ 1.0**	**$ 1.2**	**$ 1.8**	**$ 1.0**	**$ 0.7**	**$ 0.4**	**$ 0.2**	**$ 1.1**	**$ 0.2**	**$ 0.3**
5-YEAR TOTAL					**$ 5.7**					**$ 2.0**

4.5.1. Cost Factors

Estimates are formulated based on existing vendor agreements and insights gained from past projects and initiatives. However, it's crucial to acknowledge the potential impact of unknown regulatory pressures that could introduce additional unanticipated development costs. Furthermore, the scope of projects may expand due to emerging business requirements and pressures from vendors, necessitating flexibility in budget allocation and contingency planning to accommodate unforeseen expenses.

4.6. ALTERNATIVES EVALUATION

Each application within the portfolio is a vital component of an integrated landscape, with significant implications for functionality and data flow both upstream and downstream.

Effective management of technology risks and implementation of enhancements to achieve Hydro Ottawa's business objectives necessitate adequate funding. Collaborating with support partners is crucial to mitigate potential risks, maintain seamless operations, and allow continuous improvement.

Hydro Ottawa recognizes the indispensability of maintaining its corporate business applications. Given the interconnectedness of these applications and their critical role in supporting various business functions, investing in their upkeep and enhancements is imperative for sustaining operational efficiency, fostering innovation, and meeting demand from organizational growth.

4.6.1. Alternatives Considered

The impact of deferring or "doing nothing" for the Enterprise Solutions portfolio, including the JD Edwards ERP system and other major enterprise systems, could be significant. Without appropriate funding, the organization will face increased risks of system failures, security breaches, and operational inefficiencies. Adequate funding and investment prioritization in system maintenance and enhancements enable Hydro Ottawa to mitigate risks, seize opportunities, and position itself for long-term success in a rapidly evolving business landscape.

Risks associated without adequate funding, and their direct impact, are further detailed in Table 11.

1 **Table 11 - Enterprise Solution Program Alternatives Risks and Impacts**

Risk Category	Risk	Impact
Operational, Financial, Cyber Security	Delayed Refresh of Assets Driving Risks Associated with Software and Hardware Obsolescence	Increased maintenance costs, decreased system reliability, heightened cyber threats, system failures, data breaches, business disruptions, impacting customer satisfaction and revenue.
Operational, Business	Negatively Impact the Ability of Employees to Support Business Outcomes	Hindered ability to leverage JD Edwards ERP and integrated applications, missed opportunities, operational inefficiencies, decreased competitiveness.
Operational	Decreased Productivity Due to Prolonged Applications/Systems Gaps	Impeded workflow automation, collaboration, decision-making processes, manual workarounds, data discrepancies, project delivery delays, diminished productivity and efficiency.
Financial, Operational	High Unit Cost of Supporting and Servicing Applications	Escalated support costs, increased reliance on reactive measures, strained IT resources, inflated operational expenses, diversion of funds from strategic initiatives.
Operational, Vendor	Limited Vendor Support	Reduced access to updates, patches, technical assistance, prolonged issue resolution times, exacerbated system vulnerabilities, hindered adaptation to changing business needs.
Cyber Security, Regulatory	Lack of IT Security Controls	Heightened cyber security risks, data breaches, ransomware attacks, regulatory non-compliance, damaged reputation, eroded customer trust, financial losses, legal liabilities.
Operational, Business	Loss of System Integration and Data Consistency	Challenges in system integration, fragmented data silos, hindered communication between systems, reduced visibility, impacted decision-making, reduced business agility.
Financial, Operational	Risk of Project Delays and Cost Overruns	Project delays, cost overruns, missed deadlines, unmet business requirements, stakeholder dissatisfaction, affected project success, and realization of benefits.
Operational, Financial	Compromised Business Continuity and Disaster Recovery	Vulnerability to data loss, prolonged downtime, financial losses due to inadequate system maintenance and disaster recovery mechanisms.
Business, Strategic	Diminished Innovation and Adaptability	Stifled innovation, hindered ability to adapt to market trends, missed opportunities for differentiation and growth, impacted long-term sustainability and relevance.
Operational, Technical	Increased Operational Complexity and Technical Debt	Accumulation of technical debt, hindered system performance, scalability, maintainability, increased future upgrade costs and effort, reduced agility.

4.6.2. Evaluation Criteria

The alternative of not maintaining the Enterprise Solutions application portfolio is deemed impractical, as all business applications must continuously evolve alongside the dynamic landscape of the business itself. Standing still in technology equates to falling behind, and without ongoing evolution, the applications risk becoming outdated, hindering operational efficiency, innovation, and desired business outcomes.

4.6.3. Preferred Alternative

Hydro must maintain its existing portfolio of business applications to mitigate risk and support business outcomes.

4.7. PROJECT EXECUTION AND RISK MITIGATION

4.7.1. Implementation Plan

The Enterprise Solutions program outlines strategic investments aimed at proactively enhancing its technology landscape to support organizational growth, efficiency, and resilience. These investments are carefully prioritized to align with business objectives and address anticipated challenges, rather than reactively managing issues as they arise. The plan includes:

- **Annual Investments**: Focused on proactive software upgrades, implementation of new capabilities, strengthening system resilience, and optimizing processes.
- **Planned Enhancements**: The portfolio encompasses regular evaluations and updates to key systems such as JD Edwards (ERP), Salesforce, ServiceNow, and Workday, and Copperleaf C55, ensuring alignment with evolving business requirements.
- **Optimized Financial and Operational Management**: Investments to streamline financial and procurement processes, improve system integrations, and deliver a superior user experience.

Additionally, some focus areas include:

Implementation of New Business Continuity Software: A 6-month initiative to implement

BCM software that will support the preparation and management of documentation, plan and exercise implementation and action tracking. With an increase in the severity, duration and variation in types of disruptive events facing the organization, an associated increase in plan development and action management has occurred and requires a solution to consolidate and manage these items across the organization.

Evolution of Workday Human Capital Management : A six-month initiative to streamline and automate HR processes to increase efficiency, reduce manual intervention, and improve the overall employee experience. This includes automating routine tasks, implementation of more self-service tools and resolution of existing pain points.

Expansion of ServiceNow ITSM Platform: An eight-month effort focused on increasing IT service management capabilities, enhancing automation, and driving efficiency in IT operations.

Planned Upgrades and Legacy Technology Replacements: Over the 2026-2030 rate period, Hydro Ottawa will take a phased approach to upgrading or replacing aging technology, prioritizing critical systems that impact finance, HR, and customer service functions.

This structured approach ensures Hydro Ottawa not only maintains but also continuously improves the internal technology ecosystem to stay ahead of industry advancements and organizational needs.

4.7.2. Risks to Completion and Risk Mitigation Strategies

The risks to completion and mitigation strategies for the Enterprise Solutions program are outlined in Table 12.

1 **Table 12 - Key Risks of the Enterprise Solutions Program and Mitigation Strategies**

Risk	Mitigation
Resource Constraints	Implement detailed resource management plans, including internal staff training and upskilling, to reduce reliance on external vendors.
Vendor Management	Establish clear Service Level Agreements (SLAs) with vendors and engage in regular communication to mitigate scheduling risks and ensure timely service delivery.
Cost Control	Maintain a contingency budget and implement cost tracking mechanisms to monitor expenditures and address potential overruns promptly.
Cyber Security	Incorporate robust cyber security protocols, including regular vulnerability assessments, penetration testing, and vendor security checks, to mitigate risks during integrations and upgrades
Business Continuity Planning	Develop and test comprehensive business continuity and disaster recovery plans to minimize operational disruptions during system updates.
Change Management	Create a technology roadmap to prioritize upgrades and system enhancements, ensuring critical systems remain current and functional.

5. DATA AND SYSTEM INTEGRATIONS

5.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $1.6M (CAPEX)

2026-2030: $3.5M (CAPEX) and $0.5M (OM&A)

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Risk Mitigation, Scalability and Performance, Process Automation, Efficiency, Improved Customer Experience, Agility and Innovation, Regulatory Compliance, Data-Driven Culture and Decision Making

Outcomes: Operational Effectiveness, Financial Performance, Organizational Efficiency

Hydro Ottawa's Data and System Integrations program is focused on the management of corporate databases, system integration technologies, and data warehouse activities across the application landscape. These components are foundational in enabling Hydro Ottawa to sustain daily operations; deliver on strategic initiatives; and improve the quality, accessibility, and maturity of data across the enterprise. Recognizing the critical importance of transactional databases to Hydro Ottawa's operations, a robust infrastructure was implemented in the historical period to ensure its reliability, performance, and security.

Transactional databases are hosted on state-of-the-art, engineered systems with a purpose-built platform designed to deliver optimal performance for demanding workloads. These systems, which are both on-premise and cloud-based, must exchange information effectively. This is currently done automatically via multiple integration technologies established over the years, Oracle Data Integrator (ODI) being the primary. The Oracle components will be reaching end-of-life in 2027 and need to be replaced to mitigate risks associated with hardware failures and software obsolescence.

The plan aims to transition away from ODI, instead consolidating information flows on a single, modernized integration platform with redundancy and performance in mind. Improving the security posture of integrations, taking advantage of innovation and new functionality, enabling better monitoring and handling of exceptions are desirable and part of the plan.

Finally, Hydro Ottawa's Data and System Integrations program will focus on use-case automations to break down transactional silos, unlock powerful insights, identify trends, predict maintenance needs, optimize energy distribution, and enable better business intelligence. By ensuring the integrity, accessibility, and integration of data, Hydro Ottawa will drive informed decision-making, deliver exceptional customer experiences, and drive innovation in the energy sector.

5.2. PERFORMANCE OBJECTIVES AND TARGETS

Table 13 - [Performance Objectives and Targets]

Performance Outcome	Target
Operational Effectiveness	• Increase data availability across the application landscape
	• Unlock operational efficiencies through integrations and workflows
	• Reduce integration risks through upgrades and enhancements
	• Maintain Regulatory compliance
	• Better application programming interfaces (APIs)
	• Integrated cyber security and privacy by design
Financial Performance	• Reduce integration costs by eliminating legacy platforms
	• Lower IT infrastructure costs and optimize return on investment
Organizational Efficiency	• Improve data quality and awareness
	• Enhance collaboration through data integration
	• Enable data-driven decision-making
	• Improve overall business intelligence
	• Focus on continuous improvement

5.3. PROGRAM DRIVERS AND NEED

5.3.1. Main and Secondary Drivers

Primary Driver: Business Operations Support

Secondary Drivers:

- Scalability and Performance: Real-time data processing and streaming, implementation of robust data ingestion pipelines and diverse data sources (e.g., smart meters, sensors).
- Data Silos and Fragmentation: Break down of transactional silos, enabling data sharing and collaboration.
- Process Automation and Efficiency: Automate manual tasks and streamline workflows to reduce errors and improve productivity.
- Improved Customer Experience: Integrate customer data from different sources to build a 360-degree view of customers, enabling personalized interactions and better service.
- Agility and Innovation: Connect new applications and services, supporting innovation and adapting to market changes.
- Regulatory Compliance: Integration platforms help meet compliance requirements by ensuring appropriate data security and privacy.
- Risk Mitigation: Stay current with technology and mitigate the risks associated with obsolescence.
- Data-Driven Culture and Decision Making: Promote data sharing and collaboration, enabling teams across different departments to leverage data insights for improved outcomes.

5.3.2. Current Issues

Some of the current issues are as follows:

- Transactional databases are nearing end-of-life and require hardware refreshes.
- Transactional database application components require a technology upgrade to avoid obsolescence and to maintain vendor support.
- Legacy integration platform must be phased out due to obsolescence.
- Desire to implement an enhanced security posture and functionality to system integrations.

- Desire to raise and manage integration incidents into the IT Service Management system (ServiceNow) before they manifest as larger service disruptions.
- Desire to implement various use-case automations to improve business intelligence, generate customer insights, enable self-service capabilities and drive increased data maturity across the enterprise.

5.4. PROGRAM BENEFITS

5.4.1. Reliability and Aging Infrastructure

Proactively upgrading and modernizing technology will enable Hydro Ottawa to mitigate risks associated with cyber security, performance, cost-effectiveness, and business continuity.

5.4.2. Resilience and Climate Change Adaptation

Data-driven insights on assets and operations enable informed choices about resource allocation, infrastructure development, and environmental regulations.

5.4.3. Customer

Transactional databases and integrations enable critical customer data to flow to and from the billing system, customer portal, and outage communications system that are foundational to Hydro Ottawa service offerings. Data warehouses enable customer segmentation and targeting, which enhance the customer experience and power self-service analytics.

5.4.4. Cost Control and Rate Mitigation

Aligning to a single, modern integration platform will improve productivity through the reduction of manual intervention needed between systems, control maintenance costs by reducing the number of systems requiring maintenance, and optimize infrastructure costs by eliminating the need for on-premise software that becomes obsolete in a short timeframe.

5.4.5. Digitization and Technology Evolution

Modernized data warehouse platforms provide Predictive Analytics, AI and modeling capabilities to rapidly automate use case scenarios. A modern integration platform will allow for more effective use and management of APIs to improve overall productivity and efficiency in daily operations.

5.4.6. Productivity and Innovation

Automation of manual and/or repetitive tasks improves resource utilization and streamlines operational processes. Data warehouses streamline data access, promote data governance and data quality practices fueling collaboration, insights and innovation.

5.4.7. Energy Transition and Electrification

Data warehouses support sophisticated analytical tools and modeling techniques to uncover hidden trends, patterns, and anomalies to unlock within Hydro Ottawa's energy data.

5.5. PROGRAM COSTS

The Data and System Integrations program cost over the 2026-2030 rate period is $3.5M CAPEX and $0.5M OM&A.

Table 14 - Data and System Integrations Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 0.0	$ 0.3	$ 0.4	$ 0.4	$ 0.4	$ 0.8	$ 0.6	$ 0.5	$ 0.5	$ 1.1
OM&A	-	-	-	-	-	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.1
ANNUAL TOTAL	**$ 0.0**	**$ 0.3**	**$ 0.4**	**$ 0.4**	**$ 0.4**	**$ 0.8**	**$ 0.7**	**$ 0.5**	**$ 0.5**	**$ 1.2**
5-YEAR TOTAL					**$ 1.6**					**$ 3.7**

5.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations from reputable vendors to inform the budget proposed, including:

- Purchase of licenses and subscriptions
- Vendor services to implement and/or develop software
- Internal labor costs
- System monitoring (OM&A)

5.6. ALTERNATIVES EVALUATION

Transactional databases are the storage engines behind modern business applications and must be upgraded to avoid the risks associated with obsolescence, including cyber security concerns. Likewise, integration technology facilitates critical information flows between systems and this automation is key to productivity and efficiency gains. Existing integrations must be maintained and new integrations will be built to support future business objectives.

There is no suitable alternative as these existing platforms and assets are foundational in sustaining business operations. Further, Hydro Ottawa has invested in Snowflake, a cloud based data warehouse platform, purpose built for use case automations and to bolster both business intelligence and enterprise data maturity. The platform was chosen in 2018 after a comprehensive study of the market and was deemed as a best fit for Hydro Ottawa requirements. Further use case automations are planned in the near future.

5.6.1. Alternatives Considered

Hydro Ottawa's existing transactional databases, system integrations, and data warehouse program are foundational components necessary to sustain business operations. A deferral or "do nothing" approach could result in the realization of the risks outlined in Table 15.

Risks associated with adequate funding, and their direct impact, are further detailed in Table 15.

Table 15 - Data and System Integration Program Alternatives Risks and Impacts

Risk Category	Risk	Impact
Operational	Data silos and inconsistency	When integrations break down, data may not flow seamlessly between systems, leading to outdated or conflicting information. This hampers decision-making and can result in costly errors. Without a centralized data warehouse repository, data remains scattered across various systems and departments, creating silos that hinder access and analysis.
Operational	Data loss and corruption	Unmaintained databases and integrations may lead to lost or corrupted data, impacting application performance, reporting, analytics, and overall business intelligence.
Regulatory	Compliance and Security Risks	Outdated databases and integrations may not adhere to evolving security standards, increasing the risk of data breaches and regulatory non-compliance.
Operational	Technical debt	Neglecting database and integration maintenance can create a backlog of technical debt, making future updates and improvements even more challenging and expensive.
Operational	Hindered innovation and growth	Data warehouses are essential for enabling advanced analytics, such as machine learning and predictive modeling. Data warehouses provide the agility and flexibility needed to adapt to changing market conditions.
Operational	Impaired Decision-Making and Missed Opportunities	Hampers the ability to perform complex queries, trend analysis, and data mining. This limits the organization's ability to derive actionable insights and identify growth opportunities.

5.6.2. Evaluation Criteria

Hydro Ottawa transactional databases, integration technologies, and data warehouse platforms must be maintained and evolved to meet business objectives. These technologies are actively in use today and integrated into core business processes across Hydro Ottawa. There is no viable alternative without stagnating and introducing additional business risk.

5.6.3. Preferred Alternative

Hydro Ottawa’s existing transactional databases, system integrations, and data warehouse program are foundational components and must be maintained to sustain business operations

5.7. PROGRAM EXECUTION AND RISK MITIGATION

5.7.1. Implementation Plan

Hydro Ottawa’s transactional database predominantly uses Oracle technology and will be end-of-life in 2027. Recognizing the critical importance of transactional databases to Hydro Ottawa's operations, software upgrades will be required to ensure continued access to critical updates, security patches, and technical support. These upgrades will not only extend the lifespan of transactional databases but also unlock access to new features and enhancements to further optimize operations. To mitigate risks associated with hardware failures and obsolescence, a hardware refresh is planned in conjunction with the database software upgrades.

Hydro Ottawa uses a legacy integration platform based on ODI, which manages critical information flows to and from the metering systems, Customer Care & Billing system, bill print provider, and third-party systems. Oracle has advised that the ODI product will be end-of-life in 2027. Therefore, Hydro Ottawa will transition away from ODI migrating these interfaces to Boomi - a modernized data integration platform - that will simplify and streamline integration processes to better connect and collaborate.

Enhancements will be made to improve the security posture of integrations - not limited to API management, but also better encryption protocols, better identity/role-based access management, and exception reporting. Hydro Ottawa intends to integrate the Boomi platform with the IT Service Management system (ServiceNow) to provide timely visibility and collaboration on negative system events (e.g. low disk space, poor performance, failed transactions) that require human intervention to correct. Proactive monitoring and capture of these events early will minimize service disruptions and create a positive customer experience.

Finally, Hydro Ottawa has adopted Snowflake as a centralized data platform for analytical, business intelligence (BI), and reporting purposes. This cloud-based data warehouse platform offers scalability, flexibility, and powerful analytical capabilities, enabling valuable insights from the wealth of company data to be discovered. Visualization tools such as Tableau are utilized by information workers to create interactive dashboards and reports for effective data communication. Hydro Ottawa will continue to identify, prioritize and automate various use-case opportunities, driving efficiency gains and productivity improvements to unlock value for the organization and its customers.

More specifically:

- Hydro Ottawa will upgrade transactional database and system integration technology in alignment with a vendor obsolescence roadmap and will procure new hardware as needed.
- The legacy ODI platform will be decommissioned after all integrations have been successfully migrated over to the modernized Boomi integration platform in 2026.
- A new, enhanced security posture will be implemented to bolster integration cyber security efforts, minimize maintenance overhead, improve reusability through APIs, and enable more granular security controls.
- System events from database and integration monitoring will be captured and recorded into ServiceNow to be visible, trackable and actioned before they manifest as larger service disruptions.
- The data warehouse program will see various use case automations to improve business intelligence, generate customer insights, enable self-service capabilities, and drive increased data maturity across the enterprise.

5.7.2. Risks to Completion and Risk Mitigation Strategies

Table 16 below summarizes the key risks of the data and system integrations program.

Table 16 - Key Risks of the Data & System Integrations Program and Mitigation Strategies

Risk	Mitigation
Resource availability	Hydro Ottawa will need to ensure appropriate IT, vendor and business resources are available to support technology upgrades and use case automations.
Competing priorities	Hydro Ottawa will prioritize initiatives that could create business risk and/or negatively impact daily operations.

5.7.3. Other Factors

A few factors that may influence database and integration technology upgrades will be determined by:

- Vendor obsolescence timing
- Business resource availability
- New projects with technology dependencies

Data warehouse activities will be influenced by business needs, size and complexity, cost, technology considerations, and business resource availability.

6. GRID TECHNOLOGY

6.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $2.0M (CAPEX)

2026-2030: $4.3M (CAPEX) and $1.5M (OM&A)

Budget Program: Operations Initiatives

Main Driver: Business Operations Support

Secondary Driver: Grid Modernization

Outcomes: Operational Effectiveness

Hydro Ottawa's Grid Technology program is responsible for the management of systems that complement operations processes in System Service, System Renewal, and System Access. To ensure operational excellence and regulatory compliance, investment in technology infrastructure is essential. This commitment encompasses regular application upgrades, system enhancements to optimize performance and functionality, seamless integrations across platforms, and the adoption of emerging technologies to enhance efficiency and security. Key business functionality supported by this program are:

Network Visualization and Asset Register

The Geographical Information System (GIS) is the repository for Hydro Ottawa's electrical distribution network as well as an aggregation point for multiple sources of geographic data including asset location, service territory and ward boundaries, and land registry information such as property data and easement mapping. This system integrates with several key Hydro Ottawa systems including the Customer Care & Billing system for premise information. The electrical distribution network model serves as the foundation on which the Outage Management System (OMS) understands the connectivity of the electrical grid and predicts associations between individual outage reports and the fault locations.

Electrical distribution network model visualization and asset register functionality provided by GIS also supports design efforts considering factors like terrain, land use, and environmental impact.

Data Collection and Analytics

The Planning Historian is used for collecting and storing data related to the operation of the electrical distribution grid. This system is an important tool to allow performance monitoring, analytics, trend identification, and quality assurance of grid performance. It also serves as a key source of data for the asset management business process outlined in Schedule 2-5-4 - Asset Management Process as well as the Enterprise Asset Management system outlined in Section 3 of Attachment 4-1-1(A) - Transition to Cloud Computing.

This system must not only meet operational availability and reliability needs, but also scale substantially between 2026 and 2030, growing from tens of thousands of field devices in 2025 to hundreds of thousands by 2030. This increase in field devices is being driven by the introduction of intelligently-connected sensors to amplify grid observability and improve grid controllability as discussed in Section 2.3.3 of Schedule 2-5-1 - Distribution System Plan Overview as well as in Section 5 of Schedule 2-5-7 - System Renewal Investments.

Network Modeling and Simulation

This system creates detailed models of the electrical distribution network, like topology (representation of lines, transformers, switches, etc.) and electrical characteristics such as impedance, resistance and capacitance. It also provides simulation functionality for steady-state fault analysis and dynamic analysis to understand the grid’s response to disturbances and transient events. This tool aids in capacity planning, voltage regulation, and protection coordination.

Additional modules and feature functionality will be required in the 2026-2030 rate period to address the changing needs of load forecasting and effectively respond to the expanding grid capacity requirements as well as increases in connection requests discussed in Section 2.3.1 of Schedule 2-5-1 - Distribution System Plan Overview.

6.2. PERFORMANCE OBJECTIVES AND TARGETS

Hydro Ottawa employs KPIs to measure and monitor its performance. The Grid Technology program is expected to lead to improvements in the KPI metrics detailed in Table 17.

Table 17 - Performance Targets for Grid Technology Program

Performance Outcome	Target
Operational Effectiveness	● Appropriate system architecture design and regular upgrades ensures these systems maintain a 99.0% uptime with a maximum allowable downtime of 8 hours and maximum allowable data loss of 24 hours in the event of a failure. ● Facilitate operational efficiencies through digitization and automation of network modeling, simulation and visualization to enhance overall performance and effectively meeting organizational objectives. ● Enhance data-driven decision-making by consolidating data and leveraging analytics and tools to enhance visibility of grid asset performance and electrical network modeling and simulation.

6.3. PROGRAM DRIVERS AND NEED

6.3.1. Main and Secondary Drivers

Primary Driver:

Business Operations Support; this program supports core business processes such as Distribution Asset Management, System Access, System Renewal, and System Service. Investing in this program will facilitate faster, more accurate planning, design and maintenance of the electrical distribution grid supporting grid modernization objectives of enhanced reliability, adaptive grid flexibility, fortified resilience, and robust security.

Secondary Drivers:

- Scalability and Performance: enhancing data historian and simulation tools to include additional data sources (e.g., smart meters, sensors).

- Support the Enterprise Asset Management System: The Grid Technology systems are key sources of information for the Asset Management System. These systems track the geographic location and key health information of a particular asset.
- Process Automation and Efficiency: Automate manual tasks and streamline workflows, reducing errors and improving productivity.
- Faster Decision-Making: Implementing solutions to automate capacity calculations that will assist the planning process.
- Agility and Innovation: Position Hydro Ottawa to adapt to the energy transformation.
- Risk Mitigation: Stay current with technology and mitigate the risks associated with obsolescence.

6.3.2. Current Issues

The Grid Technology program aims to address the following challenges:

- **Meeting the Energy Transition & Electrification Demands:** The use of spreadsheets to track capacity and calculate offloading and rebalancing of electricity is inefficient and error-prone. It leads to suboptimal resource allocation and missed economic development opportunities due to an inability to respond in a timely fashion to connection requests. Improvements to the Data Collection and Analytics and Network Modeling and Simulation initiatives will eliminate the spreadsheets by incorporating this function within existing systems. This will reduce manual efforts and increase the speed of assessing, and responding to, connection requests.
- **Data Requirements Exceed Current Capacity:** The existing Planning Historian has a limitation on the number of data points it can track. Expanding it for AMI integration is necessary to capture a comprehensive view of grid operations. Upgrades planned to this solution will allow the system to ingest and manage the increase in data volume created by AMI 2.0.
- **Lengthy, Manual Processes:** Systems that support planning and design are fragmented and do not address the evolving needs of the business. This creates a lengthy, manual

process which limits peak load calculations to twice per year (winter and summer) and inhibits Hydro Ottawa's ability to respond to capacity requests in a timely, efficient manner.

- **Technical Obsolescence:** Outdated IT systems can cause disruptions in operations, escalating support costs, and prevent the adoption of new capabilities that deliver operational efficiency to meet the evolving needs of customers.
- **Data Accuracy:** Limited data validation is conducted at present on the electrical connectivity model, which makes future automation solutions challenging. Enhancements to the network visualization system to include automated data validation, as well as additional tools to integrate and automate fragmented systems in this space, will address data accuracy and better inform decision-making.
- **Changing Environment:** Ottawa has experienced several significant weather events over the 2021-2025 rate period. Digitizing and integrating grid capacity information will streamline decision-making in complex restoration scenarios.

6.4. PROGRAM BENEFITS

By consolidating and expanding spatial and asset performance data, and strengthening simulation tools, the utility can enhance grid visibility, improve planning and analysis, and automate tasks. This leads to:

6.4.1. Improved Distribution Model Accuracy

This program aims to improve the design-to-energization process by consolidating and enhancing tools that will reduce manual effort as well as the time between energization in the field and distribution model updates.

6.4.2. System Operation Efficiency and Cost Effectiveness

This program is a set of continuous operational technology platform upgrades and enhancements. Therefore, it is expected that the benefits from the program will increase over time as the upgrades and enhancements are deployed.

Data improvement will help to make better decisions to improve grid reliability and reduce downtime through predictive maintenance and improved operational insights. The integration and automation of these processes is expected to improve data quality and access to advanced planning and simulation capabilities.

6.4.3. Reliable Solutions to Power Advanced Applications

Using the latest software platforms, engineers and designers can rely on accurate information to make data-driven decisions on technical aspects of projects.

The program will ensure that the software infrastructure can support the integration of new technologies, such as smart meters, renewable energy sources, and advanced grid control systems. It will prioritize the security and integrity of all data managed by these software systems, implementing robust cyber security measures to protect against threats.

By improving data accuracy, grid visibility, and predictive capabilities, the program will contribute to a more stable and resilient grid and operational efficiencies. Through data analysis and simulation, the program will help optimize grid performance, reduce costs, and improve efficiency.

6.4.4. Cyber Security

The program will prioritize the security and integrity of all data managed by these software systems, implementing robust cyber security measures to protect against threats.

6.4.5. Economic Development

Energy transition and electrification is an emerging component of economic development within the City of Ottawa. Digitizing and centralizing design and engineering processes will invariably help support streamlined decision-making for those interested in building electrification, EV charging infrastructure, and DERs as well as larger commercial development opportunities such as data centers.

6.5. PROGRAM COSTS

The historical period represents the purchase and installation of the different operation technology software platforms. The future costs are to maintain these platforms using IT best practices for system upgrades and refreshes as well as the targeted implementation of enhancements to provide scalability and enable Hydro Ottawa to respond to the demands of the growing nation's capital.

Table 18 - Grid Technology Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 0.5	$ 0.2	$ 0.4	$ 0.4	$ 0.4	$ 1.1	$ 0.9	$ 1.0	$ 0.6	$ 0.6
OM&A	-	-	-	-	-	$ 0.3	$ 0.3	$ 0.3	$ 0.3	$ 0.3
ANNUAL TOTAL	**$ 0.5**	**$ 0.2**	**$ 0.4**	**$ 0.4**	**$ 0.4**	**$ 1.4**	**$ 1.2**	**$ 1.3**	**$ 0.9**	**$ 0.9**
5-YEAR TOTAL					**$ 2.0**					**$ 5.7**

6.5.1. Cost Factors

The largest singular factor which has driven adjustments to costs is the recent industry adoption of term licensing models in lieu of the standard perpetual licensing models. Term licensing restricts the life of the license to a defined period and bundles additional services such as access to free upgrades which otherwise would have been forecasted separately. Hydro Ottawa has limited control over changing licensing models, but cost optimization is a key component of solution selection and contract renewal negotiation with vendors.

6.6. ALTERNATIVES EVALUATION

6.6.1. Alternatives Considered

Alternative One - Do Nothing: Run to failure and address issues as they arise. Not upgrading can lead to a cascade of negative outcomes that impact various aspects of Hydro Ottawa's business.

- **Increased operations and cyber security risks**: The risk of software failure increases as upgrades are delayed. When failure occurs, downtime is prolonged and can impact Hydro Ottawa's ability to execute key business mandates. Outdated software also leaves vulnerabilities unaddressed, potentially leading to outages, equipment damage, data breaches, and safety hazards. This risk grows exponentially as systems age and vulnerabilities are discovered.
- **Compliance challenges**: Using outdated software may make it difficult to comply with evolving regulatory requirements for grid reliability, cyber security, and data protection, incurring penalties.
- **Inefficient grid operations**: This leads to slower outage response, higher energy losses, difficulty integrating renewable energy sources, and challenges in meeting growing demand, ultimately impacting customer satisfaction and grid reliability.
- **Missed opportunities**: Neglecting upgrades means missing out on new features, functionalities, and improvements that could enhance efficiency, optimize the grid, and support innovation.
- **Increased technical debt**: Delaying regular upgrades and maintenance may provide short term benefits by reducing immediate costs, but it invariably makes future modernization efforts more complex and costly.

Alternative Two - Maintain: Upgrade software when it reaches end-of-life, do not optimize or integrate. While this option addresses supportability and cyber security, it does not position Hydro Ottawa to respond to the energy transformation or enable it to responsibly manage labour or asset costs. The potential outcomes of this alternative include:

- **Improved individual system performance**: Incremental benefits gained through feature enhancements included in upgrades, and maintenance of cyber security posture.
- **Operational inefficiencies**: Several challenges have been outlined related to automation and integration which will not be addressed by this alternative.
- **Reduced ability to leverage data**: Data remains isolated in separate systems, limiting comprehensive analysis, identification of trends, and extraction of valuable insights for

decision-making.

- **Hindered innovation:** This approach restricts Hydro Ottawa's ability to leverage the full potential of its software and data, hindering innovation and the adoption of new technologies like AI and machine learning for grid optimization.
- **Increased complexity and costs in the long run**: Maintaining multiple standalone systems is economically inefficient and it contravenes basic TOGAF principles.

Alternative Three - Accelerated: Adopt a future-focused program that addresses business process inefficiencies caused by disparate or incomplete technical solutions and positions Hydro Ottawa to respond to the energy transformation. This alternative will upgrade solutions to the latest versions, integrate and unify solutions to support planning, design and simulation to improve operational efficiency, security, and overall performance. The potential outcomes of this alternative include:

- **Improved system performance and security**: Newer versions often come with performance enhancements, bug fixes, and new features, improving the efficiency and reliability of individual systems. Upgrading to the latest versions ensures that Hydro Ottawa core software has the latest security patches, minimizing vulnerabilities and strengthening defenses against cyberattacks.
- **Enhanced data accessibility and analysis**: Integrating with GIS allows Hydro Ottawa to leverage spatial context and visualize data from various sources, producing better analysis, informed decision-making, and optimized grid operations.
- **Streamlined workflows**: Consolidating software and moving functionalities to existing systems reduces complexity, eliminates redundancies, and streamlines workflows, leading to improved productivity and reduced manual effort.
- **Increased efficiency and cost savings**: Optimizing processes and automating tasks through integration and consolidation can lead to better resource utilization and cost savings.
- **Improved innovation and agility**: A modernized and integrated software environment

allows for better data analysis, supporting innovation and faster adaptation to changing business needs.

- **Increased Initial investment**: Implementing integration and consolidation projects requires an upfront investment in planning, development, and potentially new software licenses or customization.
- **Temporary disruption**: Integrating and consolidating systems can cause temporary disruptions to operations as employees adjust to new workflows and systems.
- **Change management challenges**: Successfully implementing integration and consolidation requires careful change management to ensure employee buy-in and adoption of new processes.

6.6.2. Evaluation Criteria

System Reliability

This criterion assesses the system's ability to meet service level agreements and provide the required level of availability and ensure potential data loss does not exceed acceptable limits. System upgrades aim to reduce the probability and impact of system failures by addressing aging infrastructure and application versions.

Operational Efficiency

This criterion considers the alternative's ability to position Hydro Ottawa to "do more, more quickly" in response to increasingly complex demands. Incorporating automation reduces manual effort and improves efficiency. Facilitating data analysis and visualization enables informed decision-making and grid optimization.

Enabling The Energy Transition

This criterion assesses the alternative's ability to address the anticipated rise in electrification within the community, including the adoption of electric vehicles, heat pumps, renewables, and light rail transit. Increased densification and other demands on the electricity grid require efficient data-driven decisions.

6.6.3. Preferred Alternative

The preferred alternative is to adopt a responsible but future-focused program which involves the integration and enhancement of Hydro Ottawa software, including simulation tools, data historians for planning, and GIS, along with upgrading and maintaining those systems. This strategy fosters a holistic view of the grid by breaking down data silos and integrating information from various sources, especially leveraging GIS. This creates design efficiencies, improved situational awareness, better-informed decision-making, and optimized grid operations. It enhances efficiency and productivity by streamlining workflows, automating tasks, and fostering collaboration among departments. Finally, upgrading and maintaining these systems ensures that they remain secure and reliable, minimizing vulnerabilities and maximizing uptime.

This approach promotes innovation and adaptability by enabling Hydro Ottawa to leverage the latest technologies and data-driven insights to meet the evolving demands of the energy landscape. By embracing this comprehensive strategy, Hydro Ottawa can achieve cost savings, improve grid reliability, and better serve its customers while positioning itself for a successful future.

6.7. PROGRAM EXECUTION AND RISK MITIGATION

6.7.1. Implementation Plan

The Grid Technology program will be executed between 2026 and 2030. Investments in this program are carefully prioritized to align with business objectives and support distribution engineering and asset management processes. The plan includes:

- **Annual Investments**: Focused on proactive software upgrades, implementation of new capabilities, strengthening system resilience, and optimizing processes.
- **Planned Enhancements**: The program encompasses regular evaluations and updates to key grid operations systems ensuring alignment with evolving business requirements.

Table 19 shows key projects proposed for the 2026-2030 rate period, as a part of the Grid Technology program.

Table 19 - Proposed Projects under the Grid Technology Program

Year	Proposed Projects
2026	• Planning Historian upgrade and integration of AMI data
2027	• Network modeling and simulation feature extension • Digitization of electrical grid planning and design processes
2028	• Network modeling and simulation feature extension • Integration of operational design tools with the geographical information system
2029	• Extension of geographical information system module and integration
2030	• Network simulation enhancement • Extension of grid simulation and modeling capabilities

6.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Grid Technology program. Table 20 outlines the key risks and corresponding mitigation strategies:

1 **Table 20 - Key Risks of the Grid Technology Program and Mitigation Strategies**

Category	Risk	Mitigation
Business Requirements and schedule	Changing business requirements or schedules can complicate project planning and increase costs.	Maintain flexibility in project designs and budgets. Regularly engage with business to anticipate and adjust for changes, ensuring resource availability and mitigating delays.
Financial Impact	Cost overruns or budget shortfalls may occur due to unexpected expenses. This may be a result of changing software licensing models affecting operating vs. capital investment as well as asset life.	Develop detailed budgets with contingencies and monitor financial performance closely throughout the project lifecycle.
Project Management	Poor project management could lead to delays or inefficiencies.	Utilize experienced project management resources and tools to track progress, manage resources, and maintain timelines.
Resource Availability	Shortages in skilled labor may hinder project progress.	Plan resource needs well in advance and maintain strong relationships with suppliers and contractors to secure reliable access to critical resources.
Rapidly Evolving Technology Landscape	Technology obsolescence, interoperability and security vulnerabilities and new as yet, unknown functionality drive changes to scope, cost and schedule.	Adopt flexible, modular systems to allow for easier upgrades and interoperability. Prioritize cyber security, and develop and regularly maintain a technology roadmap.

7. CONNECTION COST RECOVERY AGREEMENT

7.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $17.0M

2026-2030: $45.9M

Budget Program: CCRA Program

Main Driver: System Investment Support

Secondary Driver: Capacity Constraints

Outcomes: Customer Focus, Operation Effectiveness, Public Policy Responsiveness

The Connection Cost Recovery Agreement (CCRA) program is comprised of capital contributions paid (or to be paid) by Hydro Ottawa to Hydro One, the transmitter, in accordance with cost responsibility requirements under the Transmission System Code, for upgrades on Hydro One's transmission system which will support capacity investments to support Hydro Ottawa customers. The TSC includes an economic evaluation methodology which determines, for the transmission work that is Hydro Ottawa's responsibility, whether expected incremental revenues over the applicable time horizon will be sufficient. To the extent the economic evaluation methodology identifies a shortfall in the expected revenues, Hydro Ottawa is required to pay a capital contribution pursuant to a CCRA with Hydro One.

The CCRA program includes investments for transmission upgrades required to remove equipment limitations and leverage planning capacity in existing Hydro One/Hydro Ottawa owned stations as well as build adequate transmission capacity to supply new stations being planned for energization until 2030. Listed below are the new and ongoing transmission upgrades in which Hydro Ottawa will be required to make a contribution towards the upgrade through a DCF mechanism:

- Hydro Road MTS CCRA - New 44kV station

- Mer Bleue MTS CCRA - New 28kV station in the East 28kV region
- Kanata North MTS CCRA - New 28kV station in the West 28kV(North) region
- Greenbank MTS CCRA - New 28kV station in the South 28kV region
- Cyrville upgrade - Addition of capacity to existing 28kV station and convert station supply from 115kV to 230kV
- Bronson DS upgrade CCRA - Conversion from an existing 4kV to a 13kV station in the Core 13kV region
- Removal of equipment limitations such as cables and breakers and/or transformer replacements at Hydro One owned stations of Carling TS, King Edward TS, Lisgar TS
- Switchgear renewals at Hydro One owned stations- Hinchey TH and Russell TB

In total, Hydro Ottawa plans to invest an estimated $45.9M under the CCRA program in the 2026-2030 rate period compared to a historical spending of $17.0M in the 2021-2025 period. The implementation of the Capacity Upgrades program and the CCRA Program will result in an increase of over 811MVA in station capacity to the Hydro Ottawa distribution system.

7.2. PERFORMANCE OUTCOMES

Table 21 outlines the expected performance outcomes associated with the CCRA program supporting the System Capacity program. It details how these programs are expected to impact operational effectiveness, customer focus, and public policy responsiveness measures.

Table 21 - Performance Outcomes for CCRA Program

OEB Performance Outcomes	Outcome Description
Customer Focus	Hydro Ottawa's Customer Focus objectives are supported by: ● Increasing system capacity by 811MVA through new station construction and associated new distribution circuits, upgrades to limiting station cables, and BESS unit installations. ● Improving DER hosting capacity by installing substation transformers that have been designed to accommodate injection of renewable energy into the grid.
Operational Effectiveness	Hydro Ottawa's reliability objectives are supported by: ● Contributing to the improvement of reliability metrics by increasing capacity, especially in capacity-constrained regions that provide alternate supply options during N-1 contingencies.
Public Policy Responsiveness	Hydro Ottawa's Public Policy Responsiveness objectives by: ● Supporting government initiatives for sustainable energy solutions. ● Enabling electrification by investing in additional capacity and operational flexibility.

7.3. PROGRAM DRIVERS AND NEEDS

7.3.1. Main and Secondary Drivers

Primary Driver: System Capital Investment Support.

The primary driver of the CCRA Program is to provide financial support for system capital investments necessary to upgrade and expand the transmission infrastructure. These investments are crucial for maintaining a reliable and resilient electrical grid capable of meeting the growing demand for electricity in the National Capital Region. By setting aside funds through the CCRA, Hydro Ottawa contributes to large-scale transmission projects that enhance grid capacity and functionality. These projects ensure long-term system reliability, while also accommodating future growth, technological advancements, and the evolving energy needs of the region.

Secondary Driver: Capacity constraint.

The secondary driver of the CCRA Program is to address capacity constraints in the transmission system. As Ottawa's population and energy demand increase, the existing transmission infrastructure may become insufficient to meet peak load requirements. Capacity constraints can lead to inefficiencies, reliability risks, and the potential for outages during high-demand periods. Through the CCRA, Hydro Ottawa helps to finance upgrades that alleviate these constraints, ensuring that the community's electricity needs are met without compromising grid stability or service quality. This proactive capacity management supports economic growth and urban development in the city.

7.3.2. Current Issues

Hydro Ottawa has seen an increase in large load requests, driven by the increasing need for electrification to achieve decarbonization targets. These requests, spanning from 5 MVA to 57 MVA, underscore the growing demand on the distribution system. Please see further details in Section 5.1 of Schedule 2-5-4 - Asset Management Process.

It has become increasingly important to build enough transmission capacity to be able to meet the forecasted load growth. The increase in planned transmission upgrades in the 2026-2030 period will dictate Ottawa's ability to meet the needs of the community.

Hydro Ottawa needs immediate capacity upgrades to address current system limitations and meet growing demand. The need for additional upgrades by 2030 is detailed in Section 9.1 of Schedule 2-5-4 - Asset Management Process, and the projects to address these needs are discussed in Section 2 of Schedule 2-5-8 - System Service Investments. Without these investments, the existing distribution system may not be able to meet future demand or service obligations. These capacity upgrades will also necessitate transmission upgrades to ensure sufficient capacity within the provincial grid.

The investment needed to build enough capacity in the transmission system is discussed by the Integrated Regional Resource Planning working group; more details of which can be found in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

7.4. PROGRAM BENEFITS

7.4.1. Operation Efficiency and Cost Effectiveness

The CCRA Program enhances operational efficiency by ensuring timely transmission upgrades that support the observed growth in electricity demand. By addressing capacity constraints proactively, Hydro Ottawa minimizes the risk of system failures caused by overloading and stressing equipment leading to costly emergency repairs, optimizing the overall reliability and efficiency of grid operations. Additionally, investing in infrastructure through the DCF model helps to balance the costs of upgrades with long-term revenue, ensuring cost-effective capital deployment.

7.4.2. Customer

The CCRA program ensures that Hydro Ottawa customers receive reliable and uninterrupted service by preventing outages caused by transmission constraints. By contributing to infrastructure upgrades, the program supports the National Capital Region’s growing electricity demand, maintaining service quality and grid stability. This commitment to meeting customer demand fosters trust and improves customer satisfaction, as residents and businesses can rely on consistent energy availability.

7.4.3. Safety

Transmission system upgrades funded through the CCRA program enhance safety by ensuring that the grid operates within its designed capacity, reducing the risk of overloads or failures that could lead to hazardous conditions, such as fires, equipment damage, or outages. A well-maintained and updated transmission infrastructure ensures the safe delivery of electricity to homes, businesses, and critical institutions.

7.4.4. Coordination and Interoperability

The CCRA Program enhances both coordination and interoperability between Hydro Ottawa, Hydro One, and the broader provincial grid. By facilitating close collaboration on transmission upgrades, the program ensures that infrastructure improvements are aligned with both local and provincial energy strategies. This cooperation optimizes the integration of systems, ensuring smooth energy flow across interconnected networks. Upgrades funded through the CCRA program also ensure that the transmission system remains fully compatible with Ontario's larger grid, preventing bottlenecks and disruptions. By fostering effective coordination and maintaining high levels of interoperability, the program enhances the overall reliability and efficiency of the electricity supply.

7.4.5. Economic Development

By ensuring adequate transmission capacity to meet the community's growing energy needs, the CCRA program directly supports economic development. Reliable energy infrastructure is crucial for attracting businesses, supporting new residential developments, and sustaining the growth of key industries in the region. The program contributes to creating a stable environment for investors and developers, fostering job creation and economic prosperity in the city.

7.4.6. Environment

The CCRA program enables Hydro Ottawa to support transmission upgrades that incorporate environmentally-friendly practices and technologies, such as increased integration of renewable energy sources. By ensuring the grid can handle clean energy inputs and operate more efficiently, the program enables efforts to reduce the carbon footprint of the energy sector. Additionally, by avoiding overloading and inefficiencies, the program helps to reduce energy losses, leading to a more sustainable and eco-friendly electricity system

7.5. PROGRAM COSTS

Table 22 provides the historical, bridge and test year spending in the CCRA program.

Table 22 - CCRA Program Expenditures ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CCRA Payments	$ 16.9	$ (2.3)	$ (3.8)	$ 1.7	$ 4.4	$ 18.0	$ 1.3	$ 8.5	$ 17.1	$ 0.9
TOTAL	**$ 16.9**	**$ (2.3)**	**$ (3.8)**	**$ 1.7**	**$ 4.4**	**$ 18.0**	**$ 1.3**	**$ 8.5**	**$ 17.1**	**$ 0.9**
5-YEAR TOTAL					**$ 17.0**					**$ 45.9**

The annual spend for CCRA payments is expected to average $9.2M over the 2026-2030 rate period, which is an increase from the $3.4M average spend during the 2021-2025 timeframe. The greater spend is primarily driven by the increase in capacity projects required through Hydro Ottawa's System Service Investment Category, as detailed in Section 2 of Schedule 2-5-8 - System Service Investments, leading to additional transmission connection projects and costs.

The following is a list of transmission connections to new stations and Hydro One stations cable upgrades/switchgear renewals:

- **Transmission connections to new stations:**
    - Mer Bleue Station CCRA - New 28kV station in the East 28kV region
    - Hydro Road Station CCRA - New 44kV station in the 44kV region
    - Greenbank Station CCRA - New 28kV station in the South 28kV region
    - New Kanata North Station CCRA - New 28kV station in the West 28kV(North) region
    - New Bronson Station CCRA - Conversion from an existing 4kV to a 13kV station in the Core 13kV region
    - Cyrville MTS upgrade CCRA - New 230kV connection to 28kV station in the East 28kV region
- **Hydro One stations cable upgrades:** Removal of equipment limitations such as cables and breakers and/or transformer replacements at Hydro One owned stations of Carling TS, King Edward TS, Lisgar TS

- Hydro One stations switchgear renewals- Hinchey TH (switchgear), Russell TS (transformer+switchgear)

7.5.1. Cost Factors

Multi-year project considerations: This program will be subject to inflationary increases in costs that may impact Hydro Ottawa's contribution through the DCF mechanism.

Transmission Cost: Due to the transmission upgrade requirements, costs would be determined through the CIA and SIA process. While CCRAs are finalized for each project there may be increases to the cost estimates considered at this time.

Transmission line upgrade Cost: The requirement for the Cyrville MTS, New Kanata North Station, and Greenbank Station transmission line upgrades have been determined through the Integrated Resource Planning Process (IRRP). However, the cost and cost-sharing arrangements for these upgrades have not yet been determined and are therefore not included in the current forecast.

7.6. ALTERNATIVES EVALUATION

7.6.1. Alternatives Considered

Alternative One: Continue with CCRA funding to complete ongoing projects from the 2021-2025 rate period with no additional investments in the 2026-2030 rate period. In this alternative, the investments required would be CCRA payments for four new stations: 44kV Hydro Station, Brian Coburn, Piperville and Kanata North.

This "do nothing" alternative involves Hydro Ottawa opting not to contribute funds towards the CCRA program after 2025, effectively postponing or avoiding the required transmission upgrades. This approach is not recommended, as it would create increasing capacity constraints in the transmission network, risking insufficient supply to meet the National Capital Region's growing electricity demand. Over time, the lack of investment in critical infrastructure could lead to grid instability, potential outages, and an inability to accommodate new developments or economic growth.

Failure to invest in transmission upgrades would jeopardize Hydro Ottawa's ability to meet its service obligations to customers and maintain compliance with regulatory standards. This approach will likely result in most regions' capacity lagging behind growth, leading to station loads exceeding planning ratings and an inability to connect new customers or support service upgrades/new connections due to customer growth and increased demand as the National Capital Region navigates the road to a decarbonized future.

In this alternative, 10 out of 18 planning regions will be operating above the planned capacity by 2035 based on the IRRP forecast. This will impact Hydro Ottawa's system accessibility and hinder the ability to connect new customers, especially with an increase in large load requests driven by decarbonization goals.

Alternative Two: Provide CCRA funding for new projects to build transmission capacity in the 2026-2030 rate period in addition to the ongoing projects from the 2021-2025 rate period. The investments required in this alternative are:

- Six new stations: CCRA Payment for 44kV Hydro Road, Mer Bleue, Piperville, Kanata North, Bronson 13kV, Greenbank Station
- Five Existing Station Upgrades: Cyrville (full station), King Edward (Hydro One-Sec cable), Lisgar (Hydro One-sec cable), Carling (Hydro One-sec cable), Russell (Hydro One-transformer+SWG renewal)

7.6.2. Preferred Alternative

The recommended approach is Alternative Two, which aligns with the proposed station capacity upgrades discussed in Section 2 of Schedule 2-5-8 - System Service Investments. This approach ensures that Hydro Ottawa remains ahead of capacity constraints, enabling necessary system enhancements in collaboration with Hydro One. By investing in the DCF mechanism, Hydro Ottawa can mitigate risks associated with capacity limitations in the transmission system.

This strategy helps Hydro Ottawa to fulfill its service obligations, support future growth, and avoid the operational and financial repercussions of an underfunded grid infrastructure. In this alternative, only one of the 18 planning regions will operate above the planning capacity by 2035 based on the IRRP forecast.

7.7. PROGRAM EXECUTION AND RISK MITIGATIONS

7.7.1. Implementation Plan

The timelines for Capacity Upgrades, outlined in Schedule 2-5-8 - System Service Investments, and System Expansion, outlined in Schedule 2-5-6 - System Access Investments, align with the CCRA program implementation plan. Sections 2.3.2 and 2.6.1 of Schedule 2-5-8 - System Service Investments and Sections 4.3.2 and 4.6.1 of Schedule 2-5-6 - System Access Investments, detail the critical system needs and alternative considerations, respectively, that informed the assessment of CCRA payments to be executed between 2026 and 2030. The proposed projects for the 2026-2030 rate period, requiring payments to Hydro One through the CCRA as part of the Capacity Upgrade program, are listed in Table 23.

Table 23 - Proposed Projects under the Station Renewal Program

Year	Proposed Projects
2026	● Mer Bleue TS CCRA ● Greenbank TS CCRA ● New Kanata North TS CCRA ● Carling TS secondary cable upgrade CCRA ● Hinchey TH switchgear Replace CCRA ● Lisgar TS secondary cable upgrade ● Russell TS transformer replacement CCRA
2027	● Hydro Road TS CCRA
2028	● New Bronson 13kV CCRA ● Cyrville station upgrade CCRA
2029	● King Edward secondary cable upgrade CCRA ● Russell TB Switchgear Renewal CCRA
2030	● Russell TB Switchgear Renewal CCRA

7.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its CCRA Program. Table 24 identifies the key risks and corresponding mitigation strategies.

Table 24 - Key Risks for the CCRA Program and Mitigation Strategies

Category	Risk	Mitigation
Transmitter	The transmitter may experience construction and design delays due to competing priorities and limited resources, which could affect the timely completion of Hydro One-owned station upgrades. These upgrades are necessary to optimize station capacity, particularly in the Downtown Core.	Hydro Ottawa will collaborate closely with Hydro One, offering the necessary support to ensure project timelines are met. Monthly planning meetings and quarterly project meetings are scheduled throughout the year.
Approval delays	The time required to obtain approval from IESO and other federal and provincial bodies (such as National Capital Commission, etc) for some of the transmission upgrades may impact project timing.	Early coordination with IESO and other federal and provincial bodies to ensure timely submission and approval of requests.

7.8. LEAVE-TO-CONSTRUCT (IF APPLICABLE)

Section 92 of the OEB Act, 1998, pertains to the assessment of the need for and the benefits of proposed energy projects in Ontario. Specifically, it requires that any entity seeking to construct or expand electricity or natural gas facilities must obtain approval from the OEB. In this assessment, the OEB evaluates several factors, including need for the project, economic and environmental impacts, cost-benefit analysis and alternative solutions. The goal is to ensure that any new energy infrastructure is necessary, economically viable, and aligns with the province's energy policies and objectives. For the transmission upgrade projects of the New Kanata North station, Greenbank station, Cyrville upgrade and Bronson 13kV upgrade this assessment will likely be required.

8. INFRASTRUCTURE AND CYBER SECURITY

8.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $7.8M (CAPEX)

2026-2030: $12.0M (CAPEX) and $1.0M (OM&A)

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Business growth and scalability, Operational Efficiency, Regulatory Compliance, Technology Advancements, Risk Management

Outcomes: Operational Effectiveness, Customer Focus

As Hydro Ottawa has outlined in Attachment 1-3-4(B) - Digital Strategy, Utilities are experiencing “exponential growth and connectivity of electronics and information technology.” The evolution toward digital solutions creates opportunities for new service offerings and energy integration, but also increases exposure to cyber security risks. Though this migration provides opportunities for Hydro Ottawa’s entire customer base of approximately 364,000 customers to leverage new services, Hydro Ottawa has a duty to ensure that cyber security risks are identified, both on-premise and in the cloud, analyzed and mitigated to ensure that risks are maintained at acceptable levels. The Canadian Centre for Cyber Security (CCCS) has highlighted in their most recent 2024 Update: The Cyber Threat to the Energy Sector, with Mitigation Guidelines, that cybercrime remains the top cyber threat to the energy sector, and state-sponsored actors view the energy sector in Canada as a strategic target, especially in times of geopolitical tension which the sector has been experiencing since 2022 with no signs of dissipating. These ongoing threats as part of the cyber security landscape are evidence of the need for improvements and focus in cyber security. In addition, Hydro Ottawa’s IT infrastructure will require continuous enhancements to ensure it supports these new services and it stays current and relevant to the new demands. It is crucial to avoid being out of vendor support and to minimize the potential threat and risks of the ever-changing threat landscape. The OEB continues to further enhance the Ontario Cyber Security Framework and this will lead to cyber security compliance obligations that have not been present to-date for distribution entities.

Throughout the rate application cycle, different elements of Hydro's Ottawa IT and OT infrastructure will require either upgrades or transformation including its server virtualization environment, network segmentation, corporate backup system, SAN storage, switching and firewall equipment, meeting rooms technology, wireless infrastructure, data center, corporate telephony, application servers, secure remote access and the monitoring and performance technologies that oversee the network. Employee computing devices such as notebooks, their peripherals as well as mobile devices will further require continuous upgrades. Hydro Ottawa's cyber security technology stack will undergo upgrades and transformation throughout the rate app cycle. Current technology investments pertaining to detectability and preventability capabilities including network traffic analysis, application endpoint control, endpoint detection and response, patch and vulnerability management, networking proxies and email security will also need to go through technology upgrades.

Additionally, as Hydro Ottawa is looking to transform how it monitors and responds to network and cyber security events, investment in predictability-focused solutions will help ensure resilience is at the forefront in its technology footprint to ensure that response and recovery are seamless and meet the business objectives. Continuous investments are planned to unlock efficiencies through automation and orchestration of current processes in order to improve the network and system capabilities. Hydro Ottawa recognizes the industry shift in the energy sector and these investments will help to support customer demands for electrification and grid modernization impacting future Regulatory requirements.

8.2. PERFORMANCE OBJECTIVES AND TARGETS

Enhancing the Infrastructure and Cyber Security programs will help accelerate the performance objectives and targets as shown in Table 25:

Table 25 - Performance Objectives and Targets

Performance Outcome	Target
Operational Effectiveness	• Ensure IT Infrastructure meets business requirements and provides best in class service.
	• Ensure IT infrastructure remains up to date and current and does not fall in end of life support.
	• Ensure cyber security technology stack can detect and protect against threats in real-time and that the residual risk is managed appropriately
	• Strengthen cyber security defenses and safeguard sensitive information from threats and vulnerabilities.
	• Continue to address the changing threat landscape against cybercrime and state sponsored entities due to geopolitical tension.
	• Ensure technology stack is able to recover appropriately to a cyber security event such as ransomware.
	• Improve internal workflows to allow focus on more meaningful work.
Customer Focus	• Protect Hydro Ottawa brand image and reputation.

Establishing KPIs and Key Risk Indicators (KRIs) for the entire program will help manage the risks and contain impacts within acceptable targets. This will further help ensure the overall program objectives are being tracked and measured. Below is a snippet of some KPIs and KRIs examples that could be used to manage overall program and operational effectiveness:

Figure 1 - Infrastructure and Cyber Security KPIs & KRIs

Operational Effectiveness -KPI & KRIs	Current Month	Q1	Q2	Q3	Q4	Outlook	Trending	Actual	Target
Network and Service Uptime	●	●	●	●	●	●	→		
% of Systems that are Vendor Supported (not EOL)	●	●	●	●	●	●	→		
% of Systems that are Current	●	●	●	●	●	●	→		
Overall Cyber Security Program Health	●	●	●	●	●	●	→		
Corporate Risk (3rd Party Monitoring) Score	●	●	●	●	●	●	→		
CSC Top 20 Maturity Score	●	●	●	●	●	●	→		
Average of Active Critical Risks are < 270 Days	●	●	●	●	●	●	→		
Cyber Insurance Premiums annual increase	●	●	●	●	●	●	→		
Servers Security OS Patched	●	●	●	●	●	●	→		
SCADA OT Assets Patched	●	●	●	●	●	●	→		
% Servers Unresolved Vulnerabilities > 90 Days	●	●	●	●	●	●	→		
% Unpatched Workstations > 90 Days	●	●	●	●	●	●	→		
Mean-Time-to-Patch (3rd Party Apps) is Within SLA	●	●	●	●	●	●	→		
% of Assets with Security Agents Installed	●	●	●	●	●	●	→		
OT Stations Health	●	●	●	●	●	●	→		
Security Health of Public Sites	●	●	●	●	●	●	→		
Corporate Anti-Phishing Campaign CTR	●	●	●	●	●	●	→		
Targeted Anti-Phishing Campaign CTR	●	●	●	●	●	●	→		
% of Completion Awareness Training	●	●	●	●	●	●	→		
% of Contractors Completed Attestation	●	●	●	●	●	●	→		
% of assets monitored (MSSP)	●	●	●	●	●	●	→		
% of use cases implemented (MSSP)	●	●	●	●	●	●	→		
MTTR - ServiceNow Incident Tickets	●	●	●	●	●	●	→		

8.3. PROGRAM DRIVERS AND NEED

8.3.1. Main and Secondary Drivers

Primary Driver: Business operations support

Secondary Drivers:

- Business growth and scalability: Ensure alignment with business initiatives and objectives.
- Operational Efficiency: More automations, orchestration and integrations with other systems, new and modernized functionality.
- Regulatory Compliance: Meet all applicable OEB compliance obligations for cyber security.
- Technology Advancements: Ensure technology continues to drive business services.
- Risk Management: Enhance infrastructure and technology stack to improve reliability, ensure resilience, business continuity and disaster recovery through robust cyber security practices to minimize vulnerabilities, safeguard information and critical assets.

8.3.2. Current Issues

Technical Upgrades

Hydro Ottawa's current IT infrastructure and the various technologies that support it has a traditional lifespan of anywhere from three to five years. It's imperative that throughout this lifecycle, the technologies are running the latest supported iterations, are patched to acceptable levels, and are configured to industry standard baselines with security built-in. They must be continuously monitored to detect anomalies so that any threats can be identified and remediated instantaneously and, ideally, automatically. The threat landscape to the utility sector continues to expand and evolve, as defined by the Canadian Centre for Cyber Security in their National Cyber Threat Assessment 2025-2026 (NCTA)[2], so Hydro Ottawa must ensure that the risk to the attack surface is managed, particularly as new services, connections and integrations are introduced. In order for this to occur, technical upgrades are required to mitigate any threats and risks that target Hydro Ottawa across all business applications. Adversaries will continue to

[2] Canadian Centre for Cyber Security, "National Cyber Threat Assessment 2025-2026", https://www.cyber.gc.ca/sites/default/files/national-cyber-threat-assessment-2025-2026-e.pdf

target systems that are not up to date or running legacy technologies.

IT Infrastructure and Operations

In order to maintain a secure infrastructure, Hydro Ottawa requires funding to:

- Maintain IT and OT infrastructure by keeping it current so that it remains in a supported state, ensuring it continues to deliver on organizational services and aligns to industry standards and best practices.
- Ensure that notebooks, PCs, peripherals, mobile devices are inventoried, tracked, running the necessary software and replaced on an appropriate lifecycle.
- Streamline operations by automating time-consuming manual processes, allowing staff to focus on higher-value activities.

8.4. PROGRAM BENEFITS

8.4.1. Reliability and Aging Infrastructure

Upgrades to the infrastructure and cyber security technology stacks allows Hydro Ottawa to keep pace with technology, mitigate risks and ensure sustained operational excellence.

8.4.2. Cyber Security

As the threat landscape continues to evolve, it's imperative that Hydro Ottawa's infrastructure is able to detect and prevent attacks from occurring.

8.4.3. Regulatory Compliance

Enable Hydro Ottawa to respond and implement Regulatory changes related to cyber security.

8.4.4. Grid Modernization

Upgraded infrastructure to support the demands of grid modernization and increase in data flows and frequency.

8.4.5. Productivity and Innovation

Upgrades will ease adoption of future business requirements.

8.4.6. Digitization and Technology Evolution

Introduce more automation and self-serve options leveraging new technologies such as AI and machine learning.

8.5. PROGRAM COSTS

Table 26 details the historical, bridge and test year spending for the Infrastructure and Cyber Security Program.

Table 26 - Historical, Bridge and Test Year Infrastructure and Cyber Security ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 1.7	$ 2.1	$ 2.4	$ 2.9	$ 1.9	$ 2.6	$ 2.5	$ 2.2	$ 3.7	$ 4.4
OM&A	-	-	-	-	-	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2
GROSS SPEND	**$ 1.7**	**$ 2.1**	**$ 2.4**	**$ 2.9**	**$ 1.9**	**$ 2.8**	**$ 2.7**	**$ 2.4**	**$ 4.0**	**$ 4.6**
Capital Contributions	$ (0.5)	$ (0.2)	$ (0.4)	$ (1.1)	$ (1.0)	$ (0.6)	$ (0.8)	$ (0.9)	$ (0.7)	$ (0.5)
NET SPEND	**$ 1.3**	**$ 1.9**	**$ 1.9**	**$ 1.8**	**$ 0.9**	**$ 2.2**	**$ 1.8**	**$ 1.5**	**$ 3.3**	**$ 4.1**
5-YEAR TOTAL					**$ 7.8**					**$ 13.0**

8.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations for the technical upgrades and utilizes knowledge of past projects, vendor agreements, insights and upcoming projects to inform the budget. The increased projected spend in 2029 and 2030 is for hardware upgrades for firewall appliances for both its main and secondary data centres. It's crucial to acknowledge the potential impact of unknown regulatory pressures, which could introduce additional unanticipated development costs.

As the OEB CSF continues to evolve with additional requirements, development costs are expected to increase, but the timing cannot be anticipated. Finally, the scope of projects may expand due to emerging business requirements, change in direction from vendors, which can result in unaccounted for expenses.

8.6. ALTERNATIVES EVALUATION

Infrastructure is at the core of a network and system topology; without an infrastructure, it is not possible to interconnect networks, systems, appliances, applications and users. It is the foundation of technology and is the cornerstone for business applications to operate.

Hydro Ottawa's business objectives and key strategic investment priorities such as Grid Modernization and Enhancing Grid Resilience are fully dependent on a robust and modern infrastructure. In order to achieve this, technology risks must be adequately managed, appropriate funding available, technical resources in place and an ecosystem of partners to collaborate on network design, implementation and maintenance. Throughout the product lifecycle, ensuring seamless operations and continuous improvement is paramount.

Hydro Ottawa recognizes the importance of maintaining its core infrastructure. Given the critical role in supporting all business functions, investing in infrastructure upkeep and enhancements is imperative for sustaining operational efficiency, reducing cyber security risk, and meeting demand from organizational growth.

8.6.1. Alternatives Considered

Alternative One - Do Nothing: Run to failure and address issues as they arise. The consequences of failing to prioritize and invest in the Infrastructure and Cyber Security program could be devastating for the organization. Without adequate funding, Hydro Ottawa could experience increased system failures, service downtime, operational inefficiencies, and cyber security breaches, including threats. Prioritizing funding and investment in system maintenance and enhancements will mitigate these risks, minimizing the chances that Hydro Ottawa will suffer a security breach or IT failure that could have catastrophic consequences for customers' electrical supply.

Alternative Two - Maintain: Perform minimal updates and only when products reach end-of-life. While this alternative addresses the greatest risks for cyber security and obsolescence, it will not allow Hydro Ottawa to keep pace with the growth and transformation of its business, negatively impacting productivity and efficiency.

Alternative Three - Recommended Approach: Implement the program as described in Section 8.1 - Program Summary.

Risks associated with Alternatives One and Two, and their direct impact, are further detailed in Table 27.

1 **Table 27 - Infrastructure and Cyber Security Program Alternatives Risks and Impacts**

Risk Category	Risk	Impact
Operational, Financial, Cyber Security	Delayed Refresh of Assets Driving Risks Associated with Software and Hardware Obsolescence	Increased maintenance costs, decreased system reliability, heightened cyber threats, system failures, data breaches, business disruptions, impacting customer satisfaction and revenue.
Operational, Business	Negatively Impact the Ability of Employees to Support Business Outcomes	Hindered ability to leverage business applications, missed opportunities, operational inefficiencies, decreased competitiveness.
Operational	Decreased Productivity Due to Prolonged Applications/Systems Gaps	Impeded workflow automation, collaboration, decision-making processes, manual workarounds, data discrepancies, project delivery delays, diminished productivity and efficiency.
Financial, Operational	High Unit Cost of Supporting and Servicing Applications	Escalated support costs, increased reliance on reactive measures, strained IT resources, inflated operational expenses, diversion of funds from strategic initiatives towards out of support maintenance costs
Operational, Vendor	Limited Vendor Support	Reduced access to updates, patches, technical assistance, prolonged issue resolution times, exacerbated system vulnerabilities, hindered adaptation to changing business needs.
Cyber Security, Regulatory	Lack of IT Security Controls	Heightened cyber security risks, data breaches, ransomware attacks, regulatory non-compliance, damaged reputation, eroded customer trust, financial losses, legal liabilities.
Operational, Business	Loss of System Integration and Data Consistency	Challenges in system integration, fragmented data silos, hindered communication between systems, reduced visibility, impacted decision-making, reduced business agility.
Financial, Operational	Risk of Project Delays and Cost Overruns	Project delays, cost overruns, missed deadlines, unmet business requirements, stakeholder dissatisfaction, affected project success, and realization of benefits.
Operational, Financial	Compromised Business Continuity and Disaster Recovery	Vulnerability to data loss, prolonged downtime, financial losses due to inadequate system maintenance and disaster recovery mechanisms.
Business, Strategic	Diminished Innovation and Adaptability	Stifled innovation, hindered ability to adapt to market trends, missed opportunities for differentiation and growth, impacted long-term sustainability and relevance.
Operational, Technical	Increased Operational Complexity and Technical Debt	Accumulation of technical debt, hindered system performance, scalability, maintainability, increased future upgrade costs and effort, reduced agility.

8.6.2. Evaluation Criteria

Cyber Security

This criterion assesses the impact of the alternative on Hydro Ottawa's cyber security risks. As the provider of a critical service in the National Capital Region, Hydro Ottawa is a high-risk target for cyber attacks and must ensure that its digital systems have robust threat protection.

Technical Feasibility

This criterion evaluates the alternative's commercial availability, interoperability, and long-term availability. The systems of the Infrastructure and Cyber Security program are integral to the day-to-day operations of Hydro Ottawa and must be capable of evolving alongside the dynamic landscape of the business itself.

Cost Effectiveness

This criterion analyses the impact of the alternative and looks to identify the most cost-effective means of meeting requirements.

Operational Efficiency

This criterion considers the alternative's ability to position Hydro Ottawa to respond to the dynamic needs of its employees and business operations in an efficient manner.

8.6.3. Preferred Alternative

Alternative Three: Implement the program as described in Section 8.1 - Program Summary.

8.7. PROGRAM EXECUTION AND RISK MITIGATIONS

8.7.1. Implementation Plan

Hydro Ottawa's Infrastructure and Cyber Security program will go through technology upgrades and enhancement throughout the rate application period. The intention is to ensure that the infrastructure remains modern, up to date, and supports business deliverables all while ensuring cyber security threats are identified and mitigated with the proper set of detective and protective controls in place.

As many key business initiatives continue to drive innovation and change over the next five years, Hydro Ottawa's infrastructure must be able to support the technological requirements and demand. The Infrastructure and Cyber Security program is focused on implementing these technology upgrades and enhancements. Below is a list of key upgrades and enhancements to be included in this Application:

- Hydro Ottawa will modernize its IT infrastructure by implementing a virtualization environment, migrating workloads to the cloud, increasing data storage capabilities, and updating its corporate telephony system.
- To ensure the network continues to be segmented based on business functions, to support grid modernization, and to reduce the likelihood of risk against malware propagation (i.e. ransomware), it will continue to go through a segmentation effort.
- Smart switching and next generation firewalls will continue to evolve and upgrades of current infrastructure will be required in order to sustain the demand and changing requirements.
- A secondary data centre that is geographically distant from the primary one mitigates the threat of system failure if one centre is compromised by an extreme weather event.
- Managed security information and event management (SIEM) expansion. The intent is to have 100% of the applications to be ingested into Hydro Ottawa's managed SIEM.
- Both detective (identifying threats) and protective (preventing threats) cyber security controls require periodic updates to be productive against the latest threats. Workflows will be automated to increase efficiencies and reduce the mean time between detection and recovery.
- Patch and vulnerability management plays a crucial role in maintaining the security and integrity of IT systems. Effective patch and vulnerability management practices help ensure system stability, reduce security breaches, and enhance overall cyber security posture.

- In the event of a cyber attack, cyber recovery solutions will assist the organization in minimizing the impact and recovery to meet organizational recovery time objectives.
- Zero trust architecture. Hydro Ottawa is adopting a zero trust architecture model and will require appropriate technology to ensure it's implemented correctly.
- Regulatory enhancements as per the Ontario Cyber Security Framework (OCSF).

8.7.2. Risk to Completion and Risk Mitigation Strategies

Table 28 details the key risks and mitigation strategies for the Infrastructure and Cyber Security program.

Table 28 - Key Risks for the Infrastructure and Cyber Security Program and Mitigation Strategies

Risk	Mitigation
Resources	Resources allocation will be performed to ensure Hydro Ottawa delivers on the projects set to complete.
Prioritizing projects	Projects will be prioritized based on upgrade requirements to ensure no services are at end of life.

9. TOOLS REPLACEMENT

9.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $3.2M

2026-2030: $4.9M

Budget Program: Tools Replacement Budget Program

Main Driver: System Investment Support

Secondary Driver: System Maintenance Support

Outcomes: Operational Effectiveness, Financial Performance

This program ensures that frontline crews have access to the necessary tools and equipment to efficiently and effectively execute distribution maintenance and capital programs. It addresses the replacement of aging and worn tools, which are essential for safe and reliable operations. These tools are used by various frontline personnel, including linemen, cable splicers, technicians, and other field staff involved in the construction, maintenance, and repair of the electrical distribution system. The program encompasses a wide range of tools and equipment, falling into the following general categories:

- Safety Equipment: This includes safety devices such as automated external defibrillators (AEDs), gas monitors and detectors, first aid kits, fire extinguishers, fall protection systems such as harnesses and lanyards, rescue equipment and other equipment used to ensure the safety of crews and the public.
- Hand Tools: This category covers a variety of hand tools, both manual and powered, including crimpers, cutters, saws, drills, impact wrenches, and torque wrenches.
- Power Equipment: This includes chainsaws for vegetation management, generators and inverters for providing power on job sites, and hydraulic equipment for heavy-duty tasks.
- Testing and Measurement Equipment: This encompasses various electronic instruments used for testing, regulatory metering validation, and troubleshooting electrical systems, such as multimeters, megger testers, and ground testers.

- Specialized Equipment: This includes tools specific to electrical work, such as hot sticks for working on energized lines, temporary grounds and jumpers for de-energized work, and specialized equipment for working with underground cables and equipment.
- Support Equipment: This category includes items that support field operations, such as hoists for lifting and pulling, ladders for accessing elevated work areas, pumps for removing water, and ground reels for managing grounding cables.

The requested budget for the 2026-2030 rate period represents an increase compared to the 2021-2025 actual spend of $3.2M. While the budget originally approved for 2021-2025 was $2.3M, actual expenditures were $3.2M, primarily due to a higher than anticipated number of tools reaching end-of-life, the purchase of new defibrillators for fleet vehicles, and the Customer Battery Pilot program (initiated during the COVID-19 pandemic). The 2026-2030 budget request of $4.9M reflects the continued need to replace aging tools, increased tool requirements due to anticipated workforce growth and corresponding fleet growth, and the need to maintain a modern and safe tool inventory. For more information on Hydro Ottawa's anticipated workforce growth, please refer to Attachment 4-1-3(C) - Workforce Growth.

Tools are replaced based on a combination of factors, including age, condition, usage, calibration, and safety considerations. Regular inspections are conducted to identify tools that are worn, damaged, or no longer functioning correctly. Some tools have a predetermined lifespan or replacement schedule, but feedback from frontline crews is also considered when determining the need for tool replacement.

Tools are typically stored in centralized tool cribs at various facilities and are distributed to staff as needed. This centralized system allows for better inventory management and ensures that tools are properly maintained and readily available. However, some specialized or frequently used tools may be assigned to individual crews or vehicles for increased efficiency.

9.2. PERFORMANCE OUTCOMES

Table 29 outlines the expected performance outcomes associated with the Tools Replacement program.

Table 29: Performance Targets for Tools Replacement Program

OEB Performance Outcome	Target
Operational Effectiveness	Expenditure on tools supports Hydro Ottawa's overall achievement of operational effectiveness by providing the organization the proper resources required to sustain operations in an effective and efficient manner.
Financial Performance	The tools replacement program serves the overall financial performance of the organization by ensuring expenditures on tools are necessary, responsible, and in support of operational effectiveness.

9.3. PROGRAM DRIVERS AND NEED

9.3.1. Main and Secondary Drivers

Primary Driver: Business operations efficiency drives the need to purchase tools that support the day-to-day business and operations activities. As tool equipment ages, it must be replaced to sustain operations across the business. Tools are used for all critical elements of operations including construction, metering, distribution design, system operations, stations, and health and safety. Outdated or poorly-maintained tools can lead to delays, errors, and safety hazards

Secondary Driver: System maintenance support relies on the availability of appropriate and effective tools. Crews need reliable tools to perform maintenance and repairs quickly and efficiently, minimizing system downtime and service interruptions.

9.3.2. Current Issues

While there are no "program-level" current issues, individual tools are regularly assessed for condition and replaced as needed. This program proactively addresses tool replacement to prevent future issues related to tool availability, performance, and safety. A proactive replacement strategy minimizes disruptions caused by unexpected tool failures.

9.4. PROGRAM BENEFITS

This program ensures that distribution maintenance and capital programs are equipped with the tools necessary to be carried out efficiently, effectively, and safely. This translates to improved service reliability, faster response times, and a safer working environment for crews.

9.5. PROGRAM COSTS

Table 30 details the historical, bridge and test year spending for the Tools Replacement Program.

Table 30 - Tools Replacement Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Tools Replacement Budget Program	$ 0.7	$ 0.6	$ 0.4	$ 0.9	$ 0.6	$ 0.8	$ 1.0	$ 0.9	$ 0.9	$ 1.3
5-YEAR TOTAL					**$ 3.2**					**$ 4.9**

9.5.1. Cost Factors

The primary factors in determining the future spend for tools replacement was headcount and inflation. Increased operational headcount is outlined in Attachment 4-1-3(C) - Workforce Growth and includes the requirement to outfit both employees and vehicles with the necessary tools to do their job safely.

9.6. ALTERNATIVES EVALUATION

9.6.1. Alternatives Considered

Alternative One - Do Nothing: Run to failure. This approach minimizes upfront capital costs but risks increased downtime, reduced reliability, and potential safety hazards due to aging and poorly maintained tools. It can lead to higher long-term costs due to emergency replacements and lost productivity.

Alternative Two - Planned Replacement: This approach balances cost and performance by proactively replacing tools based on condition, usage, and age. It aims to optimize tool lifespan and minimize disruptions while maintaining a safe and efficient working environment.

Alternative Three - Accelerated Replacement: This approach replaces tools more frequently than necessary, resulting in higher capital expenditures. While it might offer some benefits in terms of tool availability, it does not optimize tool lifespan or minimize overall costs.

9.6.2. Evaluation Criteria

The alternatives were evaluated based on:

Safety: Impact on worker safety.

Reliability: Impact on tool availability and performance.

Cost-effectiveness: Long-term cost of tool ownership, including maintenance, repair, and replacement.

Efficiency: Impact on crew productivity and task completion time.

9.6.3. Preferred Alternative

The preferred alternative is Alternative Two: Planned Replacement. This approach offers the best balance of safety, reliability, and cost-effectiveness. It ensures crews have access to the tools they need to perform their work efficiently and safely, while also managing costs responsibly.

9.7. PROGRAM EXECUTION AND RISK MITIGATION

9.7.1. Implementation Plan

Tools will be purchased and replaced based on condition assessments, this includes regular inspections and testing of tools to identify those needing replacement.

10. BUILDINGS - FACILITIES

10.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $7.0M

2026-2030: $6.6M

Budget Program: Buildings - Facilities, Net Zero - Facilities Capital

Main Driver: System Investment Support

Secondary Driver: Health and Safety, Net Zero Operations

Outcomes: Operational Effectiveness, Financial Performance

Hydro Ottawa's administration facilities are located at Hunt Club Rd. and Bank St. The Hunt Club Rd. location serves as the Head Office and includes a work center for field operations and storage. The Bank St. facility houses a training center, project office space, and a fleet garage and maintenance center.

Investments in these facilities primarily aim to ensure productivity by maintaining safe, functional and efficient workspaces. This includes replacing aging or failing assets that could create hazards, interrupt business, or hinder operational effectiveness. These investments also support strategic objectives, such as accommodating staff growth as noted in Attachment 4-1-3(C) - Workforce Growth and advancing environmental sustainability goals.

The Buildings - Facilities capital program encompasses a range of improvements, including interior upgrades, exterior enhancements, mechanical and electrical renewals, health and safety enhancements, security upgrades and sustainability initiatives. The following sections detail the types of capital work included:

Electrical Systems:

- **Electrical Service Upgrades:** Upgrading electrical panels and systems to accommodate increased power demands from new equipment or building expansions, ensuring safety and preventing overloads.
- **Lighting Retrofits:** Replacing outdated lighting with energy-efficient LEDs to reduce energy consumption and maintenance costs.
- **Emergency Generator Replacements:** Replacing aging generators to ensure reliable backup power during outages.

HVAC Systems:

- **Chiller Replacements:** Replacing aging chillers with more energy-efficient models to reduce energy consumption and operating costs.
- **Boiler Upgrades:** Upgrading or replacing boilers to improve efficiency and reliability.
- **Air Handler Replacement:** Replacing outdated air handlers to improve indoor air quality, reduce noise levels, and enhance overall system performance.
- **Indoor Air Quality Improvements:** Upgrading HVAC systems with advanced filtration.

Plumbing and Piping:

- **Pipe Replacement:** Replacing corroded or leaking pipes to prevent water damage and maintain water quality.
- **Oil Separator:** Replacement and upgrade.
- **Septic:** Replacement and upgrade.
- **Backflow Preventer Installation:** Installing backflow preventers to protect the potable water supply.

Exterior Improvements:

- **Roofing:** Replacement, restoration, and insulation upgrades to improve energy efficiency and prevent leaks.
- **Siding:** Replacement, renewals, and coating to maintain appearance and weather

protection.

- **Windows and Doors:** Replacement with energy-efficient models and upgrades (e.g., storm windows) to reduce energy costs and improve comfort.
- **Hardscaping (Exterior Grounds):** Paving, retaining walls, and fencing for accessibility, safety, and security.
- **Softscaping (Exterior Grounds):** Irrigation and drainage improvements.
- **Foundation:** Restoration and waterproofing to ensure structural integrity.
- **Exterior Walls:** Restoration and insulation upgrades.

Health and Safety:

- **Fire System Upgrades:** Replacing outdated panels and installing new detectors, sprinkler and suppression systems.
- **Emergency Lighting:** Installing or upgrading emergency lighting fixtures.
- **Access Control Systems:** Installations or upgrades to enhance security.
- **Surveillance Systems:** Installing or upgrading cameras and surveillance systems.
- **Intrusion Detection Systems:** Installing or upgrading to detect unauthorized entry.
- **Emergency Communication Systems:** Installing or upgrading mass notification systems.
- **Emergency Power Systems:** Installing or upgrading backup generators and uninterruptible power supplies (UPS).

Interior Improvements:

- **Ergonomic Enhancements:** Providing ergonomic workstations, furniture, and equipment.
- **Accessibility Improvements:** Installing ramps, elevators, handrails, and other accessibility features to ensure buildings are accessible to people with disabilities.
- **Interior capital improvements:** Includes furniture and equipment for new employees.

Table 31 summarizes the age, book value and size of the Administration facilities.

Table 31 - Administration Building Overview

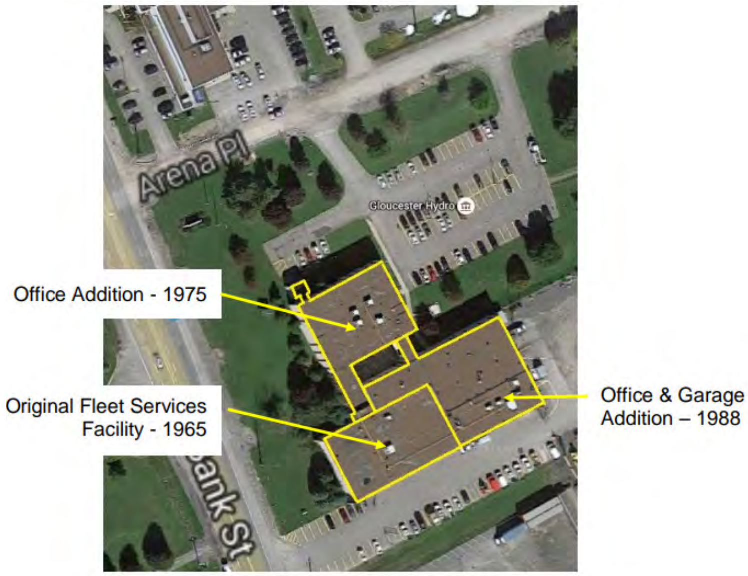
Location	Year Built	Asset Cost	Net Book Value (Dec. 31/23)	Function	Size (sq.ft.)
2711 Hunt Club Rd.	2019	$76.7M	$66.1M	Head Office, Administration, Operations and Storage	185,516
4565 Bank St.	Original Fleet Office - 1965 Office Addition - 1975 Office & Garage addition - 1988	$7.0M*	$4.4M*	Training, Fleet Garage and Storage	101,300

** Excludes disallowed asset value*

See Figures 2 and 3 showing the facilities at 2711 Hunt Club Rd. and 4565 Bank St.

Figure 2 - Head Office and Operations Centre - 2711 Hunt Club Rd.

Figure 3 - Training Centre & Garage - 4565 Bank St



10.2. PERFORMANCE OUTCOMES

Table 32 outlines the expected performance outcomes associated with the Buildings - Facilities Program.

Table 32 - Performance Targets for Buildings - Facilities Program

OEB Performance Outcome	Target
Operational Effectiveness	Provide staff with safe and functional facilities that contribute to a productive and safe work environment. Invest in building improvements and correct deficiencies to address potential safety, compliance and security issues.
Financial Performance	Make optimal decisions regarding capital vs. repair expenditures. Identified expenditures to be within the approved budget amount.
Environment	Reduce greenhouse gas (GHG) emissions related to building operations to support a migration towards the target of achieving net zero emissions.

10.3. PROGRAM DRIVERS AND NEED

10.3.1. Main and Secondary Drivers

Primary Driver: System Investment Support; this program identifies investments required to help ensure that facilities appropriately support the needs of staff to perform work and to protect equipment and materials. Work includes expenditures to remediate poor condition facilities and to address new needs such as growth or expanded work programs.

Secondary Drivers: Provide a safe and efficient work environment that supports OM&A and Capital work programs; Protect the investment in facilities assets by remediating identified deficiencies; Identify opportunities for efficiencies and carbon reduction.

10.3.2. Current Issues

Several key issues are driving the need for capital investment in Hydro Ottawa's facilities:

- Workspace Optimization: While the Hunt Club facility is relatively new and includes space for growth, it requires interior improvements, furniture, and equipment to effectively accommodate planned staff additions and optimize workspace utilization. This includes reconfiguring existing space and purchasing appropriate office furniture and equipment.
- Bank Street Facility Restoration: The Bank Street facility requires building restoration to address issues related to its age. These issues include roofing and foundation as noted in Figures 4 and 5.
- Bank Street Sanitary Sewer Connection: Hydro Ottawa's current sewage holding system at the Bank Street facility is aging, resulting in increasing maintenance costs. Furthermore, the environmental impact of transporting sewage from the facility is not aligned with Hydro Ottawa's sustainability initiatives. The City of Ottawa's planned expansion of the sanitary sewer network in the area presents an opportunity to connect the Bank Street facility to the municipal system, resolving both the maintenance and environmental concerns.

Figure 4 - 4565 Bank St (Water Pooling on Roof)

Figure 5 - 4565 Bank St (Spalling of Concrete Foundation)

10.4. PROGRAM BENEFITS

The benefits associated with expenditures in this program are substantial and contribute directly to Hydro Ottawa's operational effectiveness and employee well-being. These benefits include:

- **Improved Productivity:** Providing safe, functional, and well-configured workspaces enables staff to perform their duties more efficiently. For example, addressing workspace optimization at Hunt Club will ensure that new staff can be integrated seamlessly, minimizing any disruption to ongoing operations. Replacing aging building systems, such as HVAC, reduces downtime and ensures a comfortable working environment, further contributing to productivity.
- **Reduced Risk and Enhanced Safety:** Addressing building deficiencies, such as roof leaks at Bank Street, mitigates safety hazards and prevents costly damage to equipment and materials. Upgrading fire and security systems enhances the safety and security of employees and the facilities themselves.
- **Improved Employee Morale and Retention:** Investing in modern and comfortable workspaces, ergonomic enhancements, and improved indoor air quality contributes to a positive work environment, boosting employee morale and supporting staff retention.
- **Cost Savings:** While the program involves capital expenditures, it also generates long-term cost savings. For instance, replacing aging HVAC systems with more energy-efficient models reduces energy consumption and lowers operating costs. Preventative maintenance and timely replacements can also prevent more costly repairs or replacements down the line.
- **Enhanced Operational Efficiency:** Upgrading building systems, such as electrical service upgrades, supports the efficient operation of equipment and prevents disruptions caused by outdated or inadequate infrastructure. Connecting the Bank Street facility to the city sewer system will eliminate the increasing costs and logistical challenges associated with the aging holding system.

- **Support for Strategic Objectives:** These investments directly support Hydro Ottawa's strategic objectives, including accommodating staff growth and advancing environmental sustainability goals through energy efficiency improvements and reduced environmental impact.

10.5. PROGRAM COSTS

The historical period costs represent infrastructure improvements and sustainability initiatives. Notable examples include a shared access roadway, a new HVAC unit, additional storage, and EV charging stations.

Capital work planned over the 2026-2030 rate period consists primarily of regular replacements and upgrades that are typical for buildings as they age. These general types of expenditures are described above.

Specific capital projects planned for 2026-2030 include:

- Bank Street Exterior Wall Repairs: Repair and repainting of damaged brickwork and concrete to maintain weather protection and structural integrity.
- Bank Street Sanitary Sewer Connection: Connection to the City of Ottawa's expanded sewer network, replacing the aging and costly sewage holding system.
- Hunt Club ERV Floor Re-coating: Re-coating of the ERV (Energy Recovery Ventilator) room floor to protect it from chemical spills and wear.
- Hunt Club Utility Meter Monitoring System: Installation of a utility meter monitoring system to track energy and water usage, supporting conservation efforts.
- Bank Street Roofing Replacement and Repairs: Complete replacement of the aging roof membrane and associated repairs to flashing and insulation.
- Bank Street Fleet Compressor Replacement: Replacement of the aging fleet garage air compressor with a more efficient and reliable unit.

- Bank Street Heat Pump Replacement: Replacing the aging heat pump system with a more efficient and environmentally friendly unit.
- Bank Street Garage Door Repairs and Replacements: Repair and replacement of worn or damaged garage doors to ensure proper operation and security.
- Interior Improvements and Renovations: Reconfiguration of existing workspace and purchase of new furniture and equipment to accommodate additional staff.
- Electrical Service Upgrades: Upgrades to the electrical services at both facilities to support decarbonization and energy efficiency initiatives, including preparing for future systems such as HVAC and EV chargers.

See Table 33 below for costs by Budget Program for historical, bridge and test periods for both buildings combined. Note that the capital contribution in 2023 and 2024 represents grant funding received toward the EV charging stations, reducing the overall cost of this program.

Table 33 - Buildings - Facilities Program Costs ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Buildings - Facilities	$ 0.6	$ 2.1	$ 0.5	$ 0.6	$ 0.5	$ 1.6	$ 1.3	$ 0.7	$ 0.7	$ 0.7
EV Charging Infrastructure	-	-	$ 1.9	$ 1.1	-	-	-	-	-	-
Net Zero - Facilities Capital	-	-	-	-	-	-	-	-	$ 0.5	$ 1.0
GROSS CAPEX	$ 0.6	$ 2.1	$ 2.4	$ 1.7	$ 0.5	$ 1.6	$ 1.3	$ 0.7	$ 1.2	$ 1.7
Capital Contribution	-	-	$ (0.2)	$ (0.1)	-	-	-	-	-	-
NET CAPEX	$ 0.6	$ 2.1	$ 2.2	$ 1.6	$ 0.5	$ 1.6	$ 1.3	$ 0.7	$ 1.2	$ 1.7
5-YEAR TOTAL					**$ 7.0**					**$ 6.6**

Table 34 provides the capital expenditures planned by building in 2026-2030.

Table 34 - Building - Facilities Program Costs by Building 2026-2030 ($'000 000s)

Investment Category		Test Years					Total
		2026	2027	2028	2029	2030	2026-2030
General Plant	Hunt Club	$ 0.7	$ 0.6	$ 0.3	$ 0.4	$ 1.4	**$ 3.4**
General Plant	Bank Street	$ 0.9	$ 0.7	$ 0.4	$ 0.8	$ 0.3	**$ 3.1**
TOTAL		**$ 1.6**	**$ 1.3**	**$ 0.7**	**$ 1.2**	**$ 1.7**	**$ 6.6**

10.5.1. Cost Factors

When making investment decisions for its facilities, Hydro Ottawa takes a long-term view, considering the full life-cycle cost. While regular repairs and maintenance are essential for extending the useful life of a facility, there comes a point where continued repairs become less cost-effective and can even negatively impact operations. A leaky roof, for instance, might be temporarily patched multiple times, but eventually, a full replacement becomes the more prudent investment when considering both financial costs and the potential for business disruption.

10.6. ALTERNATIVES EVALUATION

10.6.1. Alternatives Considered

Alternative One - Reactive Maintenance (Run to failure): This approach minimizes short-term capital expenditures by only addressing facility issues as they arise. While annual repair and maintenance costs may initially appear lower, this strategy risks significant safety hazards, operational disruptions, and higher long-term costs due to emergency repairs and potential legal or regulatory non-compliance. It also leads to a suboptimal and deteriorating work environment, impacting productivity and potentially staff retention.

Alternative Two - Planned Maintenance and Replacement (Balanced Approach): This approach balances ongoing repair and maintenance with the planned replacement of assets nearing the end of their useful life. Regular monitoring of facility conditions allows for proactive interventions, preventing catastrophic failures and minimizing disruptions. This strategy prioritizes safety and ensures a functional work environment while optimizing life-cycle costs.

Alternative Three - Preventative Maintenance and Accelerated Replacement: This approach proactively invests in replacements and upgrades before assets reach the end of their useful life. While this can reduce future risks and maintenance costs and help Hydro Ottawa reach Net-Zero targets faster, it results in higher upfront capital expenditures and may not optimize asset life cycles, potentially increasing costs for customers.

10.6.2. Evaluation Criteria

The alternatives were evaluated based on the following criteria:

- **Safety:** Employee, contractor, and public safety; mitigation of workplace hazards; compliance with applicable regulations.
- **Cost:** Lowest overall life-cycle cost, balancing repair/maintenance expenditures with capital investments to optimize asset service life.
- **Efficiency:** Ability of the workspace to support timely and efficient work execution; minimizing business disruptions due to facility unavailability or inaccessibility; optimizing work productivity.
- **Practicality:** Meeting staff needs without excessive expenditure beyond what is required for effective work performance.
- **Sustainability:** Contribution to environmental sustainability goals, including energy efficiency and reduced environmental impact.

10.6.3. Preferred Alternative

Hydro Ottawa has selected Alternative Two: Planned Maintenance and Replacement, as the preferred approach for the 2026-2030 rate period. This approach provides the best balance between safety, reliability, cost-effectiveness, and environmental sustainability. It mitigates the significant risks associated with Alternative One (reactive maintenance), which could compromise safety, lead to costly emergency repairs, and negatively impact operations. While Alternative Three (accelerated replacement) offers increased reliability, it comes at a significantly higher cost without a commensurate increase in benefits. Alternative Two optimizes lifecycle costs by strategically balancing proactive maintenance with timely capital investments, ensuring a safe and functional work environment while responsibly managing ratepayer funds. This approach is consistent with Hydro Ottawa's overall asset management strategy.

10.7. PROGRAM EXECUTION AND RISK MITIGATION

10.7.1. Implementation Plan

The implementation of the 2026-2030 Buildings - Facilities capital program will be guided by a flexible and adaptive approach that considers the unique nature of each project and prioritizes operational continuity.

Project Identification and Scoping: Capital projects are identified through a variety of channels, including:

- Regular facility inspections and condition assessments: These assessments help identify potential issues and maintenance needs before they become major problems.
- Employee feedback and input: Employees are encouraged to report any concerns or suggestions for improvement related to their workspaces. These are often identified through Hydro Ottawa's Hazard Near Miss reporting.
- Technological advancements: New technologies and building systems are evaluated for their potential to improve efficiency, safety, or sustainability.
- Regulatory requirements: Changes in building codes or environmental regulations may necessitate facility upgrades.

Project Implementation: The specific implementation approach for each project will be determined based on its scope, complexity, and potential impact on operations. Some projects may be executed using in-house resources, while others may require external contractors or specialized expertise. Key considerations during project implementation include:

- Minimizing Disruption: Work will be scheduled to minimize disruption to Hydro Ottawa's operations and ensure the continued safety of employees and the public. This may involve scheduling work during off-hours or implementing temporary measures to maintain access and functionality.

- Lead Times: Adequate lead times will be factored in to account for material procurement, contractor availability, and any necessary permitting or approvals.
- Cost Control: Rigorous cost control measures will be implemented throughout the project lifecycle, including competitive bidding, value engineering, and ongoing monitoring of expenditures.

This flexible and adaptive approach allows Hydro Ottawa to effectively manage its facilities capital program, ensuring that projects are implemented efficiently, cost-effectively, and with minimal disruption to operations.

10.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces risks in managing its Building - Facilities Program. See Table 35 for key risks and corresponding mitigation strategies:

1 **Table 35 - Key Risks of Buildings - Facilities and Mitigation Strategies**

Category	Risk	Mitigation
Operational	Inability to perform work due to lack of access to or sub-optimal facilities	Proactive maintenance, regular assessments, and contingency planning
Safety	Failure of safety systems and exposure to hazards. Non-compliance with applicable legislation and codes	Regular inspections, employee training, and a strong safety culture
Financial	Required expenditures higher than planned	Accurate budgeting, rigorous cost control, and contingency planning
Environmental	Not meeting environmental legislation or targets	Understanding and adhering to environmental regulations, setting targets, and tracking performance
Project Management	Delays in project timelines	Detailed project planning, effective project management practices, and proactive risk identification
External Risks	Supply chain disruptions: This can affect the availability and cost of materials and equipment	Maintaining relationships with multiple suppliers, exploring alternative materials, and building in buffer time for procurement
External Risks	Changes in regulations or building codes: New regulations or changes to existing ones can impact project scope and costs	Staying informed about regulatory changes and incorporating flexibility into project designs

11. FLEET REPLACEMENT

11.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $17.6M

2026-2030: $40.6M

Budget Program: Fleet Replacement, Fleet Additions

Main Driver: System Investment Support

Secondary Driver: Health and Safety, Net Zero Operations

Outcomes: Operational Effectiveness, Financial Performance

The Fleet Program is responsible for the procurement, maintenance, and disposal of fleet assets (vehicles and equipment) required to support Hydro Ottawa's functional and operational needs. The primary objectives of the Fleet Program are to optimize fleet asset usage and lifecycle costs, and to ensure that these assets are available, perform reliably, and are safe.

Hydro Ottawa relies on a diverse fleet of 237[3] vehicles and 44 other units of transportation equipment to support its OM&A and capital work programs. Vehicles are essential for providing efficient and reliable customer service including timely power restoration, efficient distribution system construction and maintenance, and ensuring worker and public safety.

Hydro Ottawa's service territory comprises 662 km^2 of rural service area and 454 km^2 of urban service area. This diverse service territory requires a variety of fleet assets capable of supporting maintenance and construction activities in both overhead and underground distribution line operating environments.

The utility's Fleet Services Unit (Fleet) is responsible for both the maintenance and capital replacement of fleet assets. Fleet, in conjunction with the various distribution operations work

[3] As of September 30, 2024

groups, determines the demand for new vehicles based on the planned OM&A and capital work programs. For existing assets, Fleet conducts ongoing condition assessments to inform maintenance decisions throughout each vehicle's lifecycle. These assessments also play a key role in determining when a vehicle should be replaced. Factors considered in replacement decisions include age, mileage, repair history, and overall condition. Deterioration of fleet assets can negatively impact utility performance in areas such as reliability, productivity, and safety.

A summary of the number of fleet assets in Hydro Ottawa's fleet and their net book value is provided in Table 36.

Table 36 - Hydro Ottawa Fleet Summary (As of September 30, 2024)

Vehicle Category	# of Units	Asset Cost ($'000s)	Net Book Value ($'000s)
Light Duty Vehicles	149	$ 6,324	$ 3,358
Medium Duty Vehicles	29	$ 3,990	$ 2,685
Heavy Duty Vehicles	59	$ 18,029	$ 8,552
Other	44	$ 1,585	$ 829
TOTAL	**281**	**$ 29,929**	**$ 15,425**

Descriptions of the types of vehicles in the above categories are as follows:

- **Light Duty Vehicles:** This category includes pick-up trucks, vans, and small cars used for transporting supervisors and inspection staff. These vehicles support various tasks, such as responding to trouble calls, transporting crews and materials, metering, collections, design work, and safety inspections.

- **Medium Duty Vehicles:** This category encompasses step vans and walk-through body trucks, which serve as mobile workshops for underground splicing and station maintenance. It also includes dump trucks used for transporting compaction materials for pole line work, and flatbed trucks for transporting cable and transformers.

- **Heavy Duty Vehicles:** This category includes specialized vehicles such as bucket trucks, diggers, and cranes. These are used for performing overhead and underground line work, drilling and installing poles, and lifting heavy transformers. Also included are track machines, such as a backyard bucket/digger and a backyard transformer transporter.

- **Other:** This category comprises a range of specialized equipment, including pole trailers, flat deck trailers, underground pulling equipment, and forklifts (both indoor and outdoor) used for material handling. Other units and equipment classified here are typically pulled by heavy- or medium-duty vehicles, or are self-propelled units with their own engine/powerplant, typically used for line work. Examples include stringing/pulling trailers, compressors, backyard carriers, various types of trailers, forklifts, and reel trailers.

Hydro Ottawa's commitment to environmental responsibility is strongly reflected in its fleet strategy, a vital component of the organization's Eight point plan aimed at achieving Net Zero Operations. Hydro Ottawa has made significant strides in greening its fleet, focusing on strategic implementation of available and reliable green technologies. The availability and pricing of fully-electric (EV) vehicles, particularly full-size pick-up trucks and vans, improved considerably during the 2021-2025 rate period, compared to its planning stage. This shift enabled Hydro Ottawa to significantly increase its fleet of low- and non-emitting vehicles, as demonstrated by the substantial growth detailed in Table 37.

Table 37 – Vehicles and Equipment with Green Attributes

Vehicle Category	At May 31, 2020	At Dec 31, 2023	Projected at Dec 31, 2025
Electric	2	22	48
Plug-in Hybrid	0	3	7
Hybrid	8	11	9
Hybrid Equipment	22	24	28
TOTAL	**32**	**60**	**92**

The addition of electric vehicles, consisting of pick-up trucks, cargo vans and SUVs, has allowed Hydro Ottawa's fleet to reduce fuel consumption and these vehicles are successfully getting through their day on a single charge and reducing carbon output. Where EV vehicles are not practical or available, Hydro Ottawa has purchased Hybrid vehicles such as the Toyota Rav 4 and Sienna. These vehicles are tried and tested and are more fuel-efficient than their internal combustion engine counterparts.

Auxiliary hybrid units have been installed on medium and heavy duty vehicles to run all accessories, except for air conditioning, using an inverter and auxiliary batteries. It is no longer necessary for a vehicle to be kept running at a job site, thus reducing idling time and saving fuel. The batteries charge when the vehicle is on the road and when plugged in at night. In addition, what is known as "Cab Comfort" will be added to some new units. This is the inclusion of a Heating and Air Conditioning unit that can be run by the hybrid battery and allows the cab to be heated and cooled without running the diesel engine. Hybrid battery and inverter to power accessories is now standard specification for all new medium duty trucks purchased by Hydro Ottawa.

Fleet has also undertaken a pilot program retrofitting an existing bucket truck with a Hybrid battery pack (Viatec) smart Power Take Off (PTO), capable of operating the boom for several hours a day without operating the diesel engine. This required working with Viatec through numerous testing and adjustments to optimize the total run time of the hybrid boom. Currently, of the units that Viatec has in service, Hydro Ottawa is in the top five in North America for total run time and idle reduction per month (>60 hrs).

Fleet also has units on order that will be fit-up with factory hybrid boom packs to operate the boom without the use of the diesel engine. New heavy-duty vehicles will have an inverter and battery pack to allow operators to run accessories such as emergency lighting and equipment as well as battery charging for battery-operated tools. All of this can be managed without running the truck on diesel fuel.

Hydro Ottawa is committed to the acquisition of vehicles with hybrid technology where there is an operational and financial business case for doing so. In the 2026-2030 rate period, Hydro Ottawa plans on purchasing 14 bucket trucks with plug-in hybrid booms.

While Hydro Ottawa Holding Inc. has set a corporate net-zero target by 2030, the current plan does not include specific funding for significant additions of light-duty or medium-duty electric vehicles (EVs) during the 2026-2030 rate period. The plan does include $2.4M for hybrid boom retrofits. This approach considers several factors. First, Hydro Ottawa is already progressing towards electrification, with an expectation of having 48 fully electric vehicles in its fleet by 2025. Second, the utility anticipates that as EV technologies mature, the cost differential between EVs and their internal combustion engine (ICE) counterparts will continue to decrease. Specifically, advancements in battery technology, increased production volumes, and government incentives are expected to lower EV prices. This could enable Hydro Ottawa to acquire a larger number of fully electric vehicles within the same budget, accelerating the transition of Hydro Ottawa's fleet. At the same time, Hydro Ottawa recognizes the need to maintain some internal combustion engine (ICE) vehicles in its fleet. This is primarily due to the current limitations in backup power solutions for fully electric vehicles, which are critical for power restoration efforts during outages. The significant cost of providing reliable generation backup for a large fully electric fleet remains a key consideration. Hydro Ottawa must also balance these investments with the need to maintain affordable rates for its customers. The utility will continue to monitor developments in backup power technology, such as mobile power stations and improved battery energy density, which could further support the integration of EVs for all applications. For the 2026-2030 period, vehicle acquisitions are budgeted at ICE rates. Finally, looking ahead, the City of Ottawa plans to develop two hydrogen plants by 2036 which will offer a potential pathway for further fleet diversification.

11.2. PERFORMANCE OUTCOMES

Table 38 outlines the expected performance outcomes associated with the Fleet Replacement Program.

Table 38 - Performance Targets for Fleet Replacement Program

OEB Performance Outcome	Target
Operational Effectiveness	● Maintain the percentage of medium- and heavy-duty Fleet vehicles at end-of-life in the 10-15% target range (Refer to additional context on this target below the table). ● Provide staff with functional fleet equipment that is available when needed to support OM&A and Capital work programs. ● Provide safe fleet equipment in reliable operating condition. ● Replace end-of-life fleet prior to critical failure or costly repairs.
Financial Performance	● Manage Fleet operating and capital costs to achieve the lowest overall lifecycle cost. ● Monitor and control repair and maintenance costs within budget.
Environment	● Reduce GHG emissions associated with fleet fuel consumption through: ○ Opting for hybrid and electric vehicles while maintaining fleet reliability; ○ Implementing anti-idling technology; and ○ Using GPS reporting to monitor vehicle efficiency. ● Safe storage and disposal of automotive fluids.

The proportion of medium and heavy duty fleet vehicles that have reached or exceeded their end of useful life (EOL) is a KPI which is also included in Table 27 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. The target range is 10% to 15%. This range acknowledges that some vehicles may remain functional and safe beyond their typical lifespan due to condition-based replacement, minimizing maintenance costs and supporting operational efficiency. However, these heavy- and medium-duty vehicles are critical workhorses, representing approximately 80% of the capital expenditures in the 2026-2030 fleet program. Therefore, maintaining the EOL percentage below 15% is crucial. Exceeding this threshold poses a significant risk due to the long lead times required for replacing these specialized vehicles. Unlike light-duty assets, readily available rentals or replacements for equipment like bucket trucks are not typically an option, making fleet availability paramount for uninterrupted operations. A target range of 10-15% is considered optimal to balance cost-effectiveness with the critical need to maintain a reliable fleet.

The current actual as at September 2024 is 23%; however, with the investments in this program, it is expected to be within 14% by the end of 2030.

11.3. PROGRAM DRIVERS AND NEED

11.3.1. Main and Secondary Drivers

Primary Driver: System Investment Support; The primary driver for the Fleet Replacement Program is to ensure the availability of appropriate vehicles and equipment to support OM&A and capital work programs. This involves strategic investment in fleet assets, optimizing lifecycle costs through timely replacements and effective maintenance strategies.

Secondary Driver: Health and Safety, Net Zero Operations; The secondary drivers include ensuring the safety and reliability of vehicles 24/7, and advancing Hydro Ottawa's net-zero objectives by identifying and implementing opportunities for carbon reduction within the fleet. This includes providing safe working conditions for employees and the public.

11.3.2. Current Issues

Hydro Ottawa owns many vehicles that are either already beyond their planned useful life, or will be beyond their planned useful life during the upcoming rate period.

As a vehicle ages, higher operating expenses due to increasing levels of reactive repairs are incurred. The capital replacement program helps to ensure that investments are made at the appropriate level and timing in order to optimize asset maintenance, repair, and capital costs. An appropriately timed vehicle replacement strategy also helps to ensure that the right number of vehicles are available to support system maintenance and capital investment plans. Hydro Ottawa has identified the need to significantly re-invest in Fleet assets, as many vehicles have reached or exceeded the end of their operational service life. These vehicles are subject to increased maintenance and repair expenditures, deteriorating chassis and engine performance, and potentially pose a health and safety hazard to the public and employees. Hydro Ottawa developed its vehicle replacement strategy based on the criteria and process outlined in Section 11.6 - Alternatives Evaluation.

In addition to replacing aging vehicles, the 2026-2030 plan includes additions to the fleet to accommodate the operational needs of a growing workforce. Table 39 identifies the type and number of new vehicles required to support headcount growth.

Table 39 - Vehicles Required for Additional Headcount

Vehicle Type	# New Vehicles
Heavy Duty	14
Medium Duty	11
Light Duty	29
Other	1
TOTAL NEW VEHICLES	**55**

Further information on the number of additional staff and the rationale for the required hiring can be found in Attachment 4-1-3(C) - Workforce Growth. The plan also includes one additional mechanic to support the increasing vehicle and tool requirements.

With respect to the annual trend in expenditures, 2026-2028 have higher expenditure levels than later years due to the hiring of staff and the timing of the need to replace aging and underperforming vehicles in the earlier years of the plan. To ensure continued reliability and prevent potential negative operational impacts, Hydro Ottawa is prioritizing the replacement of a considerable number of its fleet assets that are reaching or have exceeded their expected useful life.

Of Hydro Ottawa's current fleet of 281 vehicles and equipment, 154 (55%) will be at or beyond their replacement criteria age in the 2026-2030 rate period. Of these 154 units, 106 (69%) are planned to be replaced.

11.4. PROGRAM BENEFITS

Hydro Ottawa's capital investments in its vehicle fleet will yield the following benefits:

- Increased fleet reliability
- Optimized fleet lifecycle costs
- Minimized fleet downtime and work execution delays due to unscheduled repairs
- Efficient customer outage responses due to availability of appropriate fleet equipment
- Increased vehicle efficiency, e.g. lower fuel consumption
- Improved garage efficiency by replacing older and poor-condition vehicles that are more costly to maintain with new vehicles
- Reduced environmental impacts such as reductions in greenhouse gases emissions due reduced idling hours
- Increased employee, field crew, and public safety, as newer vehicles are equipped with new technology such as back-up cameras, lane departure warning and other driver safety alerts.

11.5. PROGRAM COSTS

The historical period consists of investments made to replace vehicles including the purchase of some electric or hybrid electric vehicles to replace traditional internal combustion engine (ICE) vehicles. The capital contribution in 2023 shown in Table 40 below represents $100k in electric vehicle governmental rebates; future rebates are unknown and therefore have not been included for the 2026-2030 rate period.

The future costs are focused both on replacing vehicles in poor condition (categorized as Fleet Replacement in Table 40) as well as vehicle additions to support headcount growth (categorized as Fleet Additions in Table 40). During the 2021 to 2025 rate period, there was no headcount growth planned therefore fleet additions were nil. Although additional headcount is being hired in 2024-2025, given lead times for new vehicles, additions to the fleet only occur in 2026. To cover this timing gap, the organization is strategically delaying the disposal of some retiring vehicles, repairing them as needed to serve as temporary replacements or additions, and piloting some sharing programs. In addition, some of the new hires are at the apprentice level and will not require a dedicated vehicle of their own until they are fully licensed.

Table 40 - Fleet Replacement Program Expenditures ($'000 000s)[4]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fleet Replacement	$ 1.3	$ 4.7	$ 5.5	$ 3.2	$ 3.0	$ 9.5	$ 6.9	$ 6.5	$ 2.8	$ 0.1
Fleet Additions	-	-	-	-	-	$ 2.6	$ 7.3	$ 4.7	$ 0.3	-
GROSS CAPEX	**$ 1.3**	**$ 4.7**	**$ 5.5**	**$ 3.2**	**$ 3.0**	**$ 12.1**	**$ 14.2**	**$ 11.1**	**$ 3.0**	**$ 0.1**
Capital Contribution	-	-	$ (0.1)	-	-	-	-	-	-	-
NET CAPEX	**$ 1.3**	**$ 4.7**	**$ 5.4**	**$ 3.2**	**$ 3.0**	**$ 12.1**	**$ 14.2**	**$ 11.1**	**$ 3.0**	**$ 0.1**
5-YEAR TOTAL					**$ 17.6**					**$ 40.6**

Over the 2026-2030 rate period, a total of 140 vehicles at a cost of $40.6M will be purchased in order to replace vehicles at the end of their useful lives and to acquire additional vehicles required to support new work and staff. Table 41 summarizes the total Fleet capital expenditures

[4] Totals may not sum due to rounding.

by year and by vehicle category. While Table 42 (Fleet Replacements) and Table 43 (Fleet Additions) detail the number of vehicles planned in each year by category.

Hydro Ottawa continues to ensure that the utilization of all fleet vehicles is optimized and does not plan on adding new vehicles without assessing the overall need and usage. The numbers presented under the “Total Additions” line in Table 43 represent the total vehicle need based on projected workforce growth, please refer to Attachment 4-1-3(C) - Workforce Growth for further details, rather than the actual number of new vehicles that will be purchased. The “Reduced through Pooling” line reflects Hydro Ottawa's commitment to achieving savings and efficiencies through a pilot vehicle pooling program, which will reduce the total need and therefore the number of actual additions. The bottom line in the table, “Net Additions,” represents the total additions after applying the anticipated reductions achieved through the pooling program. This approach allows Hydro Ottawa to forecast its needs while actively working to minimize them.

The possibility of implementing an expanded vehicle pooling program (some field crews and administrative staff already utilize shared vehicles) has been under evaluation since the move to the new facilities. However, the onset of the COVID-19 pandemic in 2020 understandably led to concerns about shared vehicle use, impacting the feasibility of such a program. Furthermore, the current fleet management software lacked the necessary tools for efficient booking, scheduling, and overall management of a shared vehicle pool. These limitations made it difficult to effectively coordinate vehicle availability and usage.

Hydro Ottawa is scheduled to upgrade its fleet management software in 2025 to address these logistical challenges. This expanded pooling program, particularly in the light-duty category, represents an ambitious target and will necessitate significant change management, including adjustments to work processes, scheduling, and tool storage.

1 **Table 41 - Fleet: Total Capital Expenditures - 2026-2030 ($'000s)[5]**

Vehicle Category	Test Years										Total	
	2026		2027		2028		2029		2030		2026-2030	
	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$
Light Duty	29	$ 1,685	12	$ 710	15	$ 979	12	$ 848	2	$ 135	70	$ 4,358
Medium Duty	7	$ 1,940	7	$ 2,712	2	$ 404	-	-	-	-	16	$ 5,057
Heavy Duty	10	$ 7,153	11	$ 8,400	12	$ 9,297	3	$ 2,166	-	-	36	$ 27,016
Other	6	$ 1,320	10	$ 2,384	2	$ 459	-	-	-	-	18	$ 4,163
TOTAL	**52**	**$ 12,099**	**40**	**$ 14,206**	**31**	**$ 11,138**	**15**	**$ 3,014**	**2**	**$ 135**	**140**	**$ 40,593**

2

3 **Table 42 - Fleet: Capital Expenditure Replacement - 2026-2030 ($'000s)**

Vehicle Category	Test Years										Total	
	2026		2027		2028		2029		2030		2026-2030	
	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$
Light Duty	26	$ 1,502	10	$ 594	12	$ 796	8	$ 591	2	$ 135	58	$ 3,618
Medium Duty	2	$ 333	1	$ 268	2	$ 404	-	-	-	-	5	$ 1,004
Heavy Duty	10	$ 6,322	6	$ 4,117	7	$ 4,809	3	$ 2,166	-	-	26	$ 17,414
Other	6	$ 1,320	9	$ 1,883	2	$ 459	-	-	-	-	17	$ 3,662
TOTAL REPLACEMENTS	**44**	**$ 9,476**	**26**	**$ 6,862**	**23**	**$ 6,467**	**11**	**$ 2,757**	**2**	**$ 135**	**106**	**$ 25,697**

[5] Totals may not sum due to rounding.

Table 43 - Fleet: Capital Expenditure Additions - 2026-2030 ($'000s)[6]

Vehicle Category	Test Years										Total	
	2026		2027		2028		2029		2030		2026-2030	
	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$
Light Duty	20	$ 1,220	2	$ 116	3	$ 184	4	$ 257	-	-	29	$ 1,777
Medium Duty	5	$ 1,608	6	$ 2,445	-	-	-	-	-	-	11	$ 4,052
Heavy Duty	-	-	5	$ 3,410	9	$ 6,617	-	-	-	-	14	$ 10,027
Hybrid Boom price premium		$ 832[7]		$ 873		$ 734		-		-		$ 2,439
Other	-	-	1	$ 501	-	-	-	-	-	-	1	$ 501
TOTAL NEED	**25**	**$ 3,659**	**14**	**$ 7,344**	**12**	**$ 7,535**	**4**	**$ 257**	**-**	**-**	**55**	**$ 18,796**
Reduced through Pooling:												
Light Duty	(17)	$ (1,037)		-		-		-		-	(17)	$ (1,037)
Heavy Duty		-		-	(4)	$ (2,864)		-		-	(4)	$ (2,864)
TOTAL REDUCTIONS	**(17)**	**$ (1,037)**	**-**	**-**	**(4)**	**$ (2,864)**	**-**	**-**	**-**	**-**	**(21)**	**$ (3,901)**
TOTAL ADDITIONS	**8**	**$ 2,622**	**14**	**$ 7,344**	**8**	**$ 4,672**	**4**	**$ 257**	**-**	**-**	**34**	**$ 14,895**

11.5.1. Cost Factors

Inflation

Since 2021, the price of vehicles has increased significantly, between approximately 20% to 40% as noted below, please refer to Schedule 1-2-5 - Impacts of Inflationary Pressure for further details on this period of high inflation. This has had an impact on the cost of vehicles purchased in the 2021-2025 rate period. It is also a contributing factor to the higher fleet replacement costs in the 2026-2030 rate period. Table 44 provides examples of price increases associated with five typical vehicles in Hydro Ottawa's fleet.

[6] Totals may not sum due to rounding.
[7] Although there are no additions to the heavy duty fleet in 2026, this addition of the hybrid boom will be added to the heavy duty replacement but was included here to display the total budgeting of $2.4M on hybrid booms

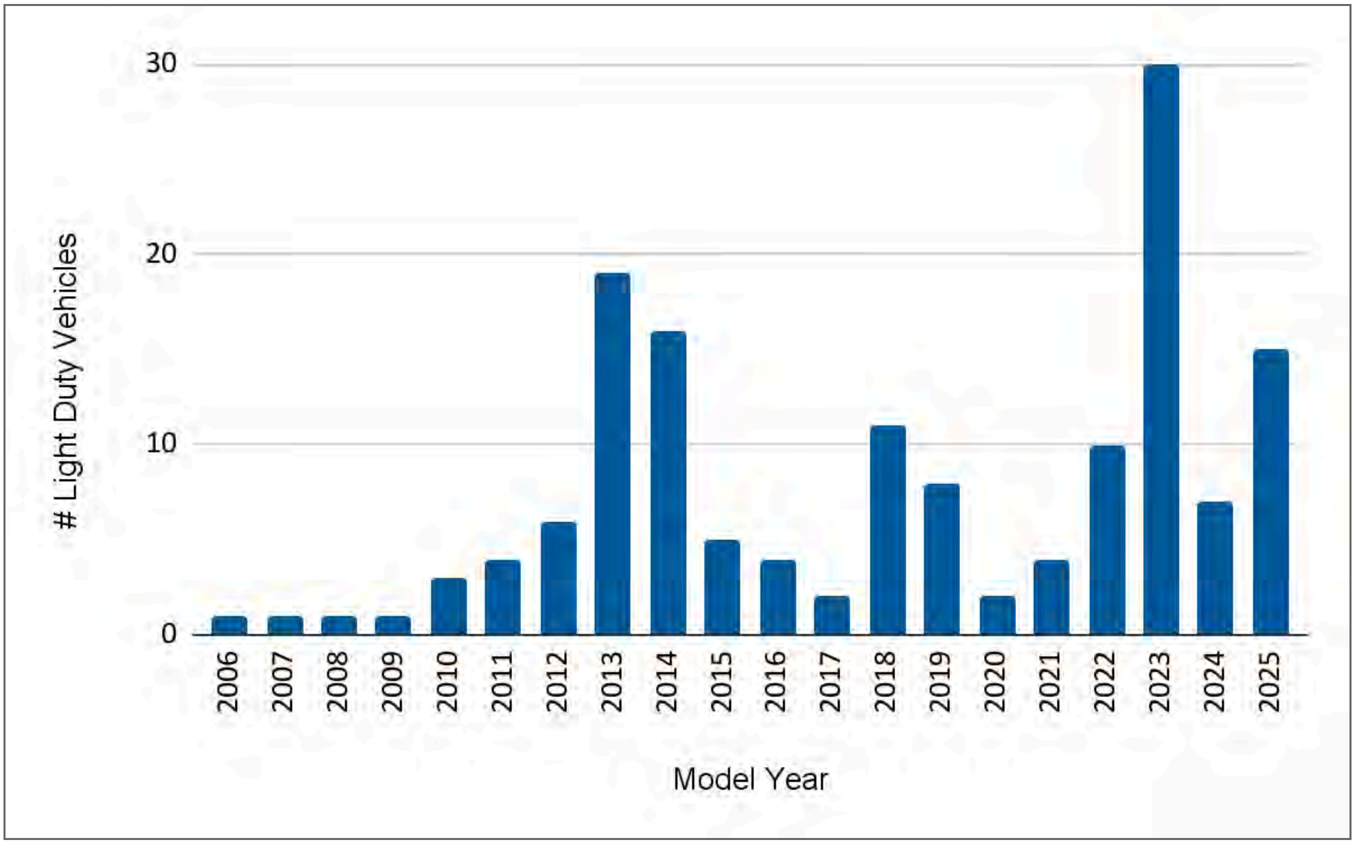
Table 44 - Vehicle Unit Price Increases 2021 vs. 2024

Vehicle Category	Example	2021	2024	% Increase
Light Duty	3/4 Ton Pick-Up	$ 51,485	$ 73,700	43.1%
Light Duty	Cargo Van	$ 38,880	$ 54,846	41.1%
Medium Duty	Step Side Van (excluding interior upfit)	$ 152,900	$ 209,500	37.0%
Heavy Duty	Large RBD	$ 435,201	$ 613,705	41.0%
Heavy Duty	Large Bucket	$ 471,800	$ 582,891	23.5%

Age of Fleet

While vehicle age is not the only criteria for replacement, it is an indication of the need to assess the condition of the vehicle and determine if there is a need for replacement. Figures 6, 7 and 8 illustrate the age distribution of light-, medium- and heavy-duty vehicles.

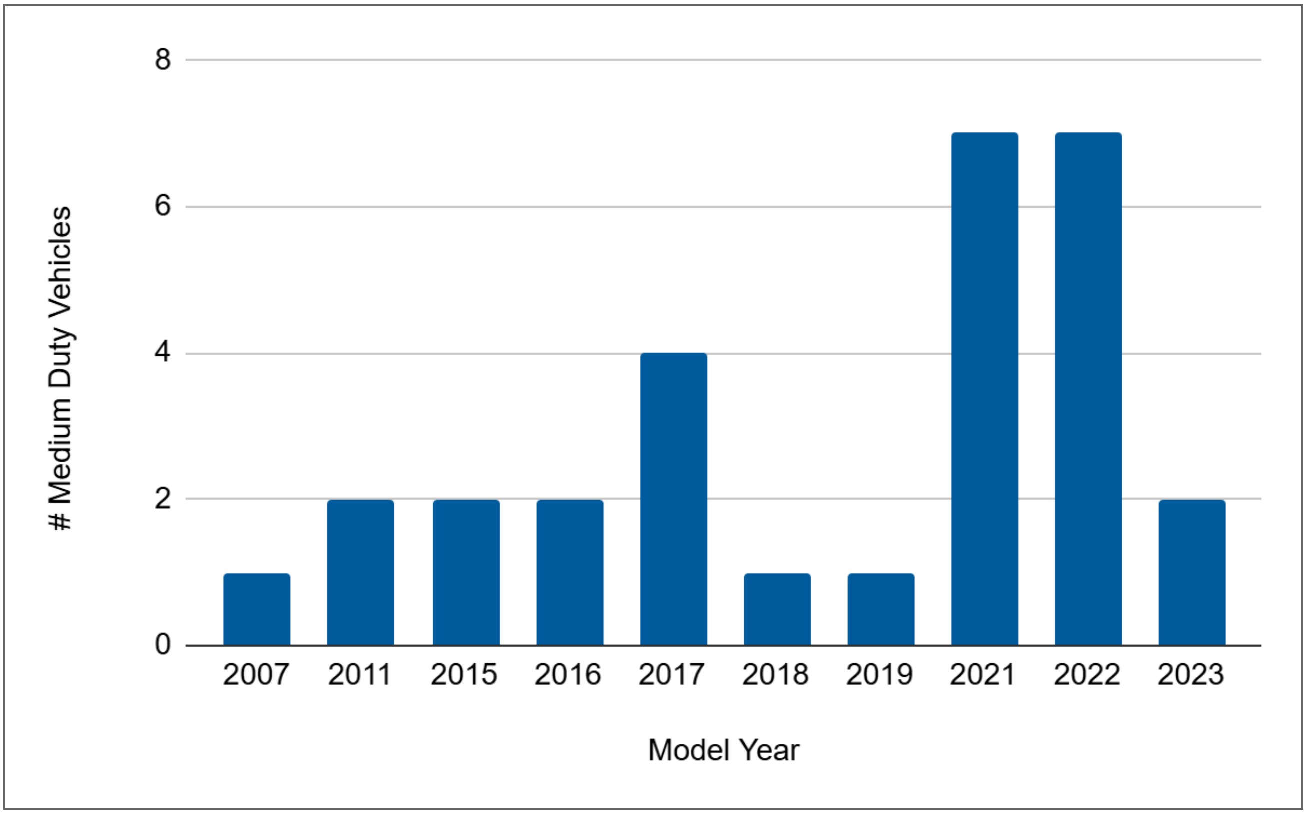
Figure 6 - Number of Light Duty Vehicles by Model Year[8]



Age replacement criteria for light-duty vehicles is between 8-10 years. Based on replacement at the high end of the range, 82 vehicles would require replacement in the 2026-2030 rate period but only 58 of these vehicles are planned to be replaced based on condition assessments.

[8] Fleet projection as of December 31, 2025. No bar indicates no vehicles of that model year.

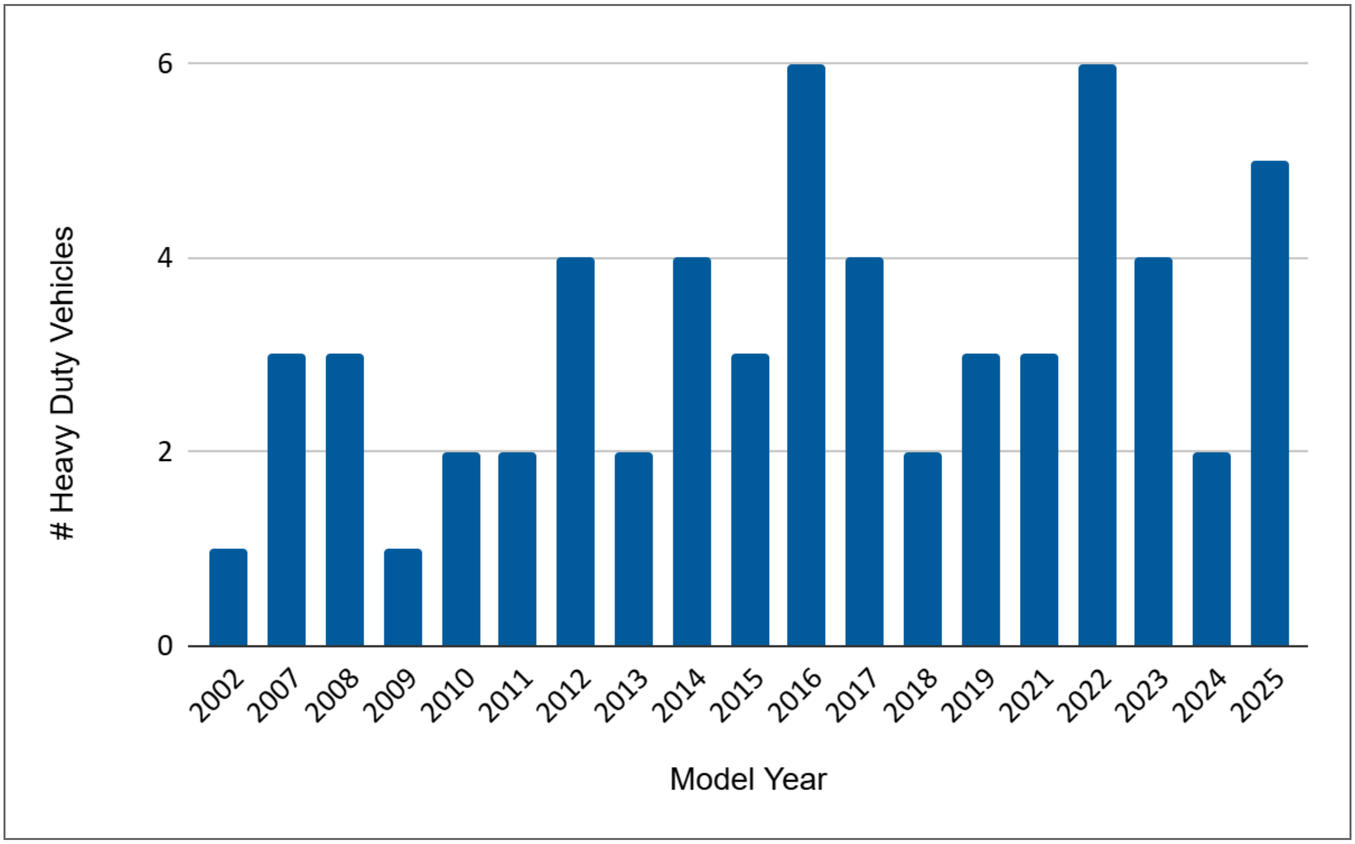
Figure 7 - Number of Medium Duty Vehicles by Model Year[9]



Age replacement criteria range for medium-duty vehicles is between 12-15 years. Based on replacement at the high end of the range, five vehicles would require replacement in the 2026-2030 rate period and all five vehicles are planned to be replaced due to their condition.

[9] Fleet projection as of December 31, 2025. No bar indicates no vehicles of that model year.

Figure 8 - Number of Heavy Duty Vehicles by Model Year[10]



Age replacement criteria range for heavy-duty vehicles is between 12-15 years. Based on replacement at the median of the range, 31 vehicles would require replacement in the 2026-2030 rate period but only 26 vehicles are planned to be replaced based on condition assessments.

[10] Fleet projection as of December 31, 2025. No bar indicates no vehicles of that model year.

11.6. ALTERNATIVES EVALUATION

Hydro Ottawa considered three alternatives in determining its approach to capital investment in Fleet. These alternatives are identified, explained, and evaluated below.

11.6.1. Alternatives Considered

Alternative One - Run to Failure with Minimal Replacement: This approach prioritizes minimizing capital expenditures by extending the life of existing vehicles beyond their target replacement criteria. This requires increased investment in maintenance and repairs, delaying new vehicle procurement until existing units are unsafe or unreliable. While this minimizes short-term capital costs, it carries significant risks, including:

- Increased long-term maintenance costs due to escalating repairs on aging vehicles.
- Higher safety risks due to potential equipment failures and the use of older vehicles.
- Reduced productivity and system reliability due to vehicle downtime and unavailability.
- Potential for higher lifecycle costs due to the inefficiencies of maintaining a fleet of increasingly obsolete vehicles.

Alternative Two - Optimized Replacement and Strategic Additions: This alternative balances the need for reliable equipment with cost optimization. It focuses on replacing priority vehicles that exceed target replacement criteria or fail qualitative assessments, while also strategically adding vehicles to support growth. Key elements include:

- Prioritizing replacements based on condition assessments, lifecycle cost analysis, and operational needs.
- Implementing vehicle pooling and optimizing work schedules to reduce the total number of vehicles required.
- Carefully evaluating new vehicle requests to ensure they are essential and cannot be met through existing resources.
- Continuously assessing vehicle condition and making strategic repair versus replacement decisions.

Alternative Three - Full Replacement: This approach advocates for replacing all vehicles meeting target replacement criteria, and with EV counterparts and hybrid features where available. While this maximizes fleet reliability and availability in the short term and helps Hydro Ottawa meet its Net-Zero targets faster, it has several drawbacks:

- Significantly higher capital expenditures, potentially replacing vehicles before the end of their useful life.
- Suboptimal lifecycle costs due to premature replacements.
- Risk of insufficient charging capacity or back-up power generation to adequately and reliably support a rapidly growing electric fleet, especially if a major weather event causes power outages.
- Based strictly on the replacement age criteria in Section 11.6.2 - Evaluation Criteria, fleet replacement and additions would require a capital funding need of $57M (for 193 vehicles) over the 2026-2030 period.

11.6.2. Evaluation Criteria

The alternatives were evaluated using quantitative criteria, as shown in Table 45 below, and qualitative assessments, including vehicle condition, repair history, mechanic/technician judgment, and operational needs. The quantitative criteria, unchanged from the EB-2019-0261 application, provide a baseline for replacement consideration. It's important to note that meeting a quantitative criterion does not automatically trigger replacement; a comprehensive assessment is always performed.

Table 45 – Quantitative Vehicle Replacement Criteria

Vehicle Description	Age	Km	Engine Hours	PTO Hours
Light Duty				
Automobile (All types)	10	150,000	4,000	N/A
Pick-up Trucks (All types)	10	100,000	5,000	N/A
Vans (Compact)	8	150,000	5,000	N/A
Vans (Cargo)	8	150,000	6,000	N/A
Medium Duty				
Vans (StepSide/Cube/ Walk-through Body)	12	150,000	8,000	N/A
Trucks (Dump)	12	125,000	6,000	N/A
Trucks (Stake / Flatbed)	15	150,000	8,000	N/A
Heavy Duty				
Trucks (Bucket, Radial Boom Derrick (RBD) and Line - includes track units)	12	200,000	10,000	5,000
Trucks (Knuckle Boom / Crane includes track units)	15	200,000	10,000	5,000
Other				
Forklifts (Inside and Outside)	15	N/A	10,000	N/A
Trailers (Pole, Utility, Pulling, Reel)	15	N/A	N/A	N/A

11.6.3. Preferred Alternative

Hydro Ottawa's preferred alternative is Alternative Two. This approach best balances the need for a reliable and efficient fleet with the imperative to manage costs effectively. While Alternative Three offers the highest level of reliability, it comes at a significantly higher cost. Alternative One, while minimizing initial capital outlay, poses substantial risks to safety, reliability, and long-term costs. Alternative Two provides a responsible and sustainable approach to fleet management, optimizing lifecycle costs while ensuring the availability of necessary equipment. The funding requested in this application reflects the balance inherent in Alternative Two, although budgetary constraints required some difficult choices regarding the timing of certain replacements, incorporating some elements of Alternative One to extend the life of some assets where the risk is deemed acceptable. This approach requires careful monitoring and proactive maintenance to mitigate any potential negative impacts.

11.7. PROGRAM EXECUTION AND RISK MITIGATION

11.7.1. Implementation Plan

Hydro Ottawa's Fleet Replacement Program will be implemented through a comprehensive approach encompassing vehicle procurement, advanced fleet management systems, and ongoing utilization analysis.

Vehicle Procurement:

Hydro Ottawa's vehicle procurement process adheres to the utility's Procurement Policy detailed in Attachment 4-2-2(A) - Procurement Policy. Capital replacement needs are identified and open tenders are issued through the Procurement group. This competitive process ensures market flexibility and the opportunity to secure the most favorable pricing and terms. Standardized fleet specifications have been developed for key vehicle models, streamlining procurement and promoting fleet uniformity. These specifications cover critical parameters such as lifting capacity, cab design, turning radius, and boom characteristics. Hydro Ottawa acknowledges the long lead times (up to 24 months) associated with certain specialized vehicles and incorporates this factor into its procurement planning.

Fleet Management and Tracking:

To maximize fleet efficiency and effectiveness, Hydro Ottawa utilizes integrated fleet management and telematics systems.

- **Fleet Management System:** This web-based system (upgrade to cloud-based system scheduled for 2025) provides a comprehensive platform for managing all aspects of fleet operations, including:
    - Asset tracking and capital replacement planning
    - Preventative maintenance scheduling

- Workshop management (workflow planning, scheduling, job assignment)
- Work order management
- Warranty, recall, and campaign tracking
- Operating cost management (fuel, licenses, permits)
- Inventory management (parts supply system)
- Risk management (MVA, safety, compliance)
- Technician records and training plans
- Upgrade to new cloud-based system in 2025 will support comprehensive motor pooling (efficient booking, scheduling, and overall management of a shared vehicle pool)

- This system facilitates proactive maintenance by providing notifications of upcoming service needs (30, 60, and 90 days in advance). This enables efficient scheduling and minimizes vehicle downtime.

- **Telematics System:** This GPS-based system integrates with the fleet management system to provide real-time vehicle location and operational data, including routes, idling time, mileage, engine hours, and driver behavior. Key benefits of the telematics system include:
  - Idle time tracking and reduction
  - Vehicle utilization monitoring and optimization
  - Garage downtime and repair time tracking
  - Real-time engine fault detection
  - Driver behavior monitoring and improvement through driver scorecards (tracking excessive idling, harsh acceleration/braking, speeding, etc.)
  - Accident review and reconstruction

The integration of the fleet management and telematics systems allows for a proactive and data-driven approach to fleet maintenance. Real-time data from the telematics system informs maintenance schedules in the fleet management system, ensuring timely service and minimizing downtime. Operator-reported defects in the telematics system are seamlessly integrated into the fleet management system's repair queue.

Utilization Optimization:

Hydro Ottawa is committed to optimizing vehicle utilization and maximizing the efficiency of its fleet assets. Data from the telematics system is used to analyze utilization patterns across all vehicle classes, identifying opportunities for rationalization, efficiency gains, and asset pooling. While traditional mileage-based utilization metrics are not directly applicable to Hydro Ottawa's diverse operations (which include 24/7 availability, specialized equipment with high boom hours but low mileage, and crew/material transport), the utility considers these factors in its comprehensive analysis.

A key strategy for optimizing utilization is asset pooling. Hydro Ottawa actively seeks opportunities to share vehicles amongst different work groups and departments The consolidation of operations into centralized facilities in 2019 has further facilitated asset pooling and improved overall fleet utilization by reducing travel time to job sites and enabling better coordination of vehicle deployment. Assigning vehicles to specific groups and positions also supports this initiative, clarifying responsibilities and streamlining the sharing process. For example, light-duty vehicles (pickups, vans, cars) are frequently shared between teams with complementary schedules, maximizing their usage. However, to further maximize vehicle sharing, the scheduled upgrade to the fleet management software in 2025 will bring about an expanded pooling program and address prior limitations due to the current fleet management software. This approach is expected to reduce the overall number of vehicles required, minimizing capital expenditures and operational costs.

Analysis of usage patterns for all vehicle types helps identify low-utilization units for potential removal or redeployment, further contributing to cost savings and efficiency gains. The planned reductions in vehicle additions through pooling, as detailed in Table 43, demonstrate Hydro Ottawa's commitment to this important initiative.

11.7.2. Risks to Completion and Risk Mitigation Strategies

Table 46 outlines the key risks associated with the Fleet Replacement Program and the corresponding mitigation strategies.

Table 46 - Key Risks of Fleet Replacement and Mitigation Strategies

Category	Risk	Mitigation
Safety	Employee and public safety issues related to fleet deterioration	• Compliance with applicable codes, standards and regulations • Management supervision, risk assessments and reporting • Proactive replacement of vehicles based on condition and usage, not just age • Training programs focusing on safe operation
Operational	Fleet assets not available when needed to support OM&A and Capital programs	• Scheduled maintenance and inspection of all fleet vehicles and equipment • Advanced ordering prior to need (accommodating lead times) • Competitive procurement process • Contractual agreement with vendors regarding delivery dates • Regular review of fleet utilization data to optimize fleet size and composition
Financial	Higher fleet life-cycle costs due to failure to replace end of life fleet	• Fleet management system and proactive assessment of vehicle condition and replacement

CAPITALIZATION POLICY

In accordance with section 2.2.9 of the *Chapter 2 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications,* as dated on December 9, 2024, Hydro Ottawa's Capitalization Policy is provided in this Schedule as Attachment 2-6-1(A) - Capitalization Policy. Hydro Ottawa converted to International Financial Reporting Standards effective January 1, 2015. No changes have been made to Hydro Ottawa's capitalization policy since its last rebasing application.[1]

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020).

HYDRO OTTAWA CORPORATE POLICY

Subject: Capitalization		
Category: Finance	**Policy Number**: POL-Fi-013.01	
Administrator: Director, Finance	**Owner:** Chief Financial Officer	**Approver:** President and Chief Executive Officer

1. PURPOSE

The purpose of this policy is to define the criteria for acquisition, capitalization, transfer and retirement of Hydro Ottawa capital assets.

2. SCOPE

This policy applies to Hydro Ottawa.

3. DEFINITIONS

Capital assets include tangible and intangible assets, exclusive of goodwill

Commissioned or energized, in the context of this policy, is when a capital asset is placed into service or when the enhancement or betterment to an existing capital asset is complete

Directly Attributable Costs are costs that bring the asset to the location and condition intended for use, and include direct labour, inventory, outside services, non-stock materials and specific burdens

Enhancement or Betterment is an expenditure that contributes towards improving an asset's productivity or output or useful life

Goodwill, as defined by IAS 38, is the difference between the purchase price of an asset and the net amount of the acquired asset and assumed liability

Grouped Assets are asset purchases that are pooled into a single capital asset category as, by their nature, it would be impractical to identify individual units. These grouped assets are managed as a single asset for the purposes of depreciation

Hydro Ottawa refers to Hydro Ottawa Holding Inc. and its affiliates

IAS refers to International Accounting Standards

IAS 16 refers to the International Accounting Standard titled Property, Plant and Equipment

IAS 23 refers to the International Accounting Standard titled Borrowing Costs

IAS 38 refers to the International Accounting Standard titled Intangible Assets

IASB refers to the International Accounting Standards Board

IFRS refers to International Financial Reporting Standards

Intangible Assets, as defined by IAS 38, are identifiable non-monetary assets without physical substance

OM&A refers to operating, maintenance and administrative expenses

PP&E refers to Property, Plant and Equipment or Tangible Assets

Readily Identifiable Assets are discrete capital assets that are easily identifiable, so the asset can be individually recorded and depreciated

Residual Value is the estimated amount that an entity would currently obtain from disposal of the asset, after deducting the estimated costs of disposal, if the asset were already of the age and in the condition expected at the end of its useful life

Tangible Assets, as defined by IAS 16, include PP&E that are used on a continuing basis in the production or supply of goods and services and are not intended for sale in the ordinary course of business

4. POLICY DIRECTIVES

a) Hydro Ottawa will capitalize assets based on the standards established by the IASB under IAS 16 and IAS 38 whereby qualifying expenditures have to meet the following criteria:
   i. It is probable that further economic benefits associated with the item, for more than one year, will flow to the entity; and
   ii. the cost of the item can be measured reliably.

b) Capital asset are recorded using the cost method, whereby the cost of a capital asset comprises:
   i. its purchase price, including import duties and non-refundable purchase taxes, after deducting trade discounts and rebates.

ii. any costs directly attributable to bringing the asset to the location and condition necessary for it to be capable of operating in the manner intended by management. This shall include borrowing costs, in accordance with IAS 23, to finance capital projects with a duration greater than six months and accumulated cost is in excess of $100,000.
iii. the initial estimate of the costs of dismantling and removing the item and restoring the site on which it is located, the obligation for which an entity incurs when the item is acquired or as a consequence of having used the item during a particular period for purposes other than to produce inventories during that period.

c) Contributed plant that meets the definition of a capital asset is measured at fair value.
d) The following cost allocation rates included in directly attributable costs are based on management's best estimates of the applicable cost allocation determinants:
   i. Direct Labour - The hourly rate recovers direct labour and benefits costs. It will be applied to all direct labour hours through timesheet reporting.
   ii. Vehicle and Equipment - Vehicle and equipment hourly rates capture the directly attributable costs associated with fleet usage. Individual rates are developed for major vehicle classifications based on expected utilization. Charges will be accomplished through vehicles timesheet reporting.
   iii. Supervision Burden - The supervision burden rate recovers the directly attributable costs associated with the supervision of internal labour and outside services.
   iv. Engineering Burden - The engineering burden rate recovers the directly attributable engineering costs. It will be applied to Distribution Capital projects where applicable.
   v. Supply Chain Burden - The supply chain burden rate recovers the directly attributable procurement and warehouse costs.
   vi. These rates are reviewed and monitored on an annual basis. Material adjustments for over or under recoveries will also be recorded at the end of the fiscal year.
e) Subsequent enhancement or betterment costs which are incurred after the original asset is available for use will be capitalized based on the same criteria as the initial capital investment.
f) The materiality value for capitalizing newly acquired readily identifiable assets or additions to existing assets will be $500.
g) The materiality value for capitalizing grouped assets will be $1,000.
h) Equipment such as switchgear, transformers and meters that are reserved for emergency (capital spares) should be accounted as capital assets otherwise these items will be accounted for as inventory.
i) Depreciation of capital assets is based on the straight-line method in accordance with IAS 16 and 38. The useful lives of assets are reviewed annually.
j) Costs that are incurred to maintain the existing service potential of capital assets should be considered repairs and will be recognized in the profit or loss in the period in which they occur.
k) Hydro Ottawa may incur expenditures for amounts paid to other distributors or transmitters for capital projects. These expenditures, once available for use, should be recorded as Intangible Assets – Capital Contributions Paid.
l) Customer contributions associated with capital projects will be treated as deferred revenue and amortized to income over the life of the assets to which they relate.
m) When assets are retired from service, the capital cost and accumulated depreciation will be removed from Hydro Ottawa's financial statements with any gain or loss (after salvage proceeds, if applicable) charged to OM&A in the period in which the decommissioning occurs.

5. RELATED POLICIES, PROCEDURES AND REFERENCE DOCUMENTS
Hydro Ottawa Code of Business Conduct

6. EXCLUSIONS
There are no exclusions from this policy

7. ADDITIONAL POLICY ELEMENTS

There are no additional policy elements

8. COMPLIANCE

Employees must report incidents of non-compliance relating to this policy in a timely manner to the Policy Owner.

All instances of non-compliance shall be addressed immediately and may result in progressive disciplinary action. All members of the work group who had prior knowledge of the non-compliance may also be subject to progressive discipline. Repeat instances of non-compliance, or those that appear to be of a serious nature, must be immediately reported directly to the Director, Finance.

9. APPROVAL HISTORY

Revision	Effective Date	Description of Changes	Policy Owner:	Approved by:
.00	January 2015	Supersedes Policy FIN5-001-02 published on January 1, 2009	G. Simpson, Chief Financial Officer	B. Conrad, President and CEO
.01	October 2019	Minor updates to wording to match IFRS Standards and clause added regarding CCRA payments	DocuSigned by: Geoff Simpson 43DC885CF33E43F... G. Simpson, Chief Financial Officer	DocuSigned by: Bryce Conrad 8EDB4595749C4E3... B. Conrad, President and CEO
Scheduled Re-affirmation Date: **October 2022**		Responsibility: **Chief Financial Officer**		
Signatures on original only; original retained by Chief Financial Officer Division				

10. POLICY EXCEPTIONS

Exceptions to the above directives and/or changes to this policy must receive written pre-authorization from the President and CEO. For clarification on any aspect of this policy, contact the Director of Finance.

CAPITALIZATION OF OVERHEAD

Effective January 1, 2012, Hydro Ottawa revised its capitalization methodology used to apply overhead costs to property, plant, and equipment and intangible assets to be in accordance with International Financial Reporting Standards (IFRS). Under IFRS, International Accounting Standard 16 – *Property, Plant and Equipment* (IAS 16) and International Accounting Standard 38 – *Intangible Assets* (IAS 38) prohibit the capitalization of administration and other general overhead costs. As a result, the amount of capitalized overhead was significantly reduced as many of the costs that were capitalized prior to the revision of the policy were considered administrative or other general overhead. There have been no changes to Hydro Ottawa's capitalization of overhead since January 1, 2012 (and thus there have likewise been no changes since the utility's last rebasing application).

Hydro Ottawa applies overhead costs to capital through three separate burden rates: Supervision burden, Engineering burden, and Supply Chain burden. The use of multiple burden rates allows overhead costs to be applied more precisely to the particular projects that are associated with the various types of overhead costs. Please refer to Attachment 2-6-1(A) - Capitalization Policy for Hydro Ottawa's capitalization policy.

As shown in Attachment 2-6-2(A) - OEB Appendix 2-D - Overhead Expenses, the overhead costs capitalized (including labour and fleet) from 2021-2026 are in the range of 19 - 26%.

Attachment 2-6-2(A) - OEB Appendix 2-D - Overhead Expense

(Refer to the attachment in Excel format)

DEPRECIATION, AMORTIZATION DISPOSAL

1. INTRODUCTION

In accordance with section 2.2.4 of the *Chapter 2 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications,* dated December 9, 2024, this Schedule demonstrates that Hydro Ottawa's proposed levels of depreciation and amortization expenses appropriately reflect the useful lives of the utility's assets and the OEB's accounting policies.

2. ANNUAL DEPRECIATION AND AMORTIZATION

In Tables 1 and 2 below, Hydro Ottawa provides details for depreciation by asset group for the Historical Years 2021-2023, Bridge Years 2024-2025, and 2026-2030 Test Years.

Table 1 – Depreciation Expense - Historical & Bridge Years ($'000s)

Asset Group	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Land and Buildings	$ 3,448	$ 3,548	$ 3,620	$ 3,918	$ 3,974
TS Primary Above 50	$ 4,005	$ 4,575	$ 4,659	$ 4,720	$ 4,785
Distribution Stations	$ 4,045	$ 4,012	$ 4,124	$ 4,283	$ 4,286
Poles, Wires	$ 21,508	$ 23,557	$ 25,543	$ 27,961	$ 30,443
Line Transformers	$ 3,461	$ 3,742	$ 4,036	$ 4,337	$ 4,651
Services and Meters	$ 6,622	$ 5,969	$ 5,593	$ 5,592	$ 5,949
General Plant	$ 1,796	$ 2,684	$ 2,703	$ 2,639	$ 2,691
Equipment	$ 3,111	$ 3,101	$ 3,369	$ 3,396	$ 3,344
IT Assets	$ 7,645	$ 8,120	$ 8,408	$ 9,845	$ 11,177
Other Distribution Assets	$ 1,434	$ 1,602	$ 1,562	$ 1,408	$ 1,450
Sub-Total	**$ 57,074**	**$ 60,911**	**$ 63,616**	**$ 68,097**	**$ 72,750**
Contributions and Grants	$ (6,383)	$ (7,124)	$ (7,955)	$ (9,309)	$ (10,815)
TOTAL	**$ 50,690**	**$ 53,786**	**$ 55,661**	**$ 58,788**	**$ 61,936**

Table 2 – Depreciation Expense - Test Years ($'000s)

Asset Group	Test Years				
	2026	**2027**	**2028**	**2029**	**2030**
Land and Buildings	$ 4,164	$ 4,393	$ 4,778	$ 4,979	$ 5,118
TS Primary Above 50	$ 5,368	$ 6,598	$ 8,654	$ 9,047	$ 9,065
Distribution Stations	$ 4,473	$ 4,719	$ 5,237	$ 5,247	$ 5,156
Poles, Wires	$ 33,263	$ 36,958	$ 40,935	$ 44,460	$ 48,261
Line Transformers	$ 5,008	$ 5,392	$ 5,782	$ 6,169	$ 6,605
Services and Meters	$ 6,614	$ 7,648	$ 9,006	$ 10,486	$ 12,135
General Plant	$ 2,826	$ 3,028	$ 3,292	$ 3,213	$ 3,498
Equipment	$ 3,252	$ 4,671	$ 6,131	$ 7,240	$ 8,120
IT Assets	$ 12,910	$ 14,145	$ 12,451	$ 13,021	$ 13,367
Other Distribution Assets	$ 1,590	$ 1,845	$ 2,042	$ 2,035	$ 2,170
Sub-Total	**$ 79,467**	**$ 89,396**	**$ 98,308**	**$ 105,897**	**$ 113,493**
Contributions and Grants	$ (12,262)	$ (14,005)	$ (16,052)	$ (17,533)	$ (19,083)
TOTAL	**$ 67,205**	**$ 75,392**	**$ 82,256**	**$ 88,364**	**$ 94,410**

For detailed depreciation and amortization expenses, please see the following Excel Attachments:

- Attachment 2-7-1(A) - OEB Appendix 2-BB - Service Life Comparison
- Attachment 2-7-1(B) - OEB Appendix 2-C - 2021-2025 Depreciation and Amortization Expense
- Attachment 2-7-1(C) - OEB Appendix 2-C- 2026-2030 Depreciation and Amortization Expense

3. DISPOSITIONS BY ASSET GROUP

In Tables 3 and 4 below, Hydro Ottawa provides details of amortization related to disposals by asset group for the Historical Years (2021-2023), Bridge Years (2023 and 2024), and Test Years (2026-2030).

1 **Table 3 – Disposals - Historical Years ($'000s)[1]**

Asset Group	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Land and Buildings	$ (12)	$ (1)	-	-	-
TS Primary Above 50	$ (85)	$ (483)	$ (12)	$ (36)	$ (35)
Distribution Stations	$ (139)	$ (139)	$ (76)	$ (76)	$ (72)
Poles, Wires	$ (41)	$ (187)	$ (147)	$ (146)	$ (139)
Line Transformers	$ (247)	$ (189)	$ (155)	$ (206)	$ (196)
Services and Meters	$ (293)	$ (161)	$ (337)	$ (250)	$ (239)
General Plant	-	-	-	-	-
Equipment	$ (160)	$ (864)	$ (528)	$ (460)	$ (438)
IT Assets	-	-	-	-	-
Other Distribution Assets	-	-	-	$ (3)	$ (3)
Sub-Total	**$ (976)**	**$ (2,025)**	**$ (1,255)**	**$ (1,176)**	**$ (1,122)**
Contributions and Grants	-	-	-	-	-
TOTAL	**$ (976)**	**$ (2,025)**	**$ (1,255)**	**$ (1,176)**	**$ (1,122)**

2

3

[1] Totals may not sum due to rounding.

Table 4 – Disposals - Test Years ($'000s)[2]

Asset Group	Test Years				
	2026	2027	2028	2029	2030
Land and Buildings	-	-	-	-	-
TS Primary Above 50	$ (34)	$ (34)	$ (34)	$ (34)	$ (34)
Distribution Stations	$ (71)	$ (71)	$ (71)	$ (71)	$ (71)
Poles, Wires	$ (136)	$ (136)	$ (136)	$ (136)	$ (136)
Line Transformers	$ (192)	$ (192)	$ (192)	$ (192)	$ (192)
Services and Meters	$ (1,299)	$ (3,211)	$ (3,726)	$ (4,665)	$ (5,650)
General Plant	-	-	-	-	-
Equipment	$ (430)	$ (430)	$ (430)	$ (430)	$ (430)
IT Assets	-	-	-	-	-
Other Distribution Assets	$ (3)	$ (3)	$ (3)	$ (3)	$ (3)
Sub-Total	**$ (2,166)**	**$ (4,077)**	**$ (4,593)**	**$ (5,532)**	**$ (6,516)**
Contributions and Grants	-	-	-	-	-
TOTAL	**$ (2,166)**	**$ (4,077)**	**$ (4,593)**	**$ (5,532)**	**$ (6,516)**

4. DEPRECIATION AND AMORTIZATION RATES

Table 5 below provides detailed rates of depreciation and amortization by Uniform System of Accounts (USofA). Depreciation and amortization rates remain unchanged between the Historical/Bridge Years and the Test Years for all Accounts.

[2] Totals may not sum due to rounding.

1 **Table 5 – Property, Plant, and Equipment Depreciation Rates 2021-2030[3]**

USofA		Depreciation Rate
1609	Capital Contributions Paid*	2.20%
1611	Computer Software	10% - 20%
1612	Land Rights*	2%
1805	Land	N/A
1808	Buildings	1.3% - 3.3%
1815	Transformer Station Equip. >50 kV	2.2% - 6.7%
1820	Distribution Station Equip. <50 kV	2.2% - 6.7%
1825	Storage Battery Equipment	5% - 10%
1830	Poles, Towers & Fixtures	2.20%
1835	Overhead Conductors & Devices	2.2% - 4%
1840	Underground Conduit	2.50%
1845	Underground Conductors & Devices	1.7% - 4%
1850	Line Transformers	2.90%
1855	Services (Overhead & Underground)	2.20%
1860	Meters	6.70%
1905	Land	N/A
1908	Buildings & Fixtures	1.3% - 5%
1915	Office Furniture & Equipment	10%
1920	Computer Equipment - Hardware	10% - 25%
1930	Transportation Equipment	6.7% - 12.5%
1935	Stores Equipment	10%
1940	Tools, Shop & Garage Equipment	10%
1945	Measurement & Testing Equipment	10%
1950	Power Operated Equipment	6.7% - 8.3%
1955	Communications Equipment	4% - 12.5%
1960	Miscellaneous Equipment*	10%
1970	Load Mgmt Controls Customer Premises*	10%
1975	Load Mgmt Controls Utility Premises*	10%
1980	System Supervisor Equipment	6.70%

[3] USofAs in this table with an asterisk (*) are not included in the Kintectrics study referenced in this Schedule.

The useful lives of Hydro Ottawa's assets and components have been determined based on experience, professional judgement, failure data, and local conditions. Some useful lives differ when compared to the useful life range noted in the Kinectrics Report.[4] However, the useful lives of Hydro Ottawa's assets have been approved in previous rate applications. The utility has therefore continued to depreciate its fixed assets using the same methodology and useful lives as in prior years.

For further details on the useful lives of Hydro Ottawa's assets, please reference Attachment 2-7-1(A) - OEB Appendix 2-BB - Service Life Comparison.

There are variances between the depreciation and amortization calculated using the formulas in the annual Appendix 2-C[5] and those presented in the annual Appendix 2-BA.[6] Hydro Ottawa uses the half-year rule for calculating depreciation/amortization in the year that capital additions are added to the rate base, for both actual and budgeted pooled assets. However, in the case of discrete material assets (e.g. a station, major investment in IT assets, and so forth), the actual or forecasted in-service month would be used to calculate the depreciation/amortization. This is consistent with Hydro Ottawa's historical practices for these types of assets, for both rate application and financial reporting purposes.

Hydro Ottawa uses its financial system to calculate depreciation and amortization expense on assets that are already in service, and uses a depreciation forecast model to calculate depreciation and amortization on budgeted capital additions. Both the financial system and forecast model incorporate actual in-service dates of discrete material assets in the calculation. Hydro Ottawa proposes to continue this method of calculating depreciation for the 2026-2030 period.

[4] Kinectrics Inc., *Asset Depreciation Study for Use by Electricity Distributors*, EB-2010-0178 (July 8, 2010).
[5] The OEB's Appendix 2-C for the years 2021-2030 can be found in Attachments 2-7-1(B) and (C), respectively.
[6] The OEB's Appendix 2-BA for the years 2021-2030 can be found in Attachments 2-2-1(A) and (B), respectively.

5. NET GAIN/LOSS ON DISPOSITION

In Hydro Ottawa's last rebasing application,[7] the OEB approved the establishment of USofA 4362 Loss from Retirement of Utility and Other Property to record the difference between the forecast and actual loss on the disposal of fixed assets related to retirement of assets or damages to plant. Table 6 provides the balance in USofA 4362 for the Historical Years (2021-2023) and Bridge Years (2024 and 2025).

Table 6 – Loss from Retirement of Utility and Other Property ($'000s)

UsofA	Net (Gain)/Loss	Historical Years			Bridge Years		TOTAL
		2021	2022	2023	2024	2025	2021-2025
4362	OEB Approved	$ 389	$ 751	$ 323	$ 336	$ 445	$ 2,243
4362	Actual (gain)/loss	$ (202)	$ 1,234	$ (897)	$ (368)	$ (273)	$ (506)
1508	**Variance**	**$ (590)**	**$ 483**	**$ (1,220)**	**$ (704)**	**$ (718)**	**$ (2,749)**

The increased loss in 2022 is as a result of the Derecho and the higher number of assets that were derecognized during this storm.

Hydro Ottawa is seeking the continuance of the net gain/loss on fixed assets variance account in Schedule 9-1-3 - Group 2 Accounts and Schedule 6-3-5 - Other Income & Deductions. Table 7 provides the annual forecast amounts for the 2026-2030 Test Years.

Table 7 – Loss from Retirement of Utility and Other Property ($'000s)

Net (Gain)/Loss	Test Years					TOTAL
	2026	2027	2028	2029	2030	2026-2030
Forecast	$ 167	$ 636	$ 596	$ 609	$ 576	**$ 2,583**

[7] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020).

Attachment 2-7-1(A) - OEB Appendix 2-BB - Service Life Comparison

(Refer to the attachment in Excel format)

Attachment 2-7-1(B) - OEB Appendix 2-C - 2021 Depreciation and Amortization Expense

(Refer to the attachment in Excel format)

Attachment 2-7-1(C) - OEB Appendix 2-C - 2022 Depreciation and Amortization Expense

(Refer to the attachment in Excel format)

RATE BASE OVERVIEW

1. INTRODUCTION

This Schedule provides an overview of Hydro Ottawa's distribution rate base and a discussion of year-over-year variances. Variance explanations are provided for program costs with variances greater than $1M, consistent with the materiality threshold that the utility is employing for purposes of this Application.

In accordance with the OEB's *Chapter 2 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications*, dated December 9, 2024, this Schedule provides yearly information on Hydro Ottawa's rate base, including information on forecast net fixed assets, calculated on a mid-year average basis, along with working capital allowance (WCA). Net fixed assets are gross assets in service minus accumulated amortization and contributed capital.

The capital expenditure plan for the 2026-2030 period is outlined in Schedule 2-5-1 - Distribution System Plan Overview, Schedule 2-5-5 - Capital Expenditure Plan and Schedules 2-5-6 - System Access Investments, 2-5-7 - System Renewal Investments, 2-5-8 - System Service Investments, and 2-5-9 - General Plant Investments. The in-service additions included in rate base are not equal to capital expenditures outlined in Schedule 2-5-5 - Capital Expenditure Plan, as some expenditures start in one year and are energized in a different year, including outside the Custom IR period.

Details regarding WCA can be found in Schedule 2-3-1 - Working Capital Requirement.

2. SUMMARY OF 2021-2025 OEB-APPROVED AND ACTUAL RATE BASE

Table 1 below shows Hydro Ottawa's OEB-Approved rate base values for 2021-2025, as per the 2021-2025 Approved Settlement Agreement.[1] Table 1 provides the opening, closing, and average balances for gross assets and accumulated depreciation. The table further provides the closing approved balance for net fixed assets and Hydro Ottawa's WCA.

Table 1 – Summary of Approved Rate Base 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Opening Gross Assets	$ 1,358,887	$ 1,507,478	$ 1,626,152	$ 1,700,252	$ 1,779,853
Closing Gross Assets	$ 1,507,478	$ 1,626,152	$ 1,700,252	$ 1,779,853	$ 1,896,452
Average Gross Assets	**$ 1,433,182**	**$ 1,566,815**	**$ 1,663,202**	**$ 1,740,052**	**$ 1,838,152**
Opening Accumulated Depreciation	$ (275,287)	$ (324,639)	$ (377,881)	$ (433,247)	$ (490,428)
Closing Accumulated Depreciation	$ (324,639)	$ (377,881)	$ (433,247)	$ (490,428)	$ (551,211)
Average Accumulated Depreciation	**$ (299,963)**	**$ (351,260)**	**$ (405,564)**	**$ (461,838)**	**$ (520,820)**
Opening Net Book Value	$ 1,083,600	$ 1,182,840	$ 1,248,271	$ 1,267,004	$ 1,289,424
Closing Net Book Value	$ 1,182,840	$ 1,248,271	$ 1,267,004	$ 1,289,424	$ 1,345,241
Average Net Book Value	**$ 1,133,220**	**$ 1,215,555**	**$ 1,257,638**	**$ 1,278,214**	**$ 1,317,333**
Working Capital Allowance	$ 85,459	$ 88,279	$ 91,546	$ 95,940	$ 99,394
RATE BASE	**$ 1,218,679**	**$ 1,303,835**	**$ 1,349,183**	**$ 1,374,154**	**$ 1,416,727**

Table 2 below summarizes Hydro Ottawa's rate base for Historical Years 2021-2023, and Bridge Years 2024 and 2025.

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Settlement Agreement*, EB-2019-0261 (September 18, 2020).

Table 2 AS ORIGINALLY SUBMITTED – Summary of Historical and Bridge Year Rate Base 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Opening Gross Assets	$ 1,345,265	$ 1,469,459	$ 1,607,631	$ 1,692,408	$ 1,810,056
Closing Gross Assets	$ 1,469,459	$ 1,607,631	$ 1,692,408	$ 1,810,056	$ 1,931,368
Average Gross Assets	**$ 1,407,362**	**$ 1,538,545**	**$ 1,650,020**	**$ 1,751,232**	**$ 1,870,712**
Opening Accumulated Depreciation	$ (271,071)	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)
Closing Accumulated Depreciation	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)	$ (545,380)
Average Accumulated Depreciation	**$ (295,928)**	**$ (346,666)**	**$ (399,750)**	**$ (455,759)**	**$ (514,973)**
Opening Net Book Value	$ 1,074,194	$ 1,148,674	$ 1,235,084	$ 1,265,454	$ 1,325,491
Closing Net Book Value	$ 1,148,674	$ 1,235,084	$ 1,265,454	$ 1,325,491	$ 1,385,988
Average Net Book Value	**$ 1,111,434**	**$ 1,191,879**	**$ 1,250,269**	**$ 1,295,472**	**$ 1,355,739**
Working Capital Allowance	$ 70,733	$ 71,503	$ 71,908	$ 73,914	$ 75,171
RATE BASE	**$ 1,182,167**	**$ 1,263,382**	**$ 1,322,177**	**$ 1,369,386**	**$ 1,430,910**

Table 2 UPDATED JUNE 4, 2025 – Summary of Historical and Bridge Year Rate Base 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	**2022**	**2023**	**2024**	**2025**
Opening Gross Assets	$ 1,345,265	$ 1,469,459	$ 1,607,631	$ 1,692,408	$ 1,810,056
Closing Gross Assets	$ 1,469,459	$ 1,607,631	$ 1,692,408	$ 1,810,056	$ 1,931,368
Average Gross Assets	**$ 1,407,362**	**$ 1,538,545**	**$ 1,650,020**	**$ 1,751,232**	**$ 1,870,712**
Opening Accumulated Depreciation	$ (271,071)	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)
Closing Accumulated Depreciation	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)	$ (545,380)
Average Accumulated Depreciation	**$ (295,928)**	**$ (346,666)**	**$ (399,750)**	**$ (455,759)**	**$ (514,973)**
Opening Net Book **Value**	$ 1,074,194	$ 1,148,674	$ 1,235,084	$ 1,265,454	$ 1,325,491
Closing Net Book Value	$ 1,148,674	$ 1,235,084	$ 1,265,454	$ 1,325,491	$ 1,385,988
Average Net Book Value	**$ 1,111,434**	**$ 1,191,879**	**$ 1,250,269**	**$ 1,295,472**	**$ 1,355,739**
Working Capital Allowance	$ 70,733	$ 71,503	$ 71,908	$ 73,992	$ 75,249
RATE BASE	**$ 1,182,167**	**$ 1,263,382**	**$ 1,322,177**	**$ 1,369,464**	**$ 1,430,988**

Table 3 below shows the variances between the OEB-Approved rate base amounts as shown in Table 1 and the Historical Year and Bridge Year amounts as shown in Table 2 for the 2021-2025 period.

Table 3 AS ORIGINALLY SUBMITTED – Variances in 2021-2025 Rate Base - OEB-Approved vs. Historical and Bridge Year Amounts ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Opening Gross Assets	$ (13,622)	$ (38,019)	$ (18,521)	$ (7,844)	$ 30,203
Closing Gross Assets	$ (38,019)	$ (18,521)	$ (7,844)	$ 30,203	$ 34,916
Average Gross Assets	**$ (25,820)**	**$ (28,270)**	**$ (13,182)**	**$ 11,180**	**$ 32,560**
Opening Accumulated Depreciation	$ 4,216	$ 3,854	$ 5,334	$ 6,293	$ 5,863
Closing Accumulated Depreciation	$ 3,854	$ 5,334	$ 6,293	$ 5,863	$ 5,831
Average Accumulated Depreciation	**$ 4,035**	**$ 4,594**	**$ 5,814**	**$ 6,079**	**$ 5,847**
Opening Net Book Value	$ (9,406)	$ (34,166)	$ (13,187)	$ (1,550)	$ 36,067
Closing Net Book Value	$ (34,166)	$ (13,187)	$ (1,550)	$ 36,067	$ 40,747
Average Net Book Value	**$ (21,786)**	**$ (23,676)**	**$ (7,369)**	**$ 17,258**	**$ 38,406**
Working Capital Allowance	$ (14,726)	$ (16,776)	$ (19,638)	$ (22,026)	$ (24,223)
RATE BASE	**$ (36,512)**	**$ (40,453)**	**$ (27,006)**	**$ (4,768)**	**$ 14,183**

Table 3 UPDATED JUNE 4,2025 – Variances in 2021-2025 Rate Base - OEB-Approved vs. Historical and Bridge Year Amounts ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Opening Gross Assets	$ (13,622)	$ (38,019)	$ (18,521)	$ (7,844)	$ 30,203
Closing Gross Assets	$ (38,019)	$ (18,521)	$ (7,844)	$ 30,203	$ 34,916
Average Gross Assets	**$ (25,820)**	**$ (28,270)**	**$ (13,182)**	**$ 11,180**	**$ 32,560**
Opening Accumulated Depreciation	$ 4,216	$ 3,854	$ 5,334	$ 6,293	$ 5,863
Closing Accumulated Depreciation	$ 3,854	$ 5,334	$ 6,293	$ 5,863	$ 5,831
Average Accumulated Depreciation	**$ 4,035**	**$ 4,594**	**$ 5,814**	**$ 6,079**	**$ 5,847**
Opening Net Book Value	$ (9,406)	$ (34,166)	$ (13,187)	$ (1,550)	$ 36,067
Closing Net Book Value	$ (34,166)	$ (13,187)	$ (1,550)	$ 36,067	$ 40,747
Average Net Book Value	**$ (21,786)**	**$ (23,676)**	**$ (7,369)**	**$ 17,258**	**$ 38,406**
Working Capital Allowance	$ (14,726)	$ (16,776)	$ (19,638)	$ (21,948)	$ (24,145)
RATE BASE	**$ (36,512)**	**$ (40,453)**	**$ (27,006)**	**$ (4,690)**	**$ 14,261**

Hydro Ottawa's rate base in 2025 is approximately $14.2M higher than the OEB-Approved amount, driven mainly by higher in-service additions over the period, offset by a reduction in the WCA compared to the OEB-Approved amount. Please refer to Table 4 below for details.

3. IN-SERVICE CAPITAL ADDITIONS VARIANCE

Table 4 below shows the variances between the OEB-Approved Net In-Service Capital Additions and the Historical Year and Bridge Year amounts for the 2021-2025 period. The in-service additions were $45M (or 8%) above the OEB-Approved amounts over the historical period.

For additional details at the capital expenditures level, refer to Schedule 2-5-5 - Capital Expenditure Plan.

Table 4 – Variances in 2021-2025 Net In-Service Capital Additions - OEB-Approved vs. Historical and Bridge Year Amounts ($'000s)[2]

	2021-2025 OEB Approved	2021-2025 Historical/Bridge	Var. ($)	Var (%)
System Access	$ 86,018	$ 114,733	$ 28,715	33%
System Renewal	$ 211,821	$ 239,167	$ 27,346	13%
System Service	$ 142,375	$ 144,242	$ 1,867	1%
General Plant	$ 114,837	$ 101,822	$ (13,015)	(11)%
NET IN-SERVICE ADDITIONS	**$ 555,052**	**$ 599,963**	**$ 44,912**	**8%**

The major drivers of the higher in-service additions are as follows:

(i) Unprecedented Supply Chain Disruption: The 2021-2025 period witnessed an unprecedented confluence of global events, severely disrupting supply chains and driving inflationary pressures. The COVID-19 pandemic initiated widespread logistical challenges, exacerbated by surging demand for essential electrical equipment. Subsequent economic factors and shipping bottlenecks compounded these issues. Critically, the war in Ukraine also introduced a significant constraint on the availability of grain-oriented electrical steel, a vital component for transformer cores, further impacting material availability and costs. As noted in Schedule 1-2-5 - Impacts of Inflationary Pressure, Canada's inflation rate in the 2020-2024 period as measured by CPI was the highest in 40 years. Also with respect to capital costs, the approved plan did not include any amounts forecast for inflation, nor did it include any cost escalation adjustment mechanisms. Essentially the capital plan assumed that a modest level of inflation would continue and the impact of any inflation would be offset by productivity and efficiency savings. Furthermore, the 2022-2025 capital related revenue requirement was reduced by a cumulative annual 0.6% capital stretch factor as outlined in Section 8.

[2] Totals may not sum due to rounding.

(ii) Customer Connections Volume, Complexity, and Cost: an unprecedented increase in the volume and complexity of non-discretionary residential subdivision customer connections due to a combination of residential intensification and a growing demand for electricity.

(iii) Unforeseen Externally-Driven Projects: driven mainly by the unprecedented increase in the volume and cost of residential subdivision and commercial development customer connections, as well as several large plant relocation works involving major revitalizations on Bank Street and Montreal Road, as well as other large plant relocation works related to Phase II of the Light Rail Transit (LRT) project.

(iv) Increased Emergency Renewal Work due to Major Storms and Equipment Failure: Emergency Renewal capital expenditures that significantly exceeded historical levels were driven largely by the devastating 2022 Derecho (which became the 6th costliest natural disaster in Canada's history), other major storms, and a general increase in the amount and cost of equipment that needed to be replaced on an emergency, reactive basis. The 2022 Derecho caused over 1,000 individual outages, left 180,000 customers without power, and resulted in restoration efforts spanning multiple weeks. Over 500 poles were damaged and required replacement. For more detail, please reference Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report. The Derecho was not the only adverse weather event Hydro Ottawa experienced in the 2021-2025 rate period. An ice storm in April 2023 also required capital investments to replace damaged infrastructure during the restoration efforts. Further details regarding the adverse weather events Hydro Ottawa experienced from 2021-2025 can be found in Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Additionally, Hydro Ottawa experienced an increase in reactive capital expenditures to address failing equipment.

In response to these challenges, Hydro Ottawa implemented proactive financial management strategies, notably deferring certain planned projects such as Major Station Rebuilds, Voltage

Conversions, Enterprise Resource Planning (ERP) Upgrades, and Underground Switchgear Renewals. For additional details, refer to Section 4.1.3 of Schedule 2-5-5 DSP - Capital Expenditure Plan Section. Furthermore, Hydro Ottawa's labour productivity initiatives, as described in Schedule 1-3-4 - Facilitation Innovation and Continuous Improvement, played a crucial role in mitigating the overall financial impact. Without these initiatives, the net capital additions variance of $44.9M against the OEB-Approved budget would have been considerably higher. It is also worth noting that Hydro Ottawa did not apply for a Z factor during the 2021-2025 period.

The following Sections 3.1 through 3.4 provide details on the in-service capital additions variance by Investment Category on a five year total basis, while Section 4 provides a year-over-year variance analysis.

3.1. SYSTEM ACCESS IN-SERVICE CAPITAL ADDITIONS VARIANCE

Capital additions related to System Access over the 2021-2025 Rate Period are expected to be $28.7M higher than approved amounts. The variance detail by capital program is included in Table 5 below.

Table 5 – Variances in Net In-Service Capital Additions - System Access ($'000s)

Capital Program	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
Plant Relocation	$ 16,098	$ 22,292	$ 6,194	38%
System Expansion	$ 26,906	$ 24,995	$ (1,911)	(7)%
Corrective Renewal	$ 412	$ 1,365	$ 952	231%
Customer Connections	$ 37,049	$ 64,141	$ 27,092	73%
Generation Connections	$ 710	$ 342	$ (368)	(52)%
Metering	$ 4,843	$ 1,599	$ (3,245)	(67)%
TOTAL ADDITIONS	**$ 86,018**	**$ 114,733**	**$ 28,715**	**33%**

A symmetrical capital variance account for capital additions for which the drivers are either plant relocation requested by 3rd parties or residential subdivision expansion was granted in Hydro Ottawa's 2021-2025 Custom IR Application. The remaining System Access spending, along with System Renewal / System Service and General Plant was tracked through an asymmetrical account.

Table 6 provides a breakdown of the OEB-Approved System Access in-service additions vs. Historical/Bridge amounts for 2021-2025 by the capital variance sub-account (symmetrical) and other (asymmetrical). The majority of the variance reflects the expected increase in residential and plant relocations.

Table 6 – Variances in Net In-Service Capital Additions - System Access by Capital Variance Sub-Account ($'000s)

Capital Variance Sub Account	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
Residential & Plant Relocation	$ 30,946	$ 60,862	$ 29,916	97%
Other	$ 55,072	$ 53,871	$ (1,201)	(2)%
TOTAL ADDITIONS	**$ 86,018**	**$ 114,733**	**$ 28,715**	**33%**

The main drivers of the residential subdivision and plant relocation variance are:

- **Residential Subdivision:** Capital Additions are expected to exceed approved amounts by $23.7M, driven primarily by actual annual volumes that were approximately 58% higher on average than forecasted volumes resulting from the City of Ottawa's intensification policies, and increases in unit costs per connection from $852 to $1,350 due to inflationary pressures.
- **Plant Relocation:** Capital additions are forecast to exceed approved amounts by $6.2M. The major drivers of the overage are scheduling delays related to the LRT Phase II Confederation Line, which led to projects completing in 2021-2025 that were originally assumed to complete in 2016-2020, post Phase I rehabilitation work on Slater & Albert streets, and the Bank Street Revitalization and Montreal Road Revitalization projects, along with inflationary increases.

The remaining capital additions under System Access were materially in-line with approved amounts for 2021-2025, with an overall shortfall vs. approved amounts of $1.2M. Further detail regarding System Access expenditures can be found in Section 5.1 of Schedule 2-5-5 - Capital Expenditure Plan.

3.2. SYSTEM RENEWAL IN-SERVICE CAPITAL ADDITIONS VARIANCE

Capital additions related to System Renewal over the 2021-2025 Rate Period are expected to be $27.3M over OEB-Approved amounts. Details by capital program are included in Table 7 below.

Table 7 – Variances in Net In-Service Capital Additions - System Renewal ($'000s)

Capital Program	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
Stations & Buildings Infrastructure Renewal	$ 47,244	$ 38,221	$ (9,023)	(19)%
Overhead Distribution Asset Renewal	$ 44,779	$ 42,825	$ (1,954)	(4)%
Underground Distribution Assets Renewal	$ 57,382	$ 62,846	$ 5,464	10%
Corrective Renewal	$ 49,326	$ 83,581	$ 34,255	69%
Metering Renewal	$ 13,091	$ 11,694	$ (1,396)	(11)%
Total Additions	**$ 211,821**	**$ 239,167**	**$ 27,346**	**13%**

Unplanned capital additions from restoration efforts in response to emergency storms accounted for $16.1M or 59% of the total $27.3M overage. Capital additions related to the 2022 Derecho totaled $15.1M while other major weather events, particularly the April 2023 ice storm, led to an additional $1.0M of unplanned capital additions. Note that in addition to capital expenditures, the nature of the storms also had a significant amount of operating and maintenance expenses as noted in Schedule 4-1-2 - Operations, Maintenance & Administration Program Costs and Section 6 of Schedule 2-5-5 - Capital Expenditure Plan.

The remaining $11.2M of the total $27.3M overage is driven largely by:

- **Stations and Buildings Infrastructure Renewal:** Forecasted capital additions are expected to be below approved amounts by approximately $9.0M due mainly to a scope change in the Fisher Station Rebuild project to a voltage conversion, and the deferral of the Dagmar Voltage conversion from 2023 to the 2026-2030 rate period. Refer to Section 5.2 of Schedule 2-5-5 - Capital Expenditure Plan for more details on these deferrals and scope changes.
- **Overhead Distribution Asset Renewal:** Despite overages in Planned Pole Renewal and System Renewal overall, active deferrals in Insulator Replacement and Overhead Switch programs are projected to keep capital additions $2.0M below the approved amount.
- **Underground Distribution Asset Renewal:** Forecasted capital additions are expected to exceed approved amounts by $5.5M, due largely to overages in the Cable Replacement program resulting from significantly higher than anticipated material price increases. Refer to Sections 3.3.2 and 4.2.1 of Schedule 1-2-5 - Impacts of Inflationary Pressure for more information.
- **Corrective Renewal (excluding the $16.1M storm costs discussed above):** The Emergency Renewal program experienced higher than OEB-Approved capital additions of approximately $12.5M related to distribution transformers. Hydro Ottawa observed a general trend/issue with leaking transformers related to a specific manufacturer and certain localized regions. The identified transformers had to be phased out and replaced, with the new transformers requiring bigger foundations. Emergency underground transformer replacements in 2024 cost as much as $122,481 when remediation and base replacement were required. This was a sharp contrast to the $25,648 average cost for emergency replacement without remediation or base replacements. Additionally, Emergency Poles capital additions are expected to exceed budgeted amounts by about $5.6M, driven largely by forecasts for 2024 and 2025 reflecting a 50% per-pole cost increase compared to actual

costs from 2021-2023, which is attributed to inflationary pressures and updated estimating methodologies.

- **Metering Renewal:** Bridge and Test Year capital additions for the Metering Renewal program are expected to be below OEB-Approved amounts by $1.4M; driven by persistent delays in acquiring Gatekeeper meters that were part of the Self-Contained Meter Phone Line Elimination project. Consequently, in 2024 the Gatekeeper solution was deemed unsuccessful, which resulted in the reduction of the Metering Renewal program in 2024 and 2025. The new solution will be addressed as part of Hydro Ottawa's Advanced Metering Infrastructure (AMI) 2.0 initiative planned for 2026-2030.

Further information on System Renewal expenditures can be found in Section 5.2.1 of Schedule 2-5-5 - Capital Expenditure Plan.

3.3. SYSTEM SERVICE IN-SERVICE CAPITAL ADDITIONS VARIANCE

Capital additions related to System Service over the 2021-2025 Rate Period are expected to be $1.9M over OEB-Approved amounts. Details by capital program are included in Table 9 below.

Table 9 – Variances in Net In-Service Capital Additions - System Service ($'000s)

Capital Program	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
Capacity Upgrades	$ 96,723	$ 92,290	$ (4,433)	(5)%
Stations Enhancements	$ 2,301	$ 2,601	$ 300	13%
Distribution Enhancements	$ 28,174	$ 26,397	$ (1,777)	(6)%
Grid Technologies	$ 8,867	$ 20,875	$ 12,008	135%
Field Area Network	$ 6,069	$ 2,077	$ (3,992)	(66)%
Metering	$ 240	$ 1	$ (239)	(100)%
Total Additions	**$ 142,375**	**$ 144,242**	**$ 1,867**	**1%**

- **Capacity Upgrades:** Capital additions are expected to be below OEB-Approved amounts by $4.4M, driven mainly by delays in the Riverdale Switchgear Upgrade project. The Riverdale Switchgear Upgrade was delayed due to necessary scope adjustments required to adhere to capacity planning requirements identified through area planning. Construction is scheduled to start in 2025, and energization is planned for 2026-2030.
- **Distribution Enhancements:** Capital additions are expected to be below OEB-Approved amounts by approximately $1.8M, due largely to project scope adjustments and reprioritization efforts.
- **Grid Technologies:** Capital additions are expected to exceed OEB-Approved amounts by approximately $12M, due largely to the replacements of Hydro Ottawa's Outage Management System (OMS) and Advanced Distribution Management System (ADMS). Once the ADMS initiative commenced, detailed planning revealed significant gaps in the original requirements. Specifically, the need for a dedicated project resource model, expanded professional services, and the crucial addition of schematics map conversion significantly broadened the project's scope. These discoveries, which emerged only during detailed implementation planning, necessitated immediate and substantial adjustments. Given the program's criticality to operational stability and cybersecurity, Hydro Ottawa made the strategic decision to prioritize the ADMS project, even at the cost of deferring other planned projects. Delaying these crucial upgrades was not a viable option due to the escalating risks. This strategic decision, while resulting in increased immediate costs, was essential to secure the future reliability and resilience of Hydro Ottawa's infrastructure, and to fully realize the vital benefits of the ADMS platform.

Hydro Ottawa notes that the ADMS program is currently undergoing a comprehensive review, and therefore specific details of the Grid Technology budget program, including the capital budget and timing of in-service additions, are subject to significant change. Updated information and supporting documentation related to the program will be filed with the responses to interrogatories. This approach ensures transparency and allows stakeholders to fully assess the program's potential impact and provide informed feedback within the rate application process. Additional details can be found in Section 5.3.2 of Schedule 2-5-5 - Capital Expenditure Plan.

- **Field Area Network:** Forecasted capital additions are expected to be below approved amounts by $4.0M due largely to project delays while awaiting a change by the Canadian Radio-television and Telecommunications Commission that would allow local distribution companies to deploy and operate wireless communication services, which hindered the purchase and installation of base stations and cellular-enabled field devices. Consequently, funds were redistributed to Grid Technologies to offset the overspend on the ADMS projects. Further information on System Service expenditures can be found in Section 5.3 of Schedule 2-5-5 - Capital Expenditure Plan.

3.4. GENERAL PLANT IN-SERVICE CAPITAL ADDITIONS VARIANCE

Capital additions related to General Plant over the 2021-2025 Rate Period are expected to be $13.0M below approved amounts. Details by capital program are included in Table 10 below.

Table 10 – Variances in Net In-Service Capital Additions - General Plant ($'000s)

Capital Program	2021-2025			
	OEB - Approved ($)	Historical / Bridge ($)	Variance ($)	Variance (%)
CCRA	$ 60,964	$ 45,434	$ (15,529)	(25)%
Fleet Replacement	$ 16,536	$ 17,748	$ 1,212	7%
Tools Replacement	$ 2,343	$ 2,909	$ 565	24%
Buildings - Facilities	$ 2,066	$ 7,045	$ 4,979	241%
Grid Technology (Ops Initiative)	$ 1,760	$ 2,073	$ 313	18%
Meter to Cash	$ 6,983	$ 3,655	$ (3,328)	(48)%
Customer Engagement Platform	$ 1,990	$ 7,622	$ 5,632	283%
Enterprise Solutions	$ 13,113	$ 5,845	$ (7,269)	(55)%
Infrastructure and Cyber Security	$ 7,474	$ 7,937	$ 463	6%
Data and System Integrations	$ 1,608	$ 1,553	$ (55)	(3)%
Total Additions	**$ 114,837**	**$ 101,822**	**$ (13,015)**	**(11)%**

- **Cost Recovery Agreement (CCRA):** Capital additions are expected to be below approved amounts by $15.5M, due largely to lower than budgeted costs for the Cambrian Municipal Transformer Station project, the elimination of the CCRA requirement on the Riverdale Switchgear Upgrade project in 2021-2025 and deferrals of payment on the Piperville station project related to delays with land acquisition.
- **Fleet Replacement:** Capital additions are expected to exceed approved amounts by $1.2M, due largely to unforeseen increases in vehicle costs well beyond historical annual inflationary increases as a result of COVID-19 supply chain disruptions. Nine vehicles were also deferred to offset the inflationary pressures.

- **Buildings - Facilities:** Capital additions are forecasted to exceed budget by $5.0M. The main drivers were the construction of a shared access roadway at the East entrance to the Hunt Club road facility which was driven by a 3rd party, the installation of EV charging stations at all Administration and Operations to accommodate Hydro Ottawa's growing EV fleet in support of its zero emissions target, and two initiatives that were completed as direct responses to health and safety hazards that were reported and required action during the period. Specifically the installation of a new HVAC/ventilation unit at the Bank Street garage to address health and safety concerns and to comply with Ministry of Labour standards for garage ventilation, as well as the creation of additional storage space at the garage to reduce trip hazards and alleviate congestion, while also providing improved conditions for vehicle servicing and training.
- **Meter to Cash:** Capital additions are expected to be below approved amounts by $3.3M, the main driver being the AMI Analytics & Integration Enablement project. The project experienced significant delays and unforeseen challenges due to external factors such as the COVID-19 pandemic, 2022 Derecho and the 84-day strike in 2023 where resources had to be deployed to other priorities.
- **Customer Engagement Platform:** Capital additions are expected to be above approved amounts by approximately $5.6M, driven largely by the replacement of Hydro Ottawa's My Account customer portal. The legacy portal had developed organically over a number of years resulting in an interconnected system of multiple web and mobile technologies, services and solutions. While the solution had served the company well, given the rate of technology change, increasing customer experience demands, a rapidly changing energy industry and continued Hydro Ottawa growth, the solution could no longer scale or adapt and was deemed inadequate to support Hydro Ottawa and customer needs. Spend was further influenced from the stated scope due to emerging regulatory obligations and necessary customer self-service enhancements. Examples of these include the implementation of Ultra-Low Overnight rate option, Net Metering, Green Button, Equal Monthly Payment Plan automation, Autopay registration and Move-In-Move-Out automation.

The investment has positioned Hydro Ottawa to better meet customer needs, adapt to unforeseen disruption and represents the company's commitment to continually enhance customer experience and engagement.

- **Enterprise Solutions:** Capital additions are expected to be below approved amounts by approximately $7.3M, largely due to the deferral of Hydro Ottawa's ERP system to the 2031-2035 time frame, which was originally scheduled for 2021-2025.

Further information on all General Plant expenditures can be found in Section 5.4 of Schedule 2-5-5 - Capital Expenditure Plan.

4. YEAR OVER YEAR IN-SERVICE CAPITAL ADDITIONS VARIANCE

4.1. 2021 APPROVED vs. 2021 ACTUAL

Table 11 below details the comparison between 2021 OEB-Approved and Historical in-service additions.

Table 11 – 2021 Net In-Service Additions, OEB Approved vs. Actual ($'000s)

Investment Category	2021 OEB Approved ($)	2021 Historical	Variance ($)	Variance (%)
System Access	$ 19,534	$ 19,808	$ 274	1%
System Renewal	$ 48,298	$ 41,857	$ (6,441)	(13)%
System Service	$ 19,207	$ 30,683	$ 11,476	60%
General Plant	$ 65,759	$ 34,462	$ (31,296)	(48)%
TOTAL	**$ 152,798**	**$ 126,811**	**$ (25,987)**	**(17)%**

Variance Analysis

- System Access capital additions were materially in line with OEB-Approved amounts.
- System Renewal in-service additions were $6.4M (13%) below OEB approved levels, driven largely by adjustments to project schedules in the Stations and Buildings Infrastructure Renewal Capital Program (Bells Corners Station Rebuild) from 2021-2023.
- System Service in-service additions were $11.5M (60%) above OEB approved amounts, the major driver being the early completion of the buildings at Cambrian Municipal Transformer Station (MTS) originally scheduled for completion in 2022.
- General Plant in-service additions were $31.3M (48%) lower than OEB approved amounts due largely to shifting energization in the CCRA program related to the Cambrian MTS from 2021 to 2022 to align with the in-use date of Hydro One's 230kV line extension connection to the station.

4.2. 2022 APPROVED vs. 2022 ACTUAL

Table 12 below details the comparison between 2022 OEB-Approved and Historical in-service additions.

Table 12 – 2022 OEB-Approved vs. Historical Net In-Service Additions, ($'000s)

Investment Category	2022 OEB Approved ($)	2022 Historical	Variance ($)	Variance (%)
System Access	$ 17,922	$ 17,796	$ (125)	(1)%
System Renewal	$ 45,132	$ 64,903	$ 19,770	44%
System Service	$ 47,330	$ 26,513	$ (20,817)	(44)%
General Plant	$ 12,086	$ 33,142	$ 21,056	174%
TOTAL	**$ 122,471**	**$ 142,354**	**$ 19,883**	**16%**

Variance Analysis

- System Access capital additions were materially in line with OEB-Approved amounts.

- System Renewal additions were $19.8M (44%) above OEB-Approved amounts driven largely by capital additions in response to the Derecho storm which totaled $15.1M. Additionally, capital additions in the Cable Replacement program were $7.5M above approved amounts, offset by shortfalls in Stations Buildings & Infrastructure Renewal (due to switching the Fisher station rebuild project to a voltage conversion project at a much lower cost) and Metering Renewal due to delays in acquiring Gatekeeper meters.
- System Service capital additions were $20.8M (44%) below approved amounts, driven largely by the early completion of the buildings at Cambrian MTS, which as mentioned above, were completed in 2021 but were expected to be completed in 2022.
- General Plant additions were $21.1M (174%) above approved amounts due to the timing of the Cambrian MTS CCRA energization, which as mentioned above was originally budgeted in 2021.

4.3. 2023 APPROVED vs. 2023 ACTUAL

Table 13 below details the comparison between 2023 OEB-Approved and Historical in-service additions.

Table 13 – 2023 OEB-Approved vs. Historical Net In-Service Additions ($'000s)

Investment Category	2023 OEB Approved ($)	2023 Historical	Variance ($)	Variance (%)
System Access	$ 17,620	$ 18,715	$ 1,095	6%
System Renewal	$ 40,813	$ 48,952	$ 8,140	20%
System Service	$ 13,106	$ 9,420	$ (3,687)	(28)%
General Plant	$ 6,237	$ 9,916	$ 3,679	59%
TOTAL	**$ 77,776**	**$ 87,003**	**$ 9,227**	**12%**

Variance Analysis

- System Access capital additions were $1.1M (6%) higher than approved amounts in 2023, driven largely by overages in Customer Connections due to increased volumes and unit costs, offset by shortfalls in Plant Relocation and System Expansion.
- System Renewal additions were $8.1M (20%) above approved amounts, driven mainly by timing of energization of the Bells Corners Station rebuild mentioned above (originally scheduled for completion in 2021).
- System Service additions were $3.7M (28%) below approved amounts, the main driver being the timing of completion of projects under the Distribution Enhancement capital program.
- General Plant additions were $3.7M (59%) higher than approved amounts, driven largely by the completion of the 1st phase of the MyAccount customer portal upgrade.

4.4. 2024 APPROVED vs. 2024 BRIDGE

Table 14 below details the comparison between 2024 OEB-Approved amounts vs. Bridge year in-service additions.

Table 14 – 2024 OEB-Approved vs. Bridge Year Net In-Service Additions ($'000s)

Investment Category	2024 OEB Approved ($)	2024 Bridge	Variance ($)	Variance (%)
System Access	$ 15,630	$ 32,616	$ 16,986	109%
System Renewal	$ 37,560	$ 43,242	$ 5,682	15%
System Service	$ 21,705	$ 28,869	$ 7,163	33%
General Plant	$ 7,877	$ 15,395	$ 7,519	95%
TOTAL	**$ 82,772**	**$ 120,122**	**$ 37,350**	**45%**

Variance Analysis

- System Access capital additions are expected to be $17M (109%) higher than OEB-Approved amounts, the main drivers being continued higher than budgeted volumes and unit costs in the Customer Connections program, which contributed $6.2M towards the overage. Additionally, approximately $8M is attributable to unforeseen cost overruns for the LRT Phase II System Expansion works, due to changes in the project's timeline and scope, as explained in Section 5.1.2 of Schedule 2-5-5 Capital Expenditure Plan.
- System Renewal additions are expected to be $5.7M (15%) higher than OEB-Approved amounts, driven largely by overages in Corrective Renewal due to higher than expected volumes of leaking transformers that required replacement.
- System Service additions are expected to be $7.2M (33%) above OEB-Approved amounts, driven largely by overages within the the Distribution Enhancements program which resulted from scheduling adjustments from prior years, and the energization of the Distribution Management System within the Grid Technologies, offset by delays of the Riverdale Switchgear replacement to 2026-2030 within the Capacity Upgrades program.
- General Plant capital additions are expected to be $7.5M (95%) higher than OEB-Approved amounts, driven largely by continued deployment of MyAccount customer portal functionality, the installation of EV Charging infrastructure at the Hunt Club and Dibblee facilities to support continued greening of Hydro Ottawa's vehicle fleet, and the deployment of the Service Now IT ticketing system.

4.5. 2025 APPROVED vs. 2025 BRIDGE

Table 15 below details the comparison between 2025 OEB-Approved amounts vs. Bridge year in-service additions.

Table 15 – 2025 OEB Approved vs. Bridge Year Net In-Service Additions, ($'000s)

Investment Category	2025 OEB Approved ($)	2025 Bridge	Variance ($)	Variance (%)
System Access	$ 15,312	$ 25,797	$ 10,485	68%
System Renewal	$ 40,018	$ 40,213	$ 195	0%
System Service	$ 41,026	$ 48,757	$ 7,731	19%
General Plant	$ 22,880	$ 8,907	$ (13,973)	(61)%
Total	**$ 119,235**	**$ 123,674**	**$ 4,438**	**4%**

Variance Analysis

- System Access capital additions are expected to be $10.5M (68%) higher than OEB-Approved amounts, the main drivers continue to be persistent higher than budgeted volumes and unit costs in Customer Connections, and overages in System Expansion resulting from the Department of National Defence Dwyer Hill Training Center Upgrade[3] and the OC Transpo's Zero Emission Buses.[4]
- System Renewal capital additions are forecasted to be materially in line with OEB-Approved amounts.
- System Service additions are expected to be $7.7M (19%) higher than OEB-Approved amounts, driven largely by the energization of the OMS replacement.
- General Plant capital additions are expected to be $14M (61%) below approved amounts, the main drivers being the deferral of the replacement of Hydro Ottawa's JD Edwards ERP system to the 2031-2035 time frame, and the deferral of CCRA payments to Hydro One for the Riverdale and Piperville station projects.

[3] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/
[4] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/news/article/oc-explained-zero-emission-bus-project/

5. SUMMARY OF SIGNIFICANT DISCRETE IN-SERVICE CAPITAL ADDITIONS (2021-2025)[5]

Table 16 below provides an overview of the significant capital additions for the 2021-2025 period compared against the OEB-Approved amounts.

[5] Totals may not sum due to rounding.

1 **Table 16 – 2021-2025 Overview of Significant In-Service Additions ($'000 000s)**

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost	Actual In-Service Date	Actual Capital Cost	Cost Variance ($)
General Plant	CCRA	Cambrian 28KV Substation	2021	$ 50.1	2021-2022	$ 44.6	$ (5.5)
General Plant	CCRA	Riverdale Switchgear Upgrade	2024-2025	$ 2.4	N/A	-	$ (2.4)
General Plant	CCRA	Piperville Station Capacity Upgrade-New East	2025	$ 6.1	N/A	-	$ (6.1)
General Plant	Customer Service	Elster EA-MS Upgrade	2021-2025	$ 1.6	2022	$ 0.4	$ (1.2)
General Plant	Operations Initiatives	AMI Program	2022	$ 1.6	N/A	-	$ (1.6)
General Plant	Customer Engagement Platform	MyAccount	N/A	-	2023-2025	$ 6.8	$ 6.8
General Plant	Enterprise Solutions	ERP Program	2025	$ 9.7	N/A	-	$ (9.7)
General Plant	Enterprise Solutions	Service Now	N/A	-	2022-2025	$ 2.7	$ 2.7
System Renewal	Stations and Buildings Infrastructure Renewal	Fisher AK Station Rebuild	2022-2024	$ 9.6	N/A	-	$ (9.6)
System Renewal	Stations and Buildings Infrastructure Renewal	Dagmar Voltage Conversion	2025	$ 6.0	N/A	-	$ (6.0)
System Renewal	Stations and Buildings Infrastructure Renewal	Bayswater Transformer Replacement	2021	$ 3.4	2021-2024	$ 5.0	$ 1.6
System Renewal	Stations and Buildings Infrastructure Renewal	Bell's Corners Station Rebuild	2021-2023	$ 10.3	2022-2024	$ 13.6	$ 3.3

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost	Actual In-Service Date	Actual Capital Cost	Cost Variance ($)
System Renewal	Stations and Buildings Infrastructure Renewal	Overbrook TO Switchgear Replacement	2022-2025	$ 6.7	2021-2024	$ 9.3	$ 2.6
System Renewal	Stations and Buildings Infrastructure Renewal	Lincoln Heights P&C Renewal	2021-2022	$ 1.1	2021-2024	$ 2.3	$ 1.2
System Renewal	Stations and Buildings Infrastructure Renewal	Rideau Heights DS T1 Renewal	2024	$ 3.2	N/A	-	$ (3.2)
System Renewal	Stations and Buildings Infrastructure Renewal	Shillington AD Station Renewal	2025	$ 2.5	N/A	-	$ (2.5)
System Renewal	Metering Renewal	2.5EL to 3EL	2021-2025	$ 2.4	2021-2025	$ 1.1	$ (1.3)
System Renewal	Metering Renewal	TR Communications Update	2021-2025	$ 2.1	2021-2025	$ 1.8	$ (0.3)
System Renewal	Metering Renewal	SC Communications Update	2021-2022	$ 2.0	2022-2025	$ 2.2	$ 0.2
System Renewal	Metering Renewal	TR Service to 200A SC	2021-2025	$ 1.1	2021-2025	$ 1.0	$ (0.1)
System Renewal	Metering Renewal	REX 1 Upgrade	2021-2025	$ 5.0	2023-2025	$ 5.3	$ 0.3
System Service	Capacity Upgrades	Cambrian 28KV Substation	2022	$ 26.9	2021-2023	$ 25.6	$ (1.3)
System Service	Capacity Upgrades	Uplands MS Second Transformer	2021	$ 11.4	2021-2023	$ 14.7	$ 3.3
System Service	Capacity Upgrades	Riverdale Switchgear Upgrade	2024-2025	$ 11.8	2024-2025	$ 5.5	$ (6.3)
System Service	Capacity Upgrades	Limebank MTS 4th Transformer	2021-2022	$ 3.0	2021-2022	$ 2.8	$ (0.2)
System Service	Capacity Upgrades	Piperville Station Capacity Upgrade-New East	2025	$ 24.6	2024-2025	$ 14.7	$ (9.9)

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost	Actual In-Service Date	Actual Capital Cost	Cost Variance ($)
System Service	Capacity Upgrades	New Mer Bleue Station	N/A	-	2025	$ 6.6	$ 6.6
System Service	Grid Technologies	Advanced Distribution Management System (ADMS)	2021-2025	$ 5.0	2025	$ 17.9	$ 12.9
System Service	Field Area Network	Field Area Network	2021-2025	$ 5.0	2023-2025	$ 1.0	$ (4.0)

1

6. SUMMARY OF PROPOSED 2026-2030 RATE BASE

Table 17 below provides a summary of Hydro Ottawa's proposed rate base for the 2026-2030 rate period.

Table 17 – Summary of 2026-2030 Rate Base ($'000s)

	Test Years				
	2026	**2027**	**2028**	**2029**	**2030**
Opening Gross Assets	$ 1,931,368	$ 2,130,263	$ 2,401,827	$ 2,684,544	$ 2,873,562
Closing Gross Assets	$ 2,130,263	$ 2,401,827	$ 2,684,544	$ 2,873,562	$ 3,077,989
Average Gross Assets	**$ 2,030,816**	**$ 2,266,045**	**$ 2,543,186**	**$ 2,779,053**	**$ 2,975,775**
Opening Accumulated Depreciation	$ (545,380)	$ (610,419)	$ (681,734)	$ (759,398)	$ (842,230)
Closing Accumulated Depreciation	$ (610,419)	$ (681,734)	$ (759,398)	$ (842,230)	$ (930,124)
Average Accumulated Depreciation	**$ (577,899)**	**$ (646,076)**	**$ (720,566)**	**$ (800,814)**	**$ (886,177)**
Opening Net Book Value	$ 1,385,989	$ 1,519,844	$ 1,720,093	$ 1,925,147	$ 2,031,332
Closing Net Book Value	$ 1,519,844	$ 1,720,093	$ 1,925,147	$ 2,031,332	$ 2,147,865
Average Net Fixed Assets	**$ 1,452,917**	**$ 1,619,969**	**$ 1,822,620**	**$ 1,978,239**	**$ 2,089,598**
Working Capital Allowance	$ 79,540	$ 81,751	$ 84,442	$ 87,076	$ 89,773
RATE BASE	**$ 1,532,457**	**$ 1,701,720**	**$ 1,907,062**	**$ 2,065,315**	**$ 2,179,372**

Table 18 provides a comparison of Hydro Ottawa's rate base for the 2025 Bridge Year vs. the 2030 Test Year.

1 **Table 18 AS ORIGINALLY SUBMITTED – 2025 Bridge vs. 2030 Test Rate Base ($'000s)**

	2025 Bridge	2030 Forecast	Variance ($)	Variance (%)
Opening Gross Assets	$ 1,810,056	$ 2,873,562	$ 1,063,506	59%
Closing Gross Assets	$ 1,931,368	$ 3,077,989	$ 1,146,621	59%
Average Gross Assets	**$ 1,870,712**	**$ 2,975,775**	**$ 1,105,063**	**59%**
Opening Accumulated Depreciation	$ (484,565)	$ (842,230)	$ (357,665)	74%
Closing Accumulated Depreciation	$ (545,380)	$ (930,124)	$ (384,744)	71%
Average Accumulated Depreciation	**$ (514,973)**	**$ (886,177)**	**$ (371,205)**	**72%**
Opening Net Book Value	$ 1,325,491	$ 2,031,332	$ 705,841	53%
Closing Net Book Value	$ 1,385,988	$ 2,147,865	$ 761,877	55%
Average Net Fixed Assets	**$ 1,355,740**	**$ 2,089,598**	**$ 733,859**	**54%**
Working Capital Allowance	$ 75,171	$ 89,773	$ 14,602	19%
RATE BASE	**$ 1,430,911**	**$ 2,179,372**	**$ 748,461**	**52%**

2

3 **Table 18 UPDATED JUNE 4,2025 – 2025 Bridge vs. 2030 Test Rate Base ($'000s)**

	2025 Bridge	2030 Forecast	Variance ($)	Variance (%)
Opening Gross Assets	$ 1,810,056	$ 2,873,562	$ 1,063,506	59%
Closing Gross Assets	$ 1,931,368	$ 3,077,989	$ 1,146,621	59%
Average Gross Assets	**$ 1,870,712**	**$ 2,975,775**	**$ 1,105,063**	**59%**
Opening Accumulated Depreciation	$ (484,565)	$ (842,230)	$ (357,665)	74%
Closing Accumulated Depreciation	$ (545,380)	$ (930,124)	$ (384,744)	71%
Average Accumulated Depreciation	**$ (514,973)**	**$ (886,177)**	**$ (371,205)**	**72%**
Opening Net Book Value	$ 1,325,491	$ 2,031,332	$ 705,841	53%
Closing Net Book Value	$ 1,385,988	$ 2,147,865	$ 761,877	55%
Average Net Fixed Assets	**$ 1,355,740**	**$ 2,089,598**	**$ 733,859**	**54%**
Working Capital Allowance	$ 75,249	$ 89,773	$ 14,524	19%
RATE BASE	**$ 1,430,989**	**$ 2,179,372**	**$ 748,383**	**52%**

4

Hydro Ottawa's rate base in 2030 is expected to be $748.4M (52%) above the 2025 Bridge Year, driven mainly by capital additions from 2026-2030.

7. SUMMARY OF SIGNIFICANT DISCRETE IN-SERVICE CAPITAL ADDITIONS (2026-2030)

Table 19 below provides an overview of significant discrete in-service capital additions proposed for the 2026-2030 rate period.

1 **Table 19 – 2026-2030 Overview of Significant In-Service Additions ($'000 000s)**

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost ($)
General Plant	CCRA	Riverdale Switchgear Upgrade	2026	$ 0.4
General Plant	CCRA	Piperville Station Capacity Upgrade-New East	2026	$ 4.7
General Plant	CCRA	New Mer Bleue Station	2027	$ 6.3
General Plant	CCRA	Hydro Road Station	2027	$ 0.8
General Plant	CCRA	CFIA Greenbank Road New Station	2028	$ 4.7
General Plant	CCRA	New Kanata Station	2028	$ 5.3
General Plant	CCRA	King Edward Cable Upgrade	2029	$ 16.4
General Plant	CCRA	Carling (secondary cable)	2026	$ 2.1
General Plant	Meter to Cash	CC&B Upgrade 2028	2028	$ 6.5
System Access	System Expansion	OC Transpo EBus St. Laurent Road	2027	$ 9.7
System Access	System Expansion	DND Dwyer Hill Expansion	2026-2027	$ 3.1
System Access	System Expansion	DND Dwyer Hill Station Upgrade	2027	$ 14.1
System Access	System Expansion	Ottawa Hospital	2030	$ 11.5
System Access	System Expansion	Hydro Road Station	2027	$ 22.7
System Renewal	Stations and Buildings Infrastructure Renewal	Longfields T2 Transformer Renewal	2027	$ 1.6
System Renewal	Stations and Buildings Infrastructure Renewal	Rideau Heights DS Switchgear Renewal	2028	$ 5.9
System Renewal	Stations and Buildings Infrastructure Renewal	Parkwood Hills DS Switchgear Renewal	2027	$ 4.2
System Renewal	Stations and Buildings Infrastructure Renewal	Hinchey TH Switchgear Renewal	2026-2027	$ 3.5
System Renewal	Stations and Buildings Infrastructure Renewal	Russell TB Switchgear Renewal	2030	$ 9.8
System Renewal	Metering Renewal	Metering Renewal AMI 2.0	2026-2030	$ 78.2
System Service	Capacity Upgrades	Riverdale Switchgear Upgrade	2026	$ 8.5

Investment Category	Capital Program	Project	Planned in-Service Date	Planned Capital Cost ($)
System Service	Capacity Upgrades	Piperville Station Capacity Upgrade-New East	2026	$ 27.6
System Service	Capacity Upgrades	New Mer Bleue Station	2027	$ 41.2
System Service	Capacity Upgrades	Greenbank Road New Station	2028	$ 38.5
System Service	Capacity Upgrades	New Kanata Station	2028	$ 44.8

8. OTHER INFORMATION

Hydro Ottawa's 2021-2025 Custom IR Application also included the following mechanisms:

- Capital stretch factor: increased annually, starting at 0% in 2021, escalating by 0.6% per year, up to 2.4% in 2025, resulting in an $8.6M[6] reduction to Hydro Ottawa's total revenue requirement over the 2021-2025 rate term.
- Performance Outcomes Accountability Mechanism (POAM): 5 outcomes-based measures and targets related to the achievement of objectives under Hydro Ottawa's 2021-2025 Distribution System Plan (DSP). The 5 performance metrics are:
  - Number of Interruptions Caused by Defective Equipment (Overhead System) - Excluding Major Event Days;
  - Number of Interruptions Caused by Defective Equipment (Underground System) - Excluding Major Event Days and Leaking Padmount Transformers;
  - System Average Interruption Duration Index (SAIDI)[7] - Excluding Major Event Days and Loss of Supply;
  - Wood Pole Replacement Unit Cost; and

[6] As presented in the 2021-2025 Settlement Agreement, Hydro Ottawa Limited, 2021-2025 Custom Incentive Rate-Setting Approved Settlement Agreement, EB-2019-0261 (September 18, 2020).
[7] The target for this metric is sourced from Table B in the response to interrogatory CCC-38, from Hydro Ottawa's 2021-2025 Custom IR Application. In addition, it is acknowledged that this approach deviates from the OEB's use of 5-year averages to calculate a distributor's SAIDI target. However, the Parties agree to the use of a 3-year average so as to maintain consistency across the 3 reliability-related performance metrics that are utilized under this accountability mechanism.

- Underground Cable Replacement Unit Cost.

In 2022 and 2023, Hydro Ottawa did not meet the SAIDI - Excluding Major Event Days and Loss of Supply or the Wood Pole Replacement Unit Cost.[8] As the outcomes of these two metrics were in the red band, the maximum annual amount of $200K was credited to the POAM Deferral Account for both of these POAM metrics in each year for a total annual credit of $400K. A total principal credit balance of $800K has been recorded into the variance account at the end of 2023. Refer to Schedule 9-1-3 - Group 2 Accounts for additional information.

- Capital Variance Accounts: designed to track, on an annual basis, the impacts on revenue requirement arising from variances between actual and forecasted cumulative capital additions as follows:
    - Symmetrical account for capital additions for which the drivers are either plant relocation requested by 3rd parties or residential subdivision expansion;
    - Asymmetrical account for capital additions for the remaining programs in the System Access investment category;
    - Asymmetrical account for the combined cumulative System Service and System Renewal Investment Categories;
    - Asymmetrical account for the General Plant investment categories; and
    - Symmetrical sub-account for capital additions variances related CCRA payments.

As of 2023, Hydro Ottawa had experienced shortfalls in actual in-service additions versus approved amounts in the asymmetrical System Access and General Plant sub-accounts, as well as the symmetrical CCRA sub-account and has recorded a total credit balance of $2.2M.

[8] For 2021 Hydro Ottawa initially reported that 1 POAM target was not met, the Wood Pole Replacement Unit Cost, which was based on preliminary numbers. When finalized, it was determined that this target was met and the credit was reversed.

Hydro Ottawa

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After the Storm

Hydro Ottawa's response to the May 2022 derecho

Hydro Ottawa

Contents

AFTER THE STORM:

A reflection from our President and CEO

From family barbecues to gardening, camping and cottaging, most Canadians associate the May long weekend with the start of summer – a pleasant time.

Our community, however, will now remember the May 2022 long weekend as the most devastating weekend our city experienced, certainly the most devastating event in Hydro Ottawa's history.

While our teams had been following the storm's path during the day, nothing could have prepared them for its impact. In the span of 15 minutes, winds of up to 190 kilometres per hour toppled transmission towers, damaged more than 500 hydro poles and downed kilometres of power lines. There were more than 1,000 simultaneous power outages across the city and 180,000 customers in the dark.

There was no illusion that restoration was going to be quick. The damage was significant and widespread, and our grid was ravaged. We swiftly mobilized additional resources and equipment through a provincial mutual-aid agreement, bolstering our efforts with an additional 335 workers from numerous utilities and contractor companies. While we were able to restore power to 50 per cent of customers within 48 hours, many were without power for days.

Like many utilities' approach to storm responses, our top priority was to restore power to first responders and essential services, followed by water treatment facilities and sewage treatment plants. We then prioritized maximizing our efforts for the greatest number of customers. **Six months post-storm, we continue to build back stronger by:**

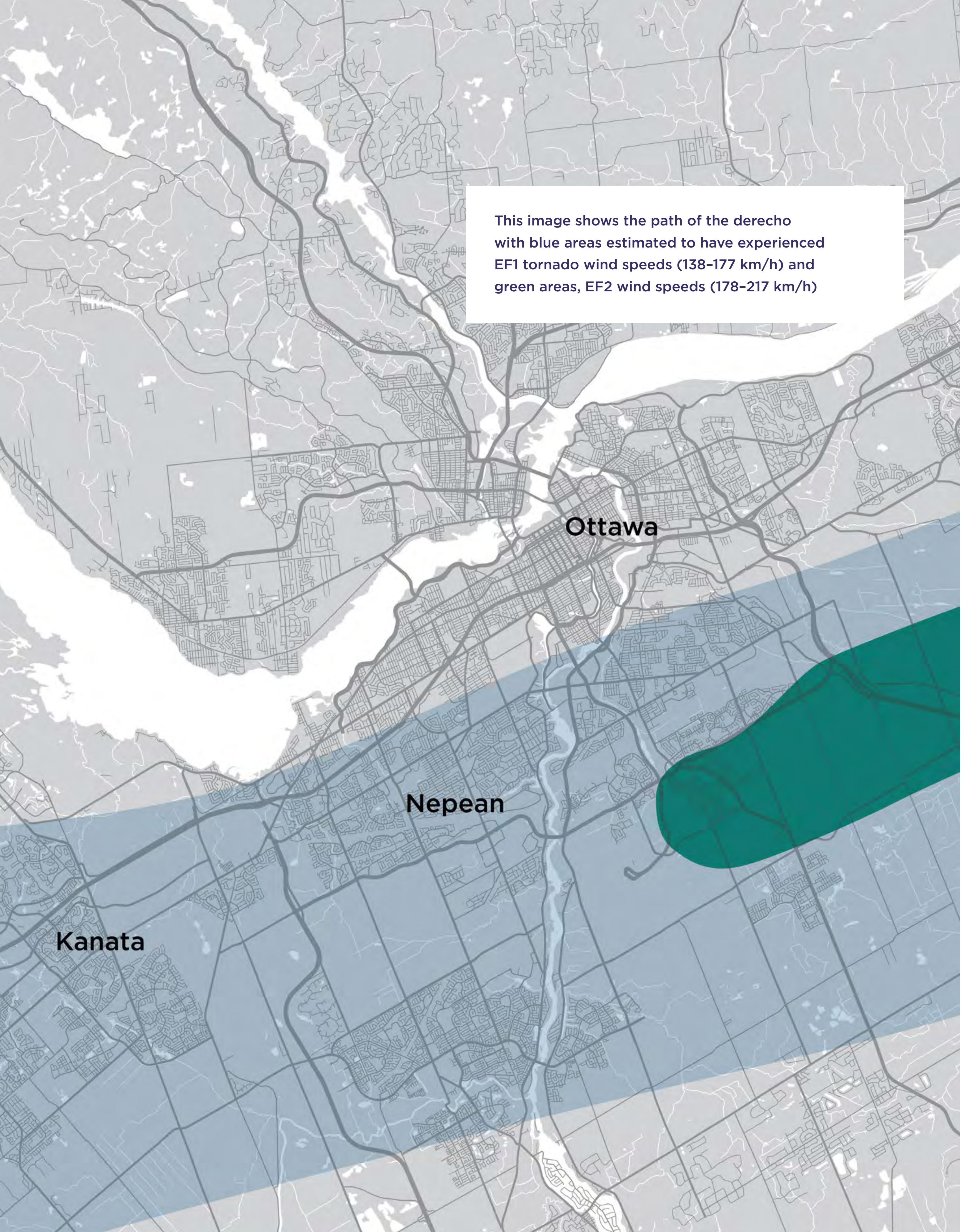
- Expanding our forestry program with shorter and enhanced tree-trimming cycles
- Increasing system inspections to find problematic equipment and make the necessary repairs
- Deploying additional resources to respond to power-outage events
- Deploying infrared scanning to preemptively identify assets at risk of failure
- Reviewing our Business Continuity Management Program, and updating our incident management and crisis communications plans to include learnings and best practices

We know that electricity is vital to our economy, public health and safety. Because of their interconnectedness, utilities and municipalities must work together to scale up solutions that can build and maintain our community's resilience, while being cost-effective for our customers.

We hope you find this report to be a helpful summary of our storm response and look forward to extending our collaboration with you to strengthen our collective emergency response for future events.

Sincerely,

Bryce Conrad
President & CEO
Hydro Ottawa



This image shows the path of the derecho with blue areas estimated to have experienced EF1 tornado wind speeds (138–177 km/h) and green areas, EF2 wind speeds (178–217 km/h)

Overview

On May 21, 2022, Ottawa experienced winds of up to 190 kilometres per hour, extensively damaging Hydro Ottawa's electrical grid. This storm cost Hydro Ottawa an estimated $23.8 million ($15.1 capital expenditures; $8.7 operating, maintenance and other costs).

Total damages in Ontario are estimated at $720 million, making this the sixth costliest weather event in Canadian history in terms of insurance claims.

Purpose

The purpose of this report is to highlight Hydro Ottawa's efforts to repair and restore the electrical distribution system damaged by the May 21, 2022, derecho storm. It also aims to identify successes, lessons learned and recommendations to strengthen our Business Continuity Management Program as well as supporting business continuity and incident management plans.

While numerous external organizations supported the response, this report focuses solely on Hydro Ottawa's role in repairing and restoring the electrical distribution system between May 21 and June 5, 2022.

Customer Impact

At the peak of the aftermath, 180,000 Hydro Ottawa customers were without power – more than half of our customer base. Unlike previous storms, damage and power outages impacted our entire service territory.

There were a total of 1,000 individual outages on the system (in comparison to 200 after the 2018 tornadoes) and more than 1,500 known or reported tree contacts or interferences.

Some of the hardest hit neighbourhoods included:

- Pineglen and Pineglen Annex
- Carlingwood and McKellar Heights
- Fisher Glen and Cityview-Skyline-Fisher Heights
- Lincoln Heights and Britannia Heights
- Parkway Park and Kenson Park
- South Keys
- Carlsbad Springs
- Blackburn Hamlet
- Riverside Park and Hog's Back
- Tanglewood
- Stittsville and surrounding areas
- Manordale and Meadowlands
- Queensway Terrace South and Ridgeview
- Bells Corners East and Lynwood Village

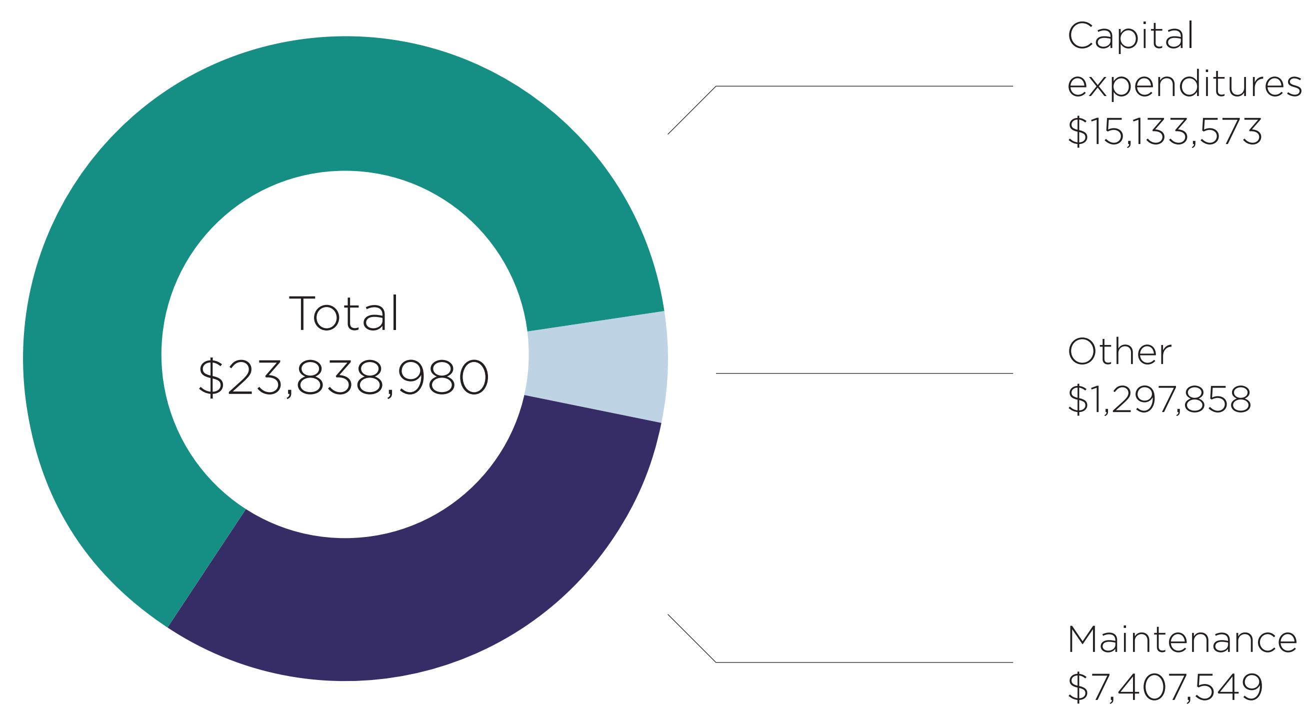
Damage Assessment

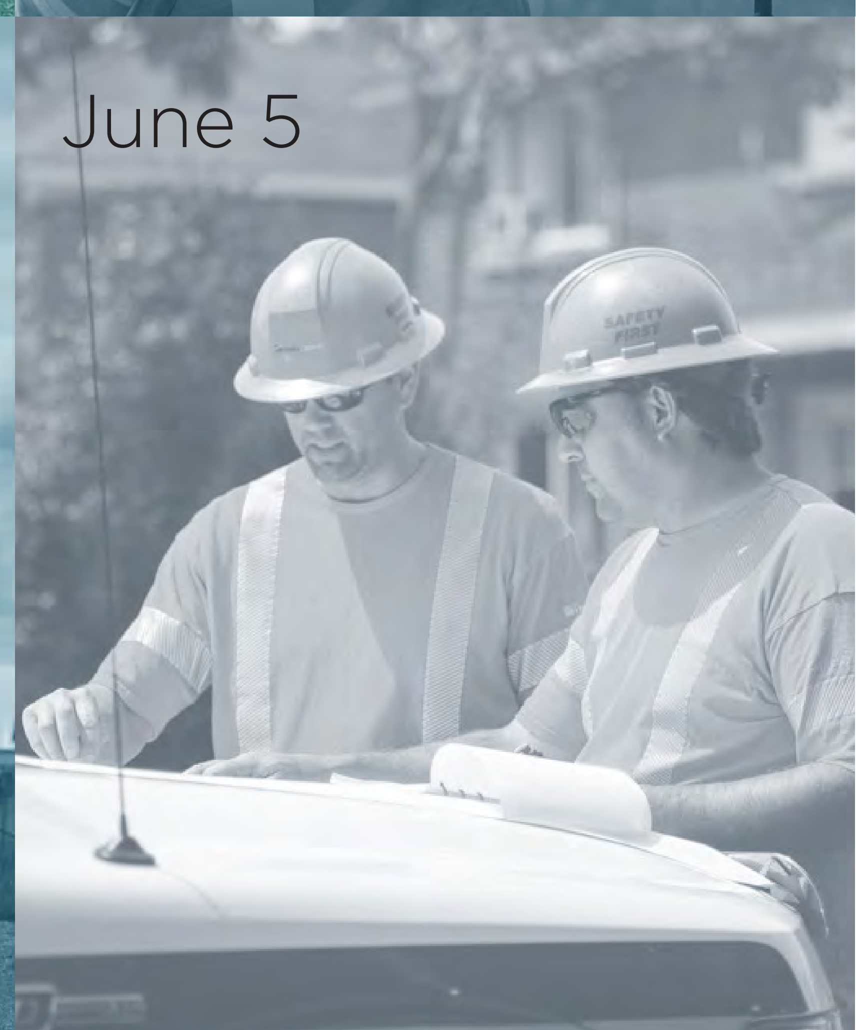
Initial damage assessments showed that more than 225 poles needed to be replaced; however, after the full extent of the damage became clear, we confirmed that number to be 540.

Property damage, downed trees and debris littered the hardest hit areas. This hampered field crews' ability to initiate restoration as traffic control and clean-up crews were required first.

The overall capital expenditure cost of the derecho to Hydro Ottawa is estimated at $15.1 million, which equates to 21.3 per cent of the 2022 system renewal and system service budget as approved by the board of directors.

Total cost of the storm to Hydro Ottawa





Response Timeline

From the beginning of our storm response, Hydro Ottawa communicated that this would be a multi-day restoration effort. We needed to take a whole-of-city approach given the widespread nature of the damage.

May 21

The derecho storm hits Ottawa

May 23

Power is restored to 50 per cent of affected customers

May 28

Most large repair projects are completed, restoring power to 90 per cent of affected customers

June 1

Power is restored to all customers except those with outstanding property/equipment damage

June 5

Power is restored to remaining customers

COMPARING OTTAWA'S BIG STORMS

SEPT 2018 TORNADOES

On September 21, 2018, a powerful storm caused tornadoes, heavy winds and lightning resulting in extensive damage to the electrical infrastructure and a major transformer station.

MAY 2022 WIND STORM

On May 21, 2022, a devastating storm caused high winds, heavy rain and lightning resulting in extensive damage to the electrical infrastructure, far worse than any other storm.

	SEPT 2018 TORNADOES	MAY 2022 WIND STORM
NUMBER OF OUTAGES	200+	1000+
CUSTOMERS WITHOUT POWER AT THE PEAK OF THE STORM	165,000	180,000
AREAS IMPACTED	SELECT AREAS	ENTIRE SERVICE TERRITORY
POLES REPLACED	88	540
CONTRACTORS WHO CAME TO ASSIST	86	335
LENGTH OF TIME TO RESTORE 50% OF OUTAGES	WITHIN 36 HRS	WITHIN 48 HRS

Lessons Learned

Hydro Ottawa's Business Continuity Management Program and supporting business continuity and incident management plans were strained due to the unprecedented nature, scope and duration of the May 2022 derecho. Since extreme weather events are occurring more frequently, we will review and enhance our plans to ensure they are scalable to events of this scope and duration.

Here's where we need to improve:

Future planning

Assumptions for future planning, design, construction and maintenance must expand to encompass the conditions experienced in this event.

Customer communication

Throughout this multi-day event, we struggled to effectively communicate estimated times of restoration and neighbourhood-specific information with customers due to the wide-spread damage, which is why we removed the outage map from our website. Recognizing that this was a critical concern for our customers, a review of our internal outage management systems and communication tools and strategies is underway in order to provide quicker and more reliable data on a continual basis moving forward.

System resilience

In addition to enhancing our storm-response capabilities, we must work to further harden our distribution system against storm damage, including, where feasible and where it makes financial sense, moving parts of our infrastructure underground.

Successes

Mutual Aid

We secured, mobilized and deployed 335 mutual-aid resources from neighbouring utilities and contractors.

Repair volume and speed

We completed the equivalent of four years of emergency asset replacements to our distribution system during the outage period.

Dedication, resilience and ingenuity

Teams worked long hours, and applied considerable ingenuity to resolving issues, and to expanding our response efforts to meet the demand of the situation.

Minimal injuries

Despite dynamic and evolving circumstances, we experienced only one medical aid injury to a contractor's employee.

Website performance

Between May 21 and June 2, 2022, our website had almost 600,000 unique visitors and 3.8 million page views.

Stakeholder communications

Daily public service announcements, memos to council and City media briefings; proactive and reactive media interviews; emails to business improvement areas and community associations; social media and website updates.

Successes

No work delays

Our procurement team ensured materials were brought in and available as needed to support all restoration efforts in spite of the long-weekend closures and existing global supply-chain issues.

24/7 fleet support

Mechanics were responsive to help with fleet-related breakdowns, including those impacting our contractors and mutual-aid crews.

Fueling efficiencies

Mobile night-time refueling of vehicles and generators ensured work staging remained and allowed crews to stay on site.

Waste-management efficiency

We provided refuse and debris bins directly to worksites for coordinated removal.

Equipment innovation

We sourced and used logging trucks and cranes creatively to handle, offload and deliver poles.

Taking care

Employees from across the organization were deployed on 720 trips to deliver 23,400 meals to worksites.

Strategic Priorities

1. OVERHEAD INFRASTRUCTURE

Hydro Ottawa has initiated plans to further storm-harden the distribution system. These plans include targeted infrastructure-hardening measures as part of the 2023 capital program, an update to the 2019 Distribution System Climate Risk and Vulnerability Assessment and the development of a Strategic Undergrounding Plan to enhance system resiliency.

2. DAMAGE ASSESSMENT

Hydro Ottawa will enhance integration of our damage assessment process and reports with our outage management system.

3. OUTAGE MANAGEMENT SYSTEM AND STORM MODE

Hydro Ottawa is establishing a process to support a systematic and simultaneous change across all systems and communication channels when "storm mode" is initiated.

4. OUTAGE MAP

Hydro Ottawa is conducting a comprehensive evaluation of the current outage map and needed features to best support customers across all scales of outages. We will implement an appropriate solution.

5. CUSTOMER-FACING TELEPHONY

Hydro Ottawa is implementing scalable telephony that leverages cloud-based technology to triage and process inbound calls to our outage centre. We will launch an SMS communication channel to support one-on-one outage reporting and restoration updates and are evaluating options to simplify outage reporting through both our website and mobile app.

6. ELECTRICITY EMERGENCY RESPONSE PLAN

Hydro Ottawa is conducting a comprehensive review and update to our Electricity Emergency Response Plan with specific considerations to ensure its scalability for large-scale, long-duration events. The review will include learnings and adaptations from the May 2022 derecho.

7. STAKEHOLDER COMMUNICATIONS

Hydro Ottawa will review and update our stakeholder communications plan to include learnings and adaptations made during the May 2022 derecho, as well as best practices used by utilities that regularly deal with large-scale weather events such as hurricanes.

8. SUPPLY CHAIN AND MATERIALS MANAGEMENT

Hydro Ottawa is conducting a thorough review of our supply chain and material management processes, including usage data from the storm. Our findings will inform our threshold inventory levels and the development of a supply-chain playbook for events of this scale.

9. BUSINESS CONTINUITY AND INCIDENT MANAGEMENT PLANS

Hydro Ottawa is reviewing and updating all business continuity and incident management plans to ensure they can scale for large-scope and long-duration events. We will be benchmarking against this storm response (e.g., city-wide impact, 500+ poles damaged, two-week response duration, mutual-aid resources required).

We will work with the City's emergency management team to review our role in the City's Emergency Operations Centre (EOC) during large-scale emergency events to ensure that we optimize communications protocols and channels with City departments, emergency services and other utilities, in support of both the restoration work, and the residents' needs.

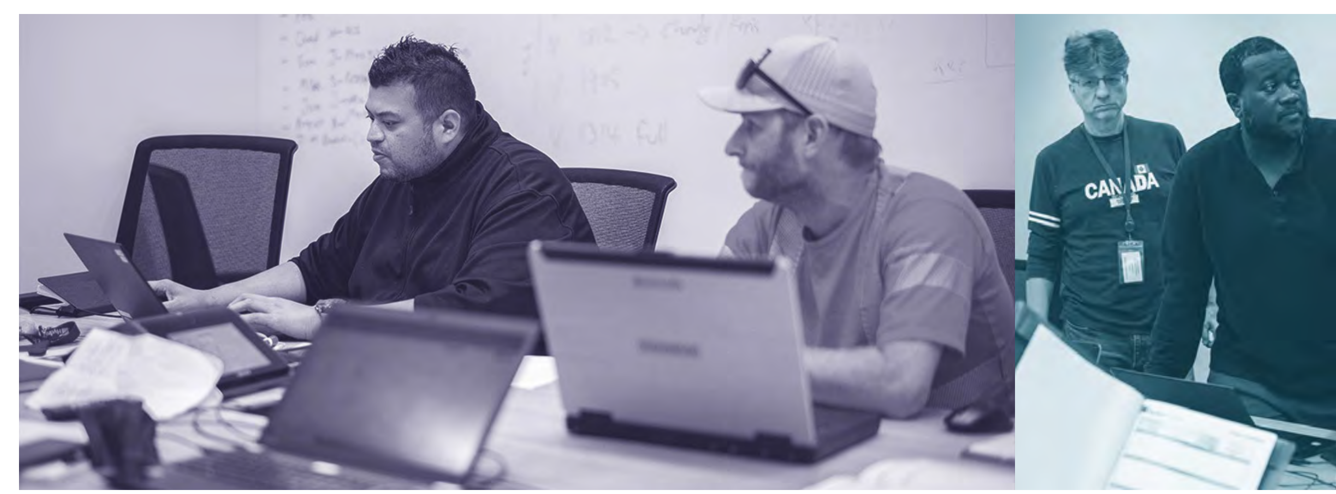
Conclusion

Adapting for the future.

Hydro Ottawa's emergency response plans are well executed and rooted in a strong foundation, as demonstrated by our day-to-day outage-response operations.

With an expected increase in more frequent and extreme weather events as a result of climate change, we're integrating learnings and focusing our efforts on both the grid and our emergency response plans to ensure scalability across our people, processes and technologies.

We're committed to keeping the lights on for our customers.



Appendix: Debrief Methodology

Debrief sessions were held during June 2022 with various divisions as well as the crisis management team, the crisis communications team and the incident command centre group. These sessions focused on identifying processes that worked well, gaps in processes and/or resources as well as opportunities for improvement.

Consultations and business continuity management program debriefs were conducted with the following:

- **Chief Information and Technology Officer Division:** infrastructure, grid technology, customer-facing technology
- **Chief Customer Officer Division:** external communications
- **Chief Electricity Distribution Officer Division:** internal contractor management team, distribution engineering and asset management team, system operations response, use of mutual aid/contractors
- **Chief Financial Officer Division:** facilities, fleet and fuel, supply chain, materials management
- **Chief Human Resources Officer Division:** human resources, safety, food, lodging
- **Executive Management Team**
- **Union Executive**

Some combined debriefs were then necessary to review the coordination among various divisions and/or groups. Information from these debriefs was consolidated and used to prepare this report.

ASSETS – PROPERTY PLANT & EQUIPMENT CONTINUITY SCHEDULE

1. INTRODUCTION

This Schedule provides information as required under section 2.2.1 of the *Chapter 2 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications*, dated December 9, 2024 (Filing Requirements). In addition, the amounts for construction work-in-progress (CWIP) have also been provided. In accordance with the Filing Requirements, appended to this Schedule are the following Excel attachments:

- Attachment 2-2-1(A) - OEB Appendix 2-BA - 2021-2025 Fixed Asset Continuity Schedule
- Attachment 2-2-1(B) - OEB Appendix 2-BA - 2026-2030 Fixed Asset Continuity Schedule

2. GROSS ASSETS BY FUNCTION

Table 1 below provides Hydro Ottawa's Approved Gross Assets balance by function for the Historical Years 2021-2023 and Bridge Years 2024 and 2025. The gross and accumulated depreciation in Table 1 below were used to calculate the settled rate base amounts per the 2021-2025 Settlement Agreement.[1] Tables 2 and 3 below provide Hydro Ottawa's actual Gross Assets balance by function for the Historical Years 2021-2023, and forecasted Gross Assets balance for Bridge Years 2024 and 2025, and Test Years 2026-2030.

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Settlement Proposal*, EB-2019-0261 (September 18, 2020).

1 **Table 1 – OEB Approved 2021-2025 - Gross Assets Breakdown by Function ($'000s)**

Gross Assets	OEB - Approved				
	2021	2022	2023	2024	2025
Transmission Plant	$ 127,104	$ 152,716	$ 156,318	$ 161,747	$ 170,971
Distribution Plant	$ 1,041,959	$ 1,119,263	$ 1,182,682	$ 1,248,693	$ 1,329,616
General Plant	$ 338,415	$ 354,173	$ 361,251	$ 369,413	$ 395,865
Subtotal	**$ 1,507,478**	**$ 1,626,152**	**$ 1,700,252**	**$ 1,779,853**	**$ 1,896,452**
Less Other Non Rate-Regulated Utility Assets	-	-	-	-	-
Total PP&E for Rate Base Purposes	**$ 1,507,478**	**$ 1,626,152**	**$ 1,700,252**	**$ 1,779,853**	**$ 1,896,452**
CWIP	$ 43,711	$ 20,576	$ 30,756	$ 43,042	$ 18,802
Accumulated Depreciation	$ (324,639)	$ (377,881)	$ (433,247)	$ (490,428)	$ (551,211)
Total PP&E	**$ 1,226,551**	**$ 1,268,846**	**$ 1,297,760**	**$ 1,332,466**	**$ 1,364,043**

2

3 **Table 2 – Historical and Bridge 2021-2025 Gross Assets Breakdown by Function ($'000s)[2]**

Gross Assets	Historical			Bridge	
	2021	2022	2023	2024	2025
Transmission Plant	$ 138,228	$ 155,080	$ 157,256	$ 157,962	$ 165,969
Distribution Plant	$ 1,031,034	$ 1,119,178	$ 1,190,677	$ 1,311,500	$ 1,399,660
General Plant	$ 312,400	$ 345,577	$ 356,678	$ 352,797	$ 377,943
Sub-Total	**$ 1,481,663**	**$ 1,619,835**	**$ 1,704,612**	**$ 1,822,259**	**$ 1,943,572**
Less Other Non Rate-Regulated Utility Assets	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)
Total PP&E for Rate Base Purposes	**$ 1,469,459**	**$ 1,607,631**	**$ 1,692,408**	**$ 1,810,056**	**$ 1,931,368**
CWIP	$ 60,435	$ 28,360	$ 35,342	$ 51,302	$ 75,574
Accumulated Depreciation	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)	$ (545,380)
Total PP&E	**$ 1,209,109**	**$ 1,263,444**	**$ 1,300,796**	**$ 1,376,792**	**$ 1,461,563**

4

[2] Totals may not sum due to rounding.

Table 3 – Test Years 2026-2030 Gross Assets Breakdown by Function ($'000s)

Gross Assets	Test Years				
	2026	2027	2028	2029	2030
Transmission Plant	$ 189,385	$ 258,770	$ 324,428	$ 325,217	$ 326,028
Distribution Plant	$ 1,539,524	$ 1,702,987	$ 1,874,795	$ 2,022,277	$ 2,205,435
General Plant	$ 413,559	$ 452,274	$ 497,525	$ 538,272	$ 558,730
Sub-Total	**$ 2,142,467**	**$ 2,414,031**	**$ 2,696,748**	**$ 2,885,766**	**$ 3,090,193**
Less Other Non Rate-Regulated Utility Assets	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)
Total PP&E for Rate Base Purposes	**$ 2,130,263**	**$ 2,401,827**	**$ 2,684,544**	**$ 2,873,562**	**$ 3,077,989**
CWIP	$ 131,106	$ 113,807	$ 42,021	$ 80,929	$ 91,698
Accumulated Depreciation	$ (610,419)	$ (681,734)	$ (759,398)	$ (842,230)	$ (930,124)
Total PP&E	**$ 1,650,950**	**$ 1,833,900**	**$ 1,967,167**	**$ 2,112,261**	**$ 2,239,562**

For detailed Fixed Asset Continuity Schedules for the years 2021-2025 and 2026-2030, please see Excel Attachments 2-2-1(A) - OEB Appendix 2-BA - 2021-2025 Fixed Asset Continuity Schedule and 2-2-1(B) - OEB Appendix 2-BA - 2026-2030 Fixed Asset Continuity Schedule. Please note the following two items related to the Fixed Asset Continuity Schedules:

- Hydro One Networks Inc. (Hydro One) actual construction costs related to the Cambrian Connection Cost Recovery Agreement (CCRA) were lower than the budgeted and invoiced amounts, leading to a refund received in 2023 of $5.7M. Hydro Ottawa had already added these costs to the asset's value based on actual payments to Hydro One when the completed line extensions were finished in 2021 and 2022. A refund for the overpayment was received by Hydro Ottawa in 2023, which reduced its asset cost base in OEB Account 1609 and is presented in the 'Asset Cost Disposals' column (which reflects reductions in asset value) in Attachment 2-2-1(A) - 2021-2025 Fixed Asset Continuity Schedule for 2023.

- In 2024 Hydro Ottawa undertook a review of its assets in OEB Accounts 1808 Buildings and Fixtures (Distribution Plant) and 1908 Buildings and Fixtures (General Plant) and identified a group of assets in Account 1908 that should have been classified in Account 1808. The transfers of asset costs and accumulated depreciation balances were completed in 2024 and are included in the asset cost additions and accumulated depreciation additions columns in Attachment 2-2-1(A) - OEB Appendix 2-BA Fixed Asset Continuity Schedule for 2024. Asset cost transfers totaled $27.3M, and asset accumulated depreciation transfers totaled $5.1M.

3. GROSS ASSETS BY MAJOR PLANT ACCOUNT

Table 4 provides Gross Assets balance by major plant account for each functionalized plant item, for Historical Years 2021-2023 and for Bridge Years 2024 and 2025.

Table 4 – 2021-2025 Gross Assets Breakdown by Major Plant Account Organized by Uniform System of Account ($'000s)

USofA	Description	Historical			Bridge	
		2021	2022	2023	2024	2025
1815	Transformer Station Equipment >50 kV	$ 138,228	$ 155,080	$ 157,256	$ 157,962	$ 165,969
Subtotal Transmission Plant		**$ 138,228**	**$ 155,080**	**$ 157,256**	**$ 157,962**	**$ 165,969**
1612	Land Rights	$ 2,731	$ 3,239	$ 3,239	$ 3,264	$ 3,289
1805	Land	$ 4,847	$ 4,847	$ 4,833	$ 10,503	$ 17,630
1808	Buildings	$ 37,561	$ 37,890	$ 37,955	$ 65,306	$ 74,900
1820	Distribution Station Equipment <50 kV	$ 132,117	$ 137,929	$ 147,685	$ 149,928	$ 150,843
1830	Poles, Towers & Fixtures	$ 154,149	$ 169,863	$ 181,005	$ 194,330	$ 208,784
1835	Overhead Conductors & Devices	$ 145,459	$ 156,265	$ 163,678	$ 176,284	$ 189,332
1840	Underground Conduit	$ 310,590	$ 350,350	$ 391,669	$ 449,745	$ 495,971
1845	Underground Conductors & Devices	$ 213,938	$ 233,255	$ 251,147	$ 278,495	$ 299,007
1850	Line Transformers	$ 113,433	$ 123,930	$ 135,537	$ 147,239	$ 158,646
1855	Services (Overhead & Underground)	$ 80,484	$ 88,045	$ 92,944	$ 100,837	$ 107,784
1860	Meters	$ 54,980	$ 57,699	$ 62,424	$ 70,494	$ 77,472
1970	Load Management Controls Customer Premises	-	-	-	-	-
1975	Load Management Controls Utility Premises	-	-	-	-	-
1980	System Supervisor Equipment	$ 19,059	$ 22,188	$ 22,927	$ 25,476	$ 26,831
1985	Sentinel Lighting Rental Units	$ 1	$ 1	$ 1	$ 1	$ 1
2440	Deferred Revenue	$ (238,313)	$ (266,323)	$ (304,366)	$ (360,402)	$ (410,831)
Subtotal Distribution Plant		**$ 1,031,034**	**$ 1,119,178**	**$ 1,190,677**	**$ 1,311,500**	**$ 1,399,660**
1609	Capital Contributions Paid	$ 63,655	$ 83,893	$ 79,137	$ 80,640	$ 80,640
1611	Computer Software	$ 74,988	$ 79,767	$ 86,031	$ 95,711	$ 102,758

USofA	Description	Historical			Bridge	
		2021	2022	2023	2024	2025
1905	Land	$ 19,740	$ 19,740	$ 19,740	$ 19,740	$ 19,740
1908	Buildings & Fixtures	$ 95,956	$ 97,473	$ 100,222	$ 75,733	$ 76,240
1915	Office Furniture and Equipment	$ 4,392	$ 4,477	$ 4,512	$ 4,688	$ 4,865
1920	Computer Equipment - Hardware	$ 11,393	$ 13,783	$ 15,970	$ 21,556	$ 34,035
1930	Transportation Equipment	$ 20,328	$ 23,734	$ 27,883	$ 30,286	$ 33,924
1935	Stores Equipment	$ 669	$ 697	$ 697	$ 697	$ 697
1940	Tools, Shop & Garage Equipment	$ 5,214	$ 5,777	$ 6,171	$ 6,845	$ 7,419
1945	Measurement & Testing Equipment	$ 209	$ 209	$ 209	$ 209	$ 209
1950	Power Operated Equipment	$ 1,330	$ 1,252	$ 1,252	$ 1,461	$ 1,421
1955	Communications Equipment	$ 14,329	$ 14,575	$ 14,654	$ 15,031	$ 15,794
1960	Miscellaneous Equipment	$ 199	$ 201	$ 201	$ 201	$ 201
Subtotal General Plant		**$ 312,400**	**$ 345,577**	**$ 356,678**	**$ 352,797**	**$ 377,943**
Subtotal		**$ 1,481,663**	**$ 1,619,835**	**$ 1,704,612**	**$ 1,822,259**	**$ 1,943,572**
Less Other Non Rate-Regulated Utility Assets		$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)
Total PP&E For Rate Base Purposes		**$ 1,469,459**	**$ 1,607,631**	**$ 1,692,408**	**$ 1,810,056**	**$ 1,931,368**
2055	Construction Work-in-Progress	$ 60,435	$ 28,360	$ 35,342	$ 51,302	$ 75,574
	Accumulated Depreciation	$ (320,785)	$ (372,547)	$ (426,954)	$ (484,565)	$ (545,380)
Total PP&E		**$ 1,209,109**	**$ 1,263,444**	**$ 1,300,796**	**$ 1,376,792**	**$ 1,461,563**

Table 5 below provides Gross Assets balance by major plant account for each functionalized plant item for Test Years 2026-2030.

Table 5 – 2026-2030 Gross Assets Breakdown by Major Plant Account Organized by Uniform System of Account ($'000s)

USofA	Description	Test years				
		2026	2027	2028	2029	2030
1815	Transformer Station Equipment >50 kV	$ 189,385	$ 258,770	$ 324,428	$ 325,217	$ 326,028
Subtotal Transmission Plant		**$ 189,385**	**$ 258,770**	**$ 324,428**	**$ 325,217**	**$ 326,028**
1612	Land Rights	$ 3,289	$ 3,289	$ 3,289	$ 3,289	$ 3,289
1805	Land	$ 17,630	$ 17,836	$ 23,576	$ 24,183	$ 25,400
1808	Buildings	$ 79,218	$ 98,695	$ 111,837	$ 113,537	$ 115,010
1820	Distribution Station Equipment <50 kV	$ 161,137	$ 178,995	$ 191,406	$ 191,708	$ 201,862
1825	Storage Battery Equipment	$ 2,400	$ 7,020	$ 14,927	$ 24,368	$ 41,120
1830	Poles, Towers & Fixtures	$ 232,472	$ 260,765	$ 284,342	$ 304,848	$ 327,138
1835	Overhead Conductors & Devices	$ 215,406	$ 247,354	$ 274,232	$ 299,258	$ 325,024
1840	Underground Conduit	$ 553,545	$ 625,637	$ 691,910	$ 755,591	$ 834,575
1845	Underground Conductors & Devices	$ 325,060	$ 356,129	$ 389,395	$ 420,220	$ 460,129
1850	Line Transformers	$ 172,901	$ 186,701	$ 200,545	$ 215,219	$ 231,440
1855	Services (Overhead & Underground)	$ 114,510	$ 121,875	$ 129,173	$ 136,532	$ 144,338
1860	Meters	$ 92,170	$ 107,236	$ 123,779	$ 142,764	$ 162,769
1970	Load Management Controls Customer Premises	-	-	-	-	-
1975	Load Management Controls Utility Premises	-	-	-	-	-
1980	System Supervisor Equipment	$ 31,115	$ 35,247	$ 38,228	$ 40,054	$ 42,382
1985	Sentinel Lighting Rental Units	$ 1	$ 1	$ 1	$ 1	$ 1
2440	Deferred Revenue	$ (461,330)	$ (543,792)	$ (601,843)	$ (649,295)	$ (709,042)
Subtotal Distribution Plant		**$ 1,539,524**	**$ 1,702,987**	**$ 1,874,795**	**$ 2,022,277**	**$ 2,205,435**
1609	Capital Contributions Paid	$ 88,337	$ 95,979	$ 106,587	$ 123,602	$ 124,626

USofA	Description	Test years				
		2026	2027	2028	2029	2030
1611	Computer Software	$ 112,452	$ 123,040	$ 134,738	$ 143,180	$ 148,917
1905	Land	$ 19,740	$ 19,740	$ 19,740	$ 19,740	$ 19,740
1908	Buildings & Fixtures	$ 77,952	$ 80,420	$ 83,612	$ 87,958	$ 95,860
1915	Office Furniture and Equipment	$ 4,865	$ 4,865	$ 4,865	$ 4,865	$ 4,865
1920	Computer Equipment - Hardware	$ 35,940	$ 37,123	$ 38,946	$ 42,346	$ 45,077
1930	Transportation Equipment	$ 44,221	$ 55,561	$ 65,758	$ 68,290	$ 67,943
1935	Stores Equipment	$ 697	$ 697	$ 697	$ 697	$ 697
1940	Tools, Shop & Garage Equipment	$ 8,246	$ 9,092	$ 9,956	$ 10,838	$ 11,739
1945	Measurement & Testing Equipment	$ 359	$ 359	$ 359	$ 359	$ 359
1950	Power Operated Equipment	$ 2,701	$ 5,046	$ 5,465	$ 5,426	$ 5,387
1955	Communications Equipment	$ 17,596	$ 19,790	$ 26,218	$ 30,387	$ 32,635
1960	Miscellaneous Equipment	$ 453	$ 564	$ 584	$ 584	$ 886
Subtotal General Plant		**$ 413,559**	**$ 452,274**	**$ 497,525**	**$ 538,272**	**$ 558,730**
Subtotal		**$ 2,142,467**	**$ 2,414,031**	**$ 2,696,748**	**$ 2,885,766**	**$ 3,090,193**
Less Other Non Rate-Regulated Utility Assets		$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)	$ (12,204)
Total PP&E For Rate Base Purposes		**$ 2,130,263**	**$ 2,401,827**	**$ 2,684,544**	**$ 2,873,562**	**$ 3,077,989**
2055	Construction Work-in-Progress	$ 131,106	$ 113,807	$ 42,021	$ 80,929	$ 91,698
	Accumulated Depreciation	$ (610,419)	$ (681,734)	$ (759,398)	$ (842,230)	$ (930,124)
Total PP&E		**$ 1,650,950**	**$ 1,833,900**	**$ 1,967,167**	**$ 2,112,261**	**$ 2,239,562**

4. RECONCILIATION OF APPENDIX 2-BA and 2-AB

Table 6 below reconciles the annual capital additions for Rate Base Purposes and the annual change in Construction Work in Progress (CWIP) in Appendix 2-BA with the annual capital spending in Appendix 2-AB. This reconciliation covers the Historical and Bridge Years 2022 and 2023.

NEW - Table 6 - Reconciliation of Appendix 2-BA and 2-AB ($'000s)

	2022	2023
Capital Additions per App 2-BA	$ 142,546	$ 86,810
Change in CWIP	$ (32,076)	$ 6,982
Sub-Total	**$ 110,471**	**$ 93,792**
Capital Spending per App 2-AB	$ 110,278	$ 93,984
Difference	**$ 192**	**$ (192)**

Reconciliation Analysis

- In 2022, Non Distribution Other Utility Plant Assets addition totaling $192K (US of A 2070) were erroneously included as Rate-Regulated Utility Assets as part of the OEB's Reporting and Record keeping Requirements, and this is reflected in additions in Appendix 2-BA. In 2023, these assets and related depreciation were corrected and were removed from Rate-Regulated Utility Assets in Appendix 2-BA.

Attachment 2-2-1(A) - OEB Appendix 2-BA - 2021-2025 Fixed Asset Continuity Schedule

(Refer to the attachment in Excel format)

Attachment 2-2-1(B) - OEB Appendix 2-BA - 2026-2030 Fixed Asset Continuity Schedule

(Refer to the attachment in Excel format)

WORKING CAPITAL REQUIREMENT

1. INTRODUCTION

This Schedule provides a summary of the Working Capital Requirement for the Historical 2021-2023, Bridge Years 2024 and 2025 and the proposed Test Years 2026-2030.

Table 1 summarizes the 2021-2025 OEB-approved working capital allowance (WCA), as per the Approved Settlement Agreement governing Hydro Ottawa's 2021-2025 rate term.[1] The values for 2022-2025 include annual adjustments using the OEB inflation factor for each applicable year and are as approved by the OEB. The 2021-2025 OEB-approved power supply expenses do not factor in the amounts for Ontario Electricity Rebate (OER).

Table 1 – OEB-Approved Working Capital Allowance 2021-2025 ($'000s)

	Approved				
	2021	**2022**	**2023**	**2024**	**2025**
Power Supply Expenses	$ 1,048,856	$ 1,083,468	$ 1,123,556	$ 1,177,487	$ 1,219,877
OM&A Expenses	$ 90,600	$ 93,590	$ 97,053	$ 101,711	$ 105,373
Total Expenses for Working Capital	$ 1,139,456	$ 1,177,058	$ 1,220,609	$ 1,279,198	$ 1,325,250
Working Capital %	7.50%	7.50%	7.50%	7.50%	7.50%
TOTAL WCA	**$ 85,459**	**$ 88,279**	**$ 91,546**	**$ 95,940**	**$ 99,394**

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Agreement,* EB-2019-0261 (September 18, 2020), page 19.

Table 2 below provides the Historical and Bridge Year WCA amounts for 2021-2025.

Table 2 AS ORIGINALLY SUBMITTED – Working Capital Allowance 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Power Supply Expenses	$ 858,376	$ 852,835	$ 845,992	$ 871,246	$ 884,398
OM&A Expenses	$ 84,737	$ 100,536	$ 112,778	$ 114,280	$ 117,882
Total Expenses for Working Capital	$ 943,113	$ 953,371	$ 958,770	$ 985,526	$ 1,002,280
Working Capital %	7.50%	7.50%	7.50%	7.50%	7.50%
TOTAL WCA	**$ 70,733**	**$ 71,503**	**$ 71,908**	**$ 73,914**	**$ 75,171**

Table 2 UPDATED JUNE 4, 2025 – Working Capital Allowance 2021-2025 ($'000s)

	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Power Supply Expenses	$ 858,376	$ 852,835	$ 845,992	$ 871,246	$ 884,398
OM&A Expenses	$ 84,737	$ 100,536	$ 112,778	$ 115,320	$ 118,922
Total Expenses for Working Capital	$ 943,113	$ 953,371	$ 958,770	$ 986,566	$ 1,003,320
Working Capital %	7.50%	7.50%	7.50%	7.50%	7.50%
TOTAL WCA	**$ 70,733**	**$ 71,503**	**$ 71,908**	**$ 73,992**	**$ 75,249**

Table 3 below provides a summary of Hydro Ottawa's proposed WCA for 2026-2030.

Table 3 – Proposed Working Capital Allowance 2026-2030 ($'000s)

	Test Years				
	2026	2027	2028	2029	2030
Power Supply Expenses	$ 920,527	$ 942,546	$ 970,565	$ 997,399	$ 1,024,647
OM&A Expenses	$ 140,010	$ 147,473	$ 155,333	$ 163,613	$ 172,333
Total Expenses for Working Capital	$ 1,060,537	$ 1,090,019	$ 1,125,898	$ 1,161,011	$ 1,196,980
Working Capital %	7.50%	7.50%	7.50%	7.50%	7.50%
TOTAL WCA	**$ 79,540**	**$ 81,751**	**$ 84,442**	**$ 87,076**	**$ 89,773**

2. WORKING CAPITAL PERCENTAGE

As part of the Chapter 2 *Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications*, dated December 9, 2024 (Filing Requirements), distributors have the ability to propose a working capital percentage by either using the OEB default allowance of 7.5% or file a lead/lag study. Hydro Ottawa has opted to use the OEB default working capital percentage of 7.5% in calculating its working capital in Table 3. This approach is consistent with what was approved as part of Hydro Ottawa's 2021-2025 rate application.

Hydro Ottawa's OEB-approved 2021-2025 WCA percentages are shown in Table 1 above. The OEB's default WCA percentage of 7.5%, as detailed in Table 3, was incorporated into Schedule 2-1-1 - Rate Base Overview for the 2026-2030 working capital requirement in Hydro Ottawa's 2026-2030 rate base. This percentage was also included in the revenue requirements and presented in Schedule 6-1-1 - Revenue Requirement and Revenue Deficiency or Sufficiency.

3. OPERATIONS, MAINTENANCE AND ADMINISTRATION

In Table 3, the Operations, Maintenance and Administration (OM&A) expense used in the WCA aligns with the proposed 2026 Test Year OM&A detailed in Schedule 4-1-1 - Operations, Maintenance and Administration Summary. For 2027-2030, Hydro Ottawa proposes the OM&A incorporated in WCA be escalated by the inflation (I) and growth factor (G), without the adjustment for productivity (X). For more details on Hydro Ottawa's proposed custom rate framework, please refer to Schedule 1-3-1 - Rate Setting Framework.

4. CALCULATION OF COMMODITY AND COST OF POWER EXPENSE

The billing determinants underpinning the estimated Power Supply Expense use the forecasted monthly purchased kWh and peak kW produced by the revenue load forecast described in Schedule 3-1-1 - Revenue Load and Customer Forecast. The Test Years calculation for commodity expense and cost of power is detailed in Appendix 2-Z, in the following Excel Attachments:

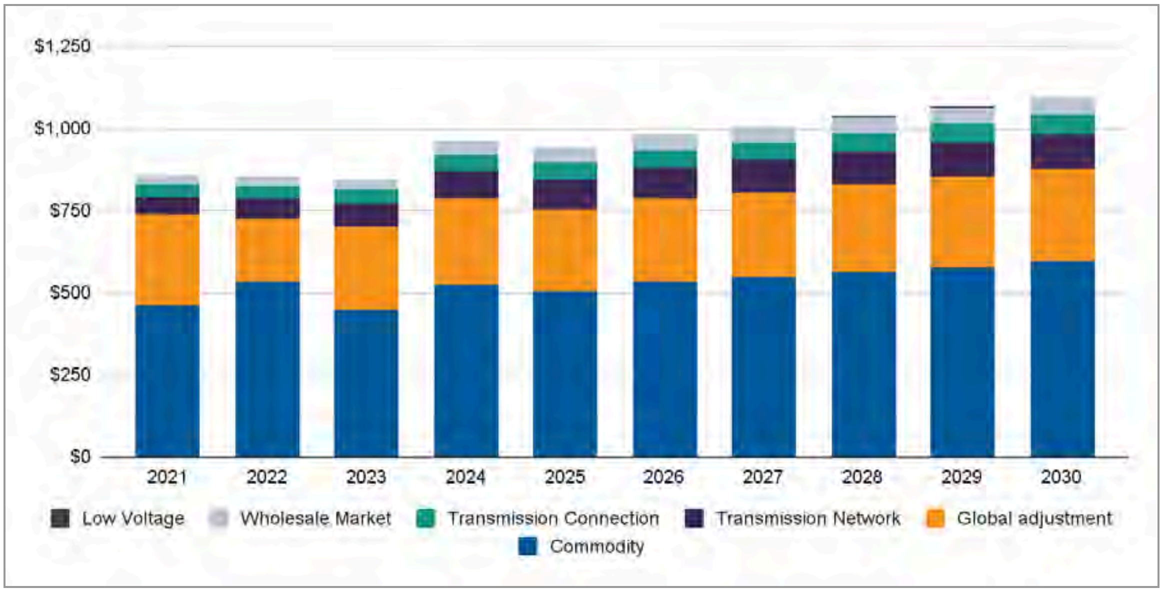
- Attachment 2-3-1(A) OEB Appendix 2-Z - 2026 Commodity Expense
- Attachment 2-3-1(B) OEB Appendix 2-Z - 2027 Commodity Expense
- Attachment 2-3-1(C) OEB Appendix 2-Z - 2028 Commodity Expense
- Attachment 2-3-1(D) OEB Appendix 2-Z - 2029 Commodity Expense
- Attachment 2-3-1(E) OEB Appendix 2-Z - 2030 Commodity Expense

Table 4 – Summary of Estimated Annual Cost of Power Expenses 2026-2030 ($'000s)

	Test Years				
	2026	2027	2028	2029	2030
Commodity	$ 787,047	$ 805,932	$ 830,311	$ 852,779	$ 875,948
Wholesale Market	$ 46,953	$ 47,878	$ 49,113	$ 50,218	$ 51,331
Transmission Network	$ 95,001	$ 97,517	$ 100,297	$ 103,467	$ 106,617
Transmission Connection	$ 53,225	$ 54,636	$ 56,193	$ 57,970	$ 59,734
Smart Meter Entity Charge	$ 1,886	$ 1,905	$ 1,969	$ 2,035	$ 2,102
Low Voltage	$ 457	$ 471	$ 483	$ 496	$ 510
OER Credit	$ (64,042)	$ (65,794)	$ (67,800)	$ (69,566)	$ (71,595)
TOTAL	**$ 920,527**	**$ 942,546**	**$ 970,565**	**$ 997,399**	**$ 1,024,647**

Figure 1 below illustrates Hydro Ottawa's annual cost of power expense from 2021-2030. Annual amounts from 2021-2023 are Historical, 2024-2025 are Bridge Years, and 2026-2030 have been forecasted using Appendix 2-Z and as described in the subsections of this Schedule.

Figure 1 – Cost of Power Expense 2021-2030 ($'000 000s)[2]



4.1. COMMODITY EXPENSE AND GLOBAL ADJUSTMENT

As per Section 2.2.5 of the Filing Requirements, Hydro Ottawa has completed Appendix 2-Z - Commodity Expense for 2026-2030.

Hydro Ottawa has used the 2023 Actual kWh and split each class by Regulated Price Plan (RPP) and non-RPP Class A and Class B customers to determine the percentage shares for the forecasted commodity and cost of power expense. The RPP Supply Cost Summary from the OEB's most recent RPP Report has been used to determine the 2025 forecast commodity price. [3] For 2026-2030 a 2.1% inflationary increase has been applied to determine the estimated RPP, Global Adjustment (GA) and Hourly Ontario Energy Price (HOEP), as described below. As noted in the most recent RPP Report,[4] the impact of the IESO's Market Renewal Program (MRP) is currently unknown. Hydro Ottawa has not factored MRP into the Test Years expense.

[2] Figure does not include Ontario Electricity Rebate amounts.
[3] Ontario Energy Board, *Regulated Price Plan Report November 1, 2024 to October 21, 2025,* (October 18, 2024).
[4] Ontario Energy Board, *Regulated Price Plan Report November 1, 2024 to October 31, 2025,* (October 18, 2024), Pages 1-2.

4.1.1. Estimated RPP Price

The commodity price for RPP customers was calculated by using the OEB's RPP Report. The 2025 RPP Rate of $99.38/MWh[5] was multiplied by a yearly inflationary factor of 2.1% to estimate the yearly RPP commodity price for 2026-2030. In addition, the annual commodity price includes an additional $1/MWh to forecast commodity price adjustments.

Table 5 – Estimated RPP Price ($/kWh)

2025	2026	2027	2028	2029	2030
$ 0.09937	$ 0.10545	$ 0.10764	$ 0.10988	$ 0.11217	$ 0.11450

4.1.2. Estimated Global Adjustment

For Class B kWh the most recent GA rate of $66.64/MWh from the OEB's RPP Report was multiplied by an annual inflationary factor of 2.1% to arrive at a yearly GA Class B rate for 2026-2030. Please see Table 6 below for the yearly rates. The Class A GA rate is based on the average $ per kWh derived from 2023 Historical Class A kWh and Class A GA expense. The 2023 rate of $51.12/MWh was multiplied by a yearly inflationary factor of 2.1% to estimate the yearly GA Class A price for 2026-2030. Please see Table 7 for yearly rates.

Table 6 – Estimated Global Adjustment Price - Class B ($/kWh)

2025	2026	2027	2028	2029	2030
$ 0.06664	$ 0.06804	$ 0.06947	$ 0.07093	$ 0.07242	$ 0.07394

Table 7 – Estimated Global Adjustment Price - Class A ($/kWh)

2025	2026	2027	2028	2029	2030
$ 0.05330	$ 0.05440	$ 0.05550	$ 0.05670	$ 0.05790	$ 0.05910

[5] Ibid, Page 3.

4.1.3. Estimated Hourly Energy Price (HOEP)

For 2026-2030, the estimated HOEP rate has been calculated by taking the estimated annual Average Supply Cost for RPP customers and subtracting the annual estimated GA and adjustment to address bias towards unfavourable variance. Table 8 identifies the estimated HOEP prices for 2026-2030.

Table 8 – Estimated HOEP ($/kWh)

2025	2026	2027	2028	2029	2030
$ 0.03566	$ 0.03641	$ 0.03717	$ 0.03795	$ 0.03875	$ 0.03956

4.2. *WHOLESALE EXPENSE*

The 2026 Wholesale Market Charge (WMC) is calculated by multiplying the total kWh purchased by the 2025 approved rate of $0.0041/kWh.[6] For years 2027-2030 the WMC rate is inflated by 2.1% annually.

4.2.1. Class A & B Capacity Based Recovery

The Class A Capacity Based Recovery (CBR) rate is calculated by dividing the 2023 Historical Class A CBR expense by 2023 Class A kWh. The calculated rate of $0.0004/kWh has been used for all years. The 2025 approved Class B CBR rate of $0.0004/kWh[7] is used to estimate the annual expense for 2026-2030.

4.2.2. Rural Remote Rate Protection

The Rural Remote Rate Protection (RRRP) Charge is calculated by multiplying the total kWh purchased by the 2025 approved rate of $0.0015/kWh[8] for all years.

[6] Ontario Energy Board, *Wholesale Market Services Rate and the Rural or Remote Electricity Rate Protection Charge Decision and Order for January 1, 2025*, EB-2024-0282 (December 10, 2024), Page 9.
[7] Ibid.
[8] Ibid.

4.3. TRANSMISSION EXPENSE

The forecasted kW monthly coincident peak from the revenue load and customer forecast is multiplied by 2023 Historical percentages for each transmission charge to establish the kWs for those charges. Table 9 below outlines the yearly rates calculated for Hydro One Networks Inc. (Hydro One) Retail Transmission Service Rates (RTSRs) and Uniform Transmission Rates (UTRs).

Table 9 – Retail Transmission Service & Uniform Transmission Rates ($/kW)

	2025	2026	2027	2028	2029	2030
RTSR - Network Service	$ 5.3280	$ 5.5054	$ 5.6172	$ 5.7352	$ 5.8556	$ 5.9786
RTSR - Line Connection Rate	$ 0.6882	$ 0.7111	$ 0.7255	$ 0.7407	$ 0.7563	$ 0.7722
RTSR - Transformation Connection Service Rate	$ 3.4894	$ 3.6056	$ 3.6788	$ 3.7561	$ 3.8350	$ 3.9155
UTRs - Network	$ 6.37	$ 6.58	$ 6.72	$ 6.86	$ 7.00	$ 7.15
UTRs - Line Connection	$ 1.00	$ 1.03	$ 1.05	$ 1.08	$ 1.10	$ 1.12
UTRs - Transformation Connection	$ 3.39	$ 3.50	$ 3.57	$ 3.65	$ 3.73	$ 3.80

4.3.1. HONI Transmission Rates

For 2026-2027 Hydro Ottawa has increased the 2025 OEB-approved[9] Hydro One Sub-Transmission RTSRs using the Transmission Custom Revenue Cap Index (RCI) method, as detailed in Hydro One's most recent Custom IR Transmission and Distribution Rate Application.[10] For 2028-2030 the transmission rates have been inflated by 2.1% annually.

[9] Ontario Energy Board, *Hydro One Networks Electricity Distribution Rates and other Charges beginning January 1, 2025, Decision and Order*, EB-2024-0032 (December 19, 2024), Schedule A, page 11

[10] Hydro One Networks Inc., *2023-2027 Custom Incentive Rate-setting Approved Settlement Agreement,* EB-2021-0110 (November 16, 2022), page 6.

4.3.2. Uniform Transmission Rates (UTRs)

For 2026 and 2027, the 2025 Approved UTRs[11] have been inflated by the Transmission RCI. Hydro Ottawa has increased the transmission rates for 2028-2030 based on a 2.1% inflationary factor.

4.4. LOW VOLTAGE (LV) CHARGES

To estimate the expense for 2026-2030, the forecasted kW monthly coincident peak is multiplied by Historical percentages of low voltage charges. Hydro Ottawa has adjusted the annual rates by the Distribution RCI method[12] as described in Hydro One's most recent application for 2026-2027 and applied a 2.1% inflationary factor for 2028-2030. Annual estimated LV expense is divided by total annual system unadjusted kWh to derive the $ per kWh rate. The yearly per kWh rates calculated are outlined in Table 10.

Table 10 – Low Voltage Charges ($/kWh)

	2025	2026	2027	2028	2029	2030
Low Voltage	$ 0.000059	$ 0.000061	$ 0.000063	$ 0.000064	$ 0.000065	$ 0.000067

4.5. SMART METERING ENTITY CHARGE

On September 8, 2022, the OEB approved a Smart Metering Entity charge of $0.42 per Residential and General Service <50 kW customer per month for the period January 1, 2023 to December 31, 2027.[13] This rate has been used for 2026-2027, with 2.1% adjustment for inflation annually for 2028-2030. Hydro Ottawa has used the monthly average load forecast count for Residential and General Service <50 kW customers to calculate the annual expense. Please refer to Schedule 3-1-1 - Revenue Load and Customer Forecast for 2026-2030 average number of customers by class.

[11] Ontario Energy Board, *2025 Uniform Transmission Rates Decision and Order*, EB-2024-0244 (January 21,2025), Schedule A.
[12] Hydro One Networks Inc., *2023-2027 Custom Incentive Rate-setting Approved Settlement Agreement,* EB-2021-0110 (November 16, 2022), page 8.
[13] Ontario Energy Board, Independent Electricity System Operator, Smart Metering Charge *Decision and Order for the years 2023 to 2027*, EB-2022-0137 (September 8, 2022), page 3.

4.6. ONTARIO ELECTRICITY REBATE CREDIT

For 2026-2030, yearly cost of power expenses related to RPP kWh and customers have been reduced by the current OER credit of 13.1%.

Attachment 2-3-1(A) - OEB Appendix 2-Z - 2026 Commodity Expense

(Refer to the attachment in Excel format)

Attachment 2-3-1(B) - OEB Appendix 2-Z - 2027 Commodity Expense

(Refer to the attachment in Excel format)

Attachment 2-3-1(C) - OEB Appendix 2-Z - 2028 Commodity Expense

(Refer to the attachment in Excel format)

Attachment 2-3-1(D) - OEB Appendix 2-Z - 2029 Commodity Expense

(Refer to the attachment in Excel format)

Attachment 2-3-1(E) - OEB Appendix 2-Z - 2030 Commodity Expense

(Refer to the attachment in Excel format)

CAPITAL EXPENDITURE SUMMARY

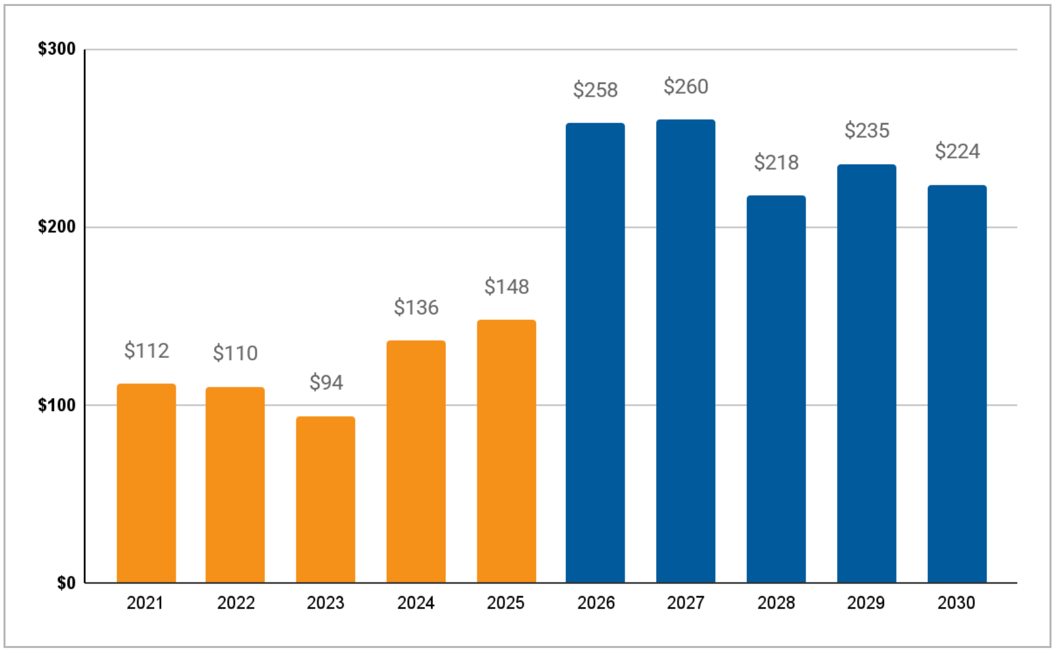
In accordance with the *Chapter 2 and Chapter 5 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications,* dated December 9, 2024, Hydro Ottawa has filed a consolidated Distribution System Plan (DSP) as Tab 2-5, specifically Schedules 2-5-1 through 2-5-9.

The nine schedules within the DSP Tab are:

- Schedule 2-5-1 - Distribution System Plan Overview;
- Schedule 2-5-2 - Coordinated Planning with Third Parties;
- Schedule 2-5-3 - Performance Measurement for Continuous Improvement;
- Schedule 2-5-4 - Asset Management Process;
- Schedule 2-5-5 - Capital Expenditure Plan;
- Schedule 2-5-6 - System Access Investments;
- Schedule 2-5-7 - System Renewal Investments;
- Schedule 2-5-8 - System Service Investments; and
- Schedule 2-5-9 - General Plant Investments.

1 Figure 1 shows annual capital expenditures for both the historic and forecast periods.

3 **Figure 1 – Summary of 2021-2030 Annual Capital Expenditures ($’000,000s)**



6 Table 1 below provides a summary of the expenditures for 2021-2025 for the Historical and Bridge
7 years by Investment Category.

9 **Table 1 – 2021-2025 Capital Expenditures ($’000 000s)**

Investment Category	Historical Years			Bridge Years		Average
	2021	2022	2023	2024	2025	2021-2025
System Access	$ 47.7	$ 47.1	$ 53.4	$ 68.7	$ 75.8	$ 58.5
System Renewal	$ 43.3	$ 65.5	$ 40.3	$ 42.3	$ 41.0	$ 46.5
System Service	$ 24.0	$ 13.8	$ 16.6	$ 47.2	$ 59.5	$ 32.2
General Plant	$ 23.7	$ 11.4	$ 12.9	$ 15.2	$ 13.1	$ 15.3
Capital Contributions	$ (26.5)	$ (27.5)	$ (29.1)	$ (37.3)	$ (41.5)	$ (32.4)
TOTAL	**$ 112.1**	**$ 110.3**	**$ 94.0**	**$ 136.1**	**$ 147.9**	**$ 120.1**

Table 2 provides a summary of the expenditures for the 2026-2030 test years by Investment Category.

Table 2 – Summary of 2026-2030 Capital Expenditures ($'000 000s)

Investment Category	Test Years					Average
	2026	2027	2028	2029	2030	2026-2030
System Access	$ 86.2	$ 78.7	$ 66.2	$ 67.0	$ 71.5	$ 73.9
System Renewal	$ 85.3	$ 83.4	$ 80.7	$ 86.9	$ 95.3	$ 86.3
System Service	$ 99.3	$ 125.3	$ 76.1	$ 85.9	$ 86.9	$ 94.7
General Plant	$ 38.3	$ 23.6	$ 33.0	$ 27.9	$ 11.0	$ 26.8
Capital Contributions	$ (50.9)	$ (50.6)	$ (38.4)	$ (32.2)	$ (41.1)	$ (42.6)
TOTAL	**$ 258.2**	**$ 260.4**	**$ 217.5**	**$ 235.5**	**$ 223.7**	**$ 239.1**

For the capital expenditure-related appendices that electricity distributors must submit, pursuant to the Filing Requirements please see the following attachments:

- Attachment 2-5-5(A) - OEB Appendix 2-AA - Capital Programs Table
- Attachment 2-5-5(B) - OEB Appendix 2-AB - Capital Expenditure Summary

As shown in Table 3 below, for the 2021-2025 historic period, Hydro Ottawa expects that its capital expenditures will exceed the approved forecast by approximately $102.8M (net) over the five-year period.

Table 3 – 2021-2025 Capital Expenditures vs. OEB-Approved Amounts ($'000 000s)

Investment Category	2021 - 2025 OEB-Approved	2021 - 2025 Historical/Bridge	Var ($)	Var (%)
System Access	$ 203.7	$ 292.6	$ 88.9	44%
System Renewal	$ 210.0	$ 232.3	$ 22.4	11%
System Service	$ 123.1	$ 161.1	$ 38.0	31%
General Plant	$ 82.0	$ 76.4	$ (5.6)	(7)%
TOTAL OEB- APPROVED CAPITAL EXPENDITURES	**$ 618.7**	**$ 762.4**	**$ 143.7**	**23%**
Capital Contributions	$ (121.2)	$ (162.0)	$ (40.9)	34%
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 497.561**	**$ 600.4**	**$ 102.8**	**21%**

For comprehensive explanatory notes and variance analyses of Hydro Ottawa's capital expenditures, please refer to Schedule 2-5-5 - Capital Expenditure Plan.

For the special studies to support Hydro Ottawa's proposed capital expenditure plan and rate base levels for the 2026-2030, please see the following attachments:

- Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report
- Attachment 2-5-4(A) - ISO 55001 Hydro Ottawa Certificate of Conformance 2023
- Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk and Vulnerability Assessment and Climate Change Adaptation Plan
- Attachment 2-5-4(C) - Asset Condition Assessment Third Party Review
- Attachment 2-5-4(D) - Failure Curves Review
- Attachment 2-5-4(E) - Resilience Investment Business Case Report
- Attachment 2-5-4(F) - Decarbonization Study

Distribution System Plan

2026-2030

Hydro Ottawa

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		5		**Program Costs**
			1	Cost Factors

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			1	Implementation Plan
			2	Risks to Completion and Risk Mitigation Strategies

DISTRIBUTION SYSTEM PLAN OVERVIEW

1. INTRODUCTION

Hydro Ottawa's Distribution System Plan (DSP) provides a comprehensive overview of how the utility manages its electricity distribution assets and plans for future investments to deliver safe, reliable, and cost-effective service to customers over the 2026-2030 period. The DSP is included in this Application as Schedules 2-5-1 through 2-5-9, and encompasses the following key areas:

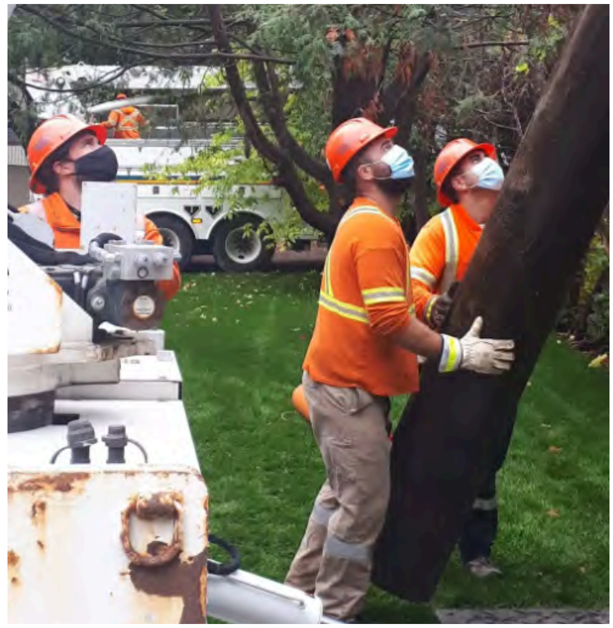
- **Coordinated Planning with Third Parties:** Details how Hydro Ottawa coordinates infrastructure planning with customers, transmitters, other distributors, the IESO and other third parties where appropriate.
- **Performance Reporting:** Outlines how Hydro Ottawa tracks key performance indicators to monitor the effectiveness of its asset management practices and ensure performance targets are met.
- **Asset Management Strategy:** Details how Hydro Ottawa identifies, assesses, and manages risks and opportunities associated with its infrastructure. This includes the utility's approach to maintenance, refurbishment and equipment replacement.
- **Capital Expenditure Plan:** Details Hydro Ottawa's planned investments in the distribution system, which includes upgrades, expansions, and new technologies aimed at improving reliability, safety, and accommodating load growth.
- **Material Investments:** Details capital expenditure projects and programs that meet Hydro Ottawa’s materiality threshold. Material investments are grouped by the four investment categories identified by the OEB, namely System Access, System Renewal, System Service and General Plant.

Hydro Ottawa’s 2026-2030 DSP is a comprehensive roadmap for managing and investing in the electricity distribution system. It outlines a systematic approach used to collect and analyze information on physical assets, current and future system operating conditions, and Hydro Ottawa's business and customer service goals. This thorough assessment allows Hydro Ottawa to strategically prioritize and optimize expenditures related to system upgrades, maintenance, and overall operation. The DSP ensures that Hydro Ottawa's investments are aligned with its overarching goals and the current and future needs of customers and the electricity grid.

Hydro Ottawa continuously maintains and improves its robust asset management practices. The ongoing evaluation and adjustment of the processes and information informing the DSP ensure alignment with evolving industry best practices, regulatory changes, and emerging technologies. This proactive asset management approach supports the achievement of the OEB's four RRF performance outcomes: Customer Focus, Operational Effectiveness, Public Policy Responsiveness, and Financial Performance, contributing to the safe, reliable, and sustainable electricity service essential for community growth and economic development.

The DSP was developed in alignment with the OEB's *Chapter 5 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications*, dated December 9, 2024, as well as with the *Handbook for Utility Rate Applications* issued by the OEB in 2016.

1.1. CONTEXT



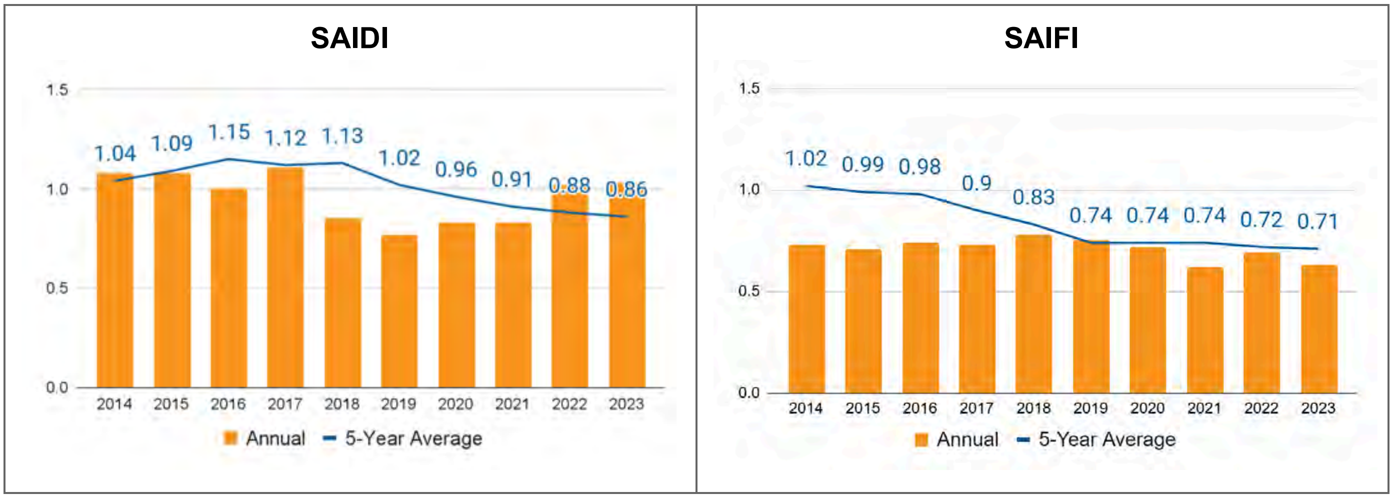
Hydro Ottawa crew during COVID-19

Between 2021 and 2024, Hydro Ottawa faced an unprecedented series of unforeseen challenges that tested its resilience. These challenges included the COVID-19 pandemic and its associated supply chain disruptions and inflationary pressures; a historic storm (the 2022 Derecho) that caused extensive damage to the electricity grid; eleven other major weather events requiring emergency response; and a 84-day strike in 2023. Despite these obstacles, Hydro Ottawa's robust systems and processes, coupled with its agile approach to adapting priorities and programs, enabled the utility to effectively assess and navigate these extraordinary circumstances. This resilience and adaptability allowed for continued progress towards the goals outlined in the 2021-2025 DSP, underscoring Hydro Ottawa's commitment to operational continuity and achieving its long-term strategic objectives.

Hydro Ottawa's 2021-2025 DSP, as filed in its 2021-2025 Custom Incentive Rate-Setting (Custom IR) Application,[1] focused on expanding system capacity and renewing aging infrastructure. This included strategic investments to increase system capacity by 160MVA (Cambrian-100MVA, Limebank-33MVA and Uplands-27MVA) through new station construction and upgrades. The distribution capacity upgrade program also significantly unlocked new distribution line capacity. Targeted infrastructure renewal projects supported the overall improvement to system reliability as evidenced by the reduction to the 5-year average SAIDI and SAIFI performance excluding Loss of Supply and Major Event Days, shown in Figure 1.

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020).

Figure 1 - SAIDI & SAIFI - Annual and 5-Year Average (Excluding Loss of Supply and Major Event Days)



Restoration work after the 2022 Derecho

Hydro Ottawa's 2026-2030 DSP outlines a comprehensive investment strategy that aligns with customer expectations and addresses the evolving needs of Hydro Ottawa's electricity grid. The updated 2026-2030 plan incorporates key improvements, including enhanced asset management processes, expanded grid modernization and resilience planning, updated system capacity assessments, and refined long-term forecasting based on customer feedback and system needs.

Hydro Ottawa has identified four strategic investment priorities for its 2026-2030 DSP. These priorities were determined through a comprehensive analysis that considered customer preferences identified through engagement activities, system needs, historical system performance, and trends identified through the business planning process.[2] The four Investment Priorities are:

1. **Growth & Electrification - Powering the Growing Community:** Focusing on expanding grid capacity to serve a growing community and ensure a reliable, resilient electricity system capable of meeting increasing demand driven by new customer connections and distributed energy resources (DERs).
2. **Renewing Deteriorating Infrastructure:** Focusing on mitigating reliability risk by strategically upgrading or replacing deteriorating and critical infrastructure, prioritizing assets with the greatest impact on system reliability and safety based on condition assessments.
3. **Grid Modernization - Enabling the Energy Transition:** Focusing on modernizing the grid through strategic technology adoption and infrastructure upgrades to enable the energy transition, facilitate customer participation, and optimize DER integration, thereby enhancing grid capabilities and efficiency.
4. **Enhancing Grid Resilience:** Focusing on enhancing grid resilience by proactively upgrading infrastructure and implementing measures to protect against increasingly frequent and intense severe weather events and cyber threats.

[2] For further details on Hydro Ottawa's business planning process, see Schedule 1-2-3 - Business Plan.

These four investment priorities address Hydro Ottawa's key distribution system planning challenges and opportunities, supported by two foundational focuses: Managing Rising Costs and Investing in the Workforce. In all aspects of planning, execution and performance monitoring, Hydro Ottawa emphasizes maintaining affordability for customers while ensuring a reliable and resilient electricity system to meet growing demand. To accomplish the priorities set out in this plan, Hydro Ottawa recognizes the importance of workforce development and safety to ensure a skilled and secure energy future.

1.2. 2026-2030 CAPITAL EXPENDITURE PLAN

Hydro Ottawa's planned capital investments for 2026-2030 represent a significant increase compared to the previous five-year period, reflecting the substantial challenge of modernizing and expanding the grid to meet the evolving needs of the community. The scale of these investments underscores Hydro Ottawa's commitment to providing safe and reliable electricity to the City of Ottawa and Municipality of Casselman while ensuring resilience in the face of climate change.

Figure 2 below provides a visual representation of 2026-2030 planned expenditures by Investment Priority.

Clearing damaged equipment after the May 2022 Derecho

Figure 2 - 2026-2030 Capital Expenditure by Investment Priority

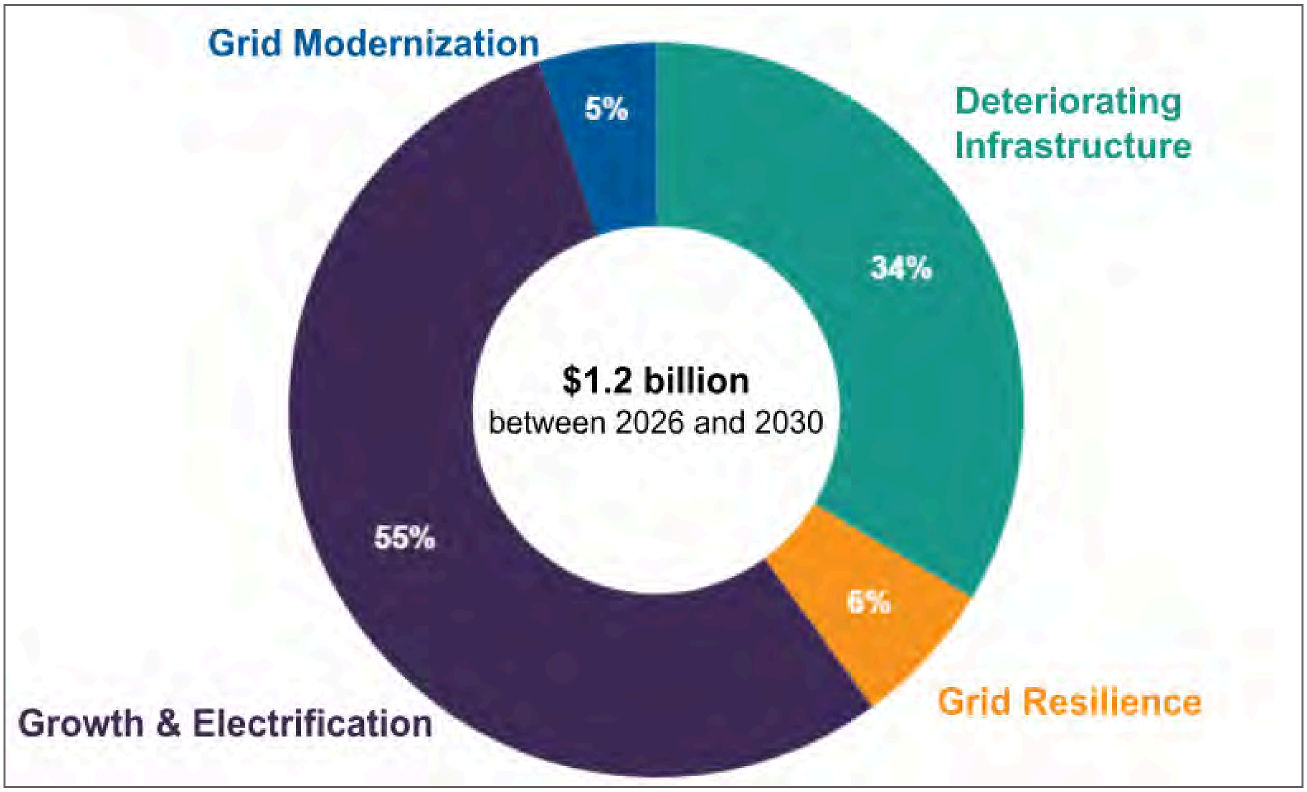


Table 1 below outlines the variance between Hydro Ottawa's 2021-2025 and 2026-2030 planned investments by investment category.

Table 1 - Capital Expenditure Variance by Investment Category - 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)

Investment Category	Historical / Bridge Years	Test Years	Variance
	2021-2025	2026-2030	
System Access	$ 293	$ 369	$ 77
System Renewal	$ 232	$ 432	$ 199
System Service	$ 161	$ 473	$ 312
General Plant	$ 76	$ 134	$ 57
Total Capital Expenditures	**$ 762**	**$ 1,409**	**$ 646**
Capital Contributions	$ (162)	$ (213)	$ (51)
Net Capital Expenditures	**$ 600**	**$ 1,195**	**$ 595**

Hydro Ottawa's 2026-2030 DSP strikes a balance between customer priorities and system needs, representing the minimum investment required to ensure a reliable, resilient and sustainable electricity grid. Through strategic planning and prudent investment aligned with customer priorities, Hydro Ottawa is committed to meeting the evolving energy needs of the community while ensuring continued safe, reliable and affordable electricity for its customers.

2. KEY ELEMENTS OF THE DSP

This section details the key elements included within the DSP. It outlines the essential components and considerations that shape the DSP's development and implementation, ensuring a robust and effective approach to managing the distribution system. Key elements of the 2026-2030 DSP include details of the updates to the DSP since filed with the 2021-2025 Rate Application, customer priorities, the challenges and trends faced by the utility, and resulting focus areas that inform investment plans.

2.1. CHANGES IN THE DSP

The following sections detail the key changes that impact the inputs into the DSP since the previous DSP submission in the 2021-2025 rate application.

2.1.1. Asset Management Process

To ensure a reliable, resilient, and customer-centric electricity grid, Hydro Ottawa has made significant enhancements to its asset management process. These improvements, centered on predictive analysis, refined testing, inspection, and maintenance, and a more robust ACA framework, reflect a forward-thinking approach that strategically aligns asset management practices with the company's broader objectives and customer needs. Hydro Ottawa has also continued to demonstrate a commitment to advanced asset management, evidenced by initially achieving ISO 55001 Asset Management Standard certification in 2020 and recertified in 2023. This certification highlights the maturity of the asset management system, which includes enhancements like a comprehensive risk register and targeted mitigation plans. These practices support strategic asset decision-making, balancing cost, risk, and performance to meet customer expectations and regulatory requirements.

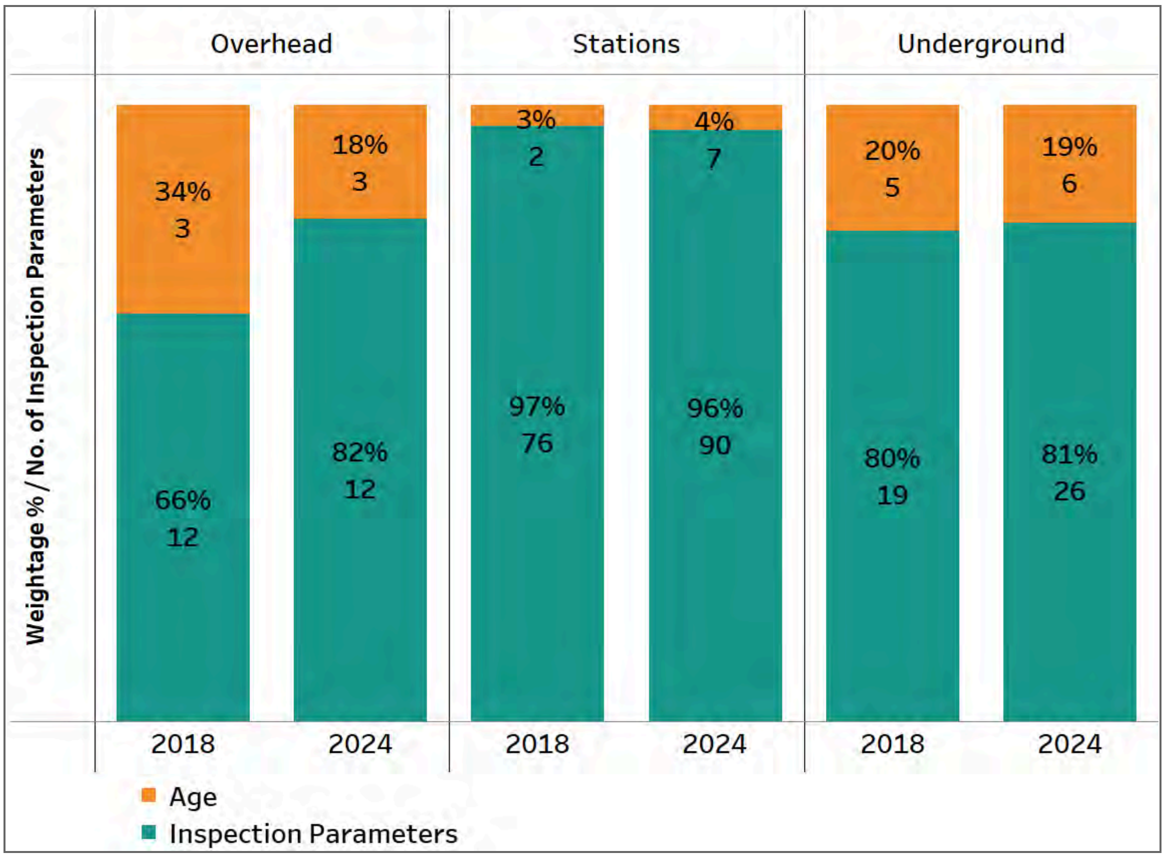
A key enhancement is the incorporation of predictive analysis into system renewal investment planning. This involves using the Copperleaf Asset Predictive Analytics (PA) module to model distribution assets and forecast system renewal needs. This predictive capability allows Hydro Ottawa to move towards a more proactive approach by predicting the effects of asset degradation over time and optimizing replacement schedules. The PA module analyzes asset data, including condition and risk information, to forecast the impact of asset degradation and inform investment decisions. This analysis helps determine the optimal timing for interventions like replacements or upgrades, considering factors such as risk mitigation and cost-effectiveness. By leveraging PA, Hydro Ottawa aims to make higher-value investment decisions, ultimately improving the management of its assets.

In addition to PA, Hydro Ottawa has also significantly refined its testing, inspection, and maintenance programs. These refinements aim to capture more detailed data on asset conditions. For instance, the overhead asset inspection program now captures information on pole-mounted transformers, switches, and related hardware at every pole inspected, rather than only when an issue is found. This provides a more comprehensive understanding of the health of these assets. For underground infrastructure, Hydro Ottawa has enhanced its cable testing methodology, incorporating advanced testing methods such as Very Low Frequency Tan-Delta, Partial Discharge, and Time Domain Reflectometry. These advanced techniques provide a deeper understanding of the condition of cable components, facilitating more targeted remediation efforts. This improved data collection allows for more precise condition assessments to inform investment planning.

Hydro Ottawa has also enhanced its Asset Condition Assessment (ACA) framework to provide a more accurate and comprehensive evaluation of asset health. A key improvement involves incorporating additional condition parameters derived from testing, inspection, and maintenance programs into the calculation of asset health index scores. This integration of diverse data sources results in a more holistic view of an asset's condition.

Hydro Ottawa's Asset Condition Assessment framework has undergone significant evolution between 2018 and 2024, as evidenced by the data presented in Figure 3 below. A notable shift from age-based to condition-based asset evaluation is demonstrated across various asset categories. For overhead assets, the reliance on age was substantially reduced due to improvements to the condition assessment framework for poles, alongside moderate improvements to condition data quality from Overhead (OH) switches and transformers through ground-based inspections. Station assets saw a significant increase in the number of parameters utilized, reflecting the integration of previously underutilized inspection data, with minimal reliance on age. Underground assets experienced an increase in assessment parameters, though the reliance on age remains comparatively higher. However, Hydro Ottawa has implemented ongoing improvements to the cable testing and vault inspection programs, demonstrating a commitment to enhancing condition data accuracy. Hydro Ottawa's strategic enhancements to the ACA framework underscore a commitment to proactive maintenance and risk management, aligning with industry best practices and emphasizing the importance of real-time, accurate condition data for informed decision-making.

Figure 3 - Hydro Ottawa's ACA Framework Enhancements



More information on Hydro Ottawa's ACA process can be found in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process.

These improvements collectively contribute to a more data-driven and risk-based approach to asset management, enabling Hydro Ottawa to optimize investments, enhance reliability, and ensure the long-term sustainability of its electricity grid. More details on the improvements that Hydro Ottawa made to its Asset Management Process are provided in Section 4.4 of Schedule 2-5-4 - Asset Management Process.

2.1.2. Grid Modernization

Grid Modernization Strategy & Roadmap Creation

Recognizing the challenges and opportunities of the evolving energy landscape, Hydro Ottawa engaged Hatch in 2022 to develop a comprehensive Grid Modernization Strategy and Roadmap. This initiative prioritized enhancing grid reliability, flexibility, resilience, and sustainability through a methodical, two-phased approach.

The first phase began with establishing a baseline maturity level by completing an assessment of Hydro Ottawa's existing grid infrastructure and operational capabilities. This evaluation was then compared against a desired future state vision across various time horizons, which revealed key areas for improvement. The second phase of the project used these key findings to develop the Grid Modernization Strategy, also drawing upon existing corporate directives, operational plans, ongoing initiatives, and industry best practices to ensure alignment and efficacy. This structured approach was designed to ensure that Hydro Ottawa's grid modernization efforts are strategically aligned, operationally sound, and effectively address the evolving demands of the energy landscape.

The Grid Modernization Strategy translates the corporate priorities into actionable objectives, which are then translated into investment plans by informing the objectives of both the Asset Management and Digital strategies. For more information, please see Section 3.4 of Schedule 2-5-4 - Asset Management Process. This ensures coordinated investment and avoids duplicated effort or inefficiencies that could arise from shared asset accountabilities. Specifically, it allows for sole oversight and coordination of distribution assets under the Asset Management framework and information technology assets under the Digital framework.

The Grid Modernization Roadmap operationalizes the Grid Modernization Objectives in conjunction with the Capital Expenditure plan. The Strategy defines the needs, which are then translated through the Asset Management and Digital Strategies into concrete investment plans. These plans are consolidated within the capital expenditure planning process and monitored through the Grid Modernization Roadmap to ensure the Grid Modernization Objectives are achieved.

April 2023 Ice Storm

More details on the Grid Modernization Strategy are available in Section 3.4.2 of Schedule 2-5-4 - Asset Management Process.

2.1.3. Resilience

As part of Hydro Ottawa's ongoing commitment to grid resilience and service reliability, a 2023 Climate Study Reaffirmation and the Resilience Investment Business Case assessments were undertaken. See Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan and Attachment 2-5-4(E) - Resilience Investment Business Case Report, respectively. These assessments support planning to enhance grid resilience and prioritize system reliability in the face of increasingly frequent severe weather events and growing dependence on stable power. The Climate Study Reaffirmation reconfirmed the necessity of continued adaptation and mitigation strategies, while the Resilience Investment Business Case Report offered a data-driven approach to identify and prioritize areas for strategic undergrounding of overhead lines.

Hydro Ottawa's resilience assessment aligns with the OEB's new and ongoing Vulnerability Assessment and System Hardening (VASH) framework, which intends to set out how distributors should incorporate climate resilience into their asset and investment planning to mitigate climate-related vulnerabilities. Hydro Ottawa uses an asset-based approach, leveraging climate forecast data from models developed by Burns & McDonnell's subsidiary 1898 & Co. by quantitatively comparing asset threshold criteria with the probability of extreme weather events during the project evaluation stage, Hydro Ottawa ensures investments enhance climate resilience within the distribution system.

Assessing Damage after the 2022 Derecho

Climate Study Reaffirmation

In 2023, Hydro Ottawa commissioned Stantec Consulting Ltd. to conduct a study to update the 2019 climate risk assessment,[3] incorporating the latest climate projection data and factoring in recent extreme weather events, including the 2022 Derecho storm. This comprehensive assessment utilized updated climate models and regional projections to refine the probability estimations of extreme weather events. Notably, two new wind speed thresholds, exceeding 130 km/h and 180 km/h, were introduced based on updated criteria and empirical observations from the 2022 Derecho storm. This led to a reassessment of potential high-wind impacts on infrastructure, resulting in elevated consequence ratings.

Despite the increased risk scores associated with severe wind events, the overall risk level for the majority of Hydro Ottawa's infrastructure remains unchanged. This finding indicates that the adaptation and mitigation measures outlined in the 2019 plan retain their efficacy. Consequently, the primary areas of vulnerability within Hydro Ottawa's system, namely overhead assets, remain consistent with previous assessments.

As a result, Hydro Ottawa commissioned a further study to explore strategic opportunities for undergrounding vulnerable sections of overhead lines to enhance the overall resilience of the electricity distribution system. Further details on the study's findings can be found in Section 4.4.8 of Schedule 2-5-4 - Asset Management Process.

Resilience Investment Business Case

Hydro Ottawa engaged 1898 & Co. to conduct a comprehensive assessment and develop a Resilience Investment Business Case for strategically burying vulnerable sections of the overhead distribution system. Refer to Attachment 2-5-4(E) - Resilience Investment Business Case Report. The report emphasizes the growing importance of grid resilience, highlighting the

[3] See Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020), Attachment 2-5-4(B): Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan.

increasing frequency of severe weather events and the community's dependence on reliable service. Employing a data-driven model, the study identified and prioritized resilience investments, focusing on the strategic conversion of overhead lines to underground systems.

Hydro Ottawa integrated the study's findings with empirical evidence from recent storm events to proactively incorporate resilience investments into the capital plan. The resulting Distribution System Resilience program encompasses a multi-faceted approach, including:

- Strategic undergrounding of vulnerable overhead lines;
- Reinforcement of existing overhead infrastructure;
- Feeder reconfiguration;
- Undergrounding of station egress points; and
- Relocation of lines.

April 2023 Ice Storm

These investments are designed to mitigate system disruptions caused by severe weather events, ultimately minimizing restoration costs, customer outage durations, and overall system recovery time.

A detailed description of the Distribution System Resilience program is provided in Section 3 of Schedule 2-5-8 - System Service Investments.

2.1.4. System Planning

Decarbonization Study

Decarbonization targets set out by federal and municipal bodies are increasingly impacting Hydro Ottawa's distribution system. Traditional forecasting methods which primarily rely on historical consumption patterns and projected growth based on known and observable trends fail to capture the uncertainties introduced by decarbonization goals and the resulting electrification of building, water heating and transportation. Recognizing this gap, the IESO created a Decarbonization Sub-Working Group to support studying the impacts of electrification on regional forecasts. In support of this sub-working group, Hydro Ottawa commissioned Black & Veatch in 2023 to conduct a Decarbonization Study, included in this Application as Attachment 2-5-4(F) - Decarbonization Study. This study evaluates the potential impacts of societal electrification trends on Hydro Ottawa's distribution system out to 2050 with a scenario-based approach. Five scenarios with varying assumptions of decarbonization initiatives on the distribution system are assessed in the Study with refinement from the Decarbonization Sub-Working Group. More details about this group are provided in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Hydro Ottawa is utilizing the Decarbonization Study's Reference Scenario forecast to inform its Integrated Regional Resource Plan (IRRP) forecast. This alignment is crucial for long-term regional transmission planning, given the extended lead times of transmission grid investments. Recognizing the uncertainties associated with government policies and technological advancements, Hydro Ottawa leveraged the forecast derived from the Decarbonization Study's

Reference scenario to augment its own investment decisions. Hydro Ottawa's 2026-2030 capital expenditure plans balance investment needs with affordability by prioritizing a mix of wire and Non-Wire Solutions (NWSs). Investments are focused on already constrained regions and areas with immediate, confirmed, and committed load requirements necessary to meet customer service obligations. These infrastructure investments were sized to accommodate demand growth projections in the IRRP forecast through 2035 to ensure efficient capital deployment. The most notable examples of projects, programs or updates that were informed by the decarbonization study include (a) the decision to increase the capacity of the Hydro Road, Cyrville, Kanata North and Greenbank stations to align with Hydro Ottawa's standard 100MVA design, (b) the decision to convert voltage levels to 13kV when replacing deteriorated 4kV station assets to support intensification and other known large projects such as the New Ottawa Hospital and (c) the reaffirmation of Hydro Ottawa's residential transformer sizing guideline. This strategic approach balances immediate operational demands with long-term sustainability goals thereby optimizing capital allocation and asset utilization. By leveraging decarbonization projections to inform the mid to long term outlook (beyond 2030) and aligning investments with both near-term (until 2030) and future needs, Hydro Ottawa ensures the development of a reliable, resilient, and cost-effective power grid capable of supporting the transition to a sustainable, net-zero energy future.

Further details on the Decarbonization Study are available in Section 9 of Schedule 2-5-4 - Asset Management Process, and Attachment 2-5-4(F) - Decarbonization Study.

2.2. CUSTOMER PRIORITIES

Hydro Ottawa prioritizes ongoing customer engagement as a core component of its business operations. This commitment is reflected in various initiatives and channels designed to gather customer feedback, understand evolving needs, and ensure a customer-centric approach to service delivery. For details on Hydro Ottawa's ongoing customer engagement initiatives, please see Schedule 1-4-1 - Customer Engagement Ongoing. Hydro Ottawa's 2026-2030 DSP was developed with extensive and targeted customer input gathered in two phases in collaboration with Innovative Research Group Inc, a national consulting firm with extensive expertise in public opinion research and specifically in the context of energy policy and utility operations. Phase I focused on strategy, and sought input aimed at understanding customer needs and preferences. This was distilled into priorities and principles that Hydro Ottawa planners and subject matter experts were guided by in developing the draft distribution system and business plans (as reflected in the “Needs and Preferences Planning Placemat” in Appendix.08 of the consolidated Customer Engagement Report found in Attachment 1-4-2(A) - Customer Engagement Report on Hydro Ottawa's 2026-2030 Rate Application). In Phase II, the Customer Engagement process focused on gathering customer feedback on Hydro Ottawa's proposed investment plan. This was achieved through an online survey that presented the plan's four key categories: Growth and Electrification, Aging Infrastructure, Grid Modernization, and Grid Resilience. The survey aimed to gauge customer investment preferences across these categories and assess the overall level of support for the proposed plan by outlining priority investment options with varying paces and cost impacts, enabling them to directly influence the final plan by providing feedback on their preferred balance of cost, timing, and system outcomes (reliability, resilience, renewable integration).

Key Findings:

- **Strong Support for the Plan:** The results demonstrated strong overall support for the plan, particularly among commercial customers who recognize the value of a reliable and modern electricity grid. An average of 87% of customers, across all rate classes, gave Hydro Ottawa social permission to proceed with its draft plan. These customers provided social permission by indicating either:
  - 16% think Hydro Ottawa should accelerate spending beyond the level in the draft plan to deliver better system outcomes.
  - 28% support the proposed rate increase that is reflected in the draft plan, or
  - 43% feel that the proposed rate increase in the draft plan is necessary, even though they don’t like the proposed rate increase.

- **Acceptance of Necessary Increases:** While many customers expressed a general dislike for bill increases, a majority within each customer category acknowledged the necessity of these increases to fund critical system investments.
- **Desire for Accelerated Investment:** A significant minority of respondents favored an even faster pace of investment, indicating a willingness to absorb higher near-term costs to expedite system upgrades and realize their associated benefits sooner.

A summary of Hydro Ottawa's customer engagement on the 2026-2030 Application priorities are summarized below, with fulsome details available in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

Phase I

Phase I took place from February to May 2024 and focused on understanding customer needs through focus groups and interviews. This comprehensive approach ensured that diverse customer perspectives were gathered and analyzed to shape Hydro Ottawa's investment plan from its early stages.

Engagement results and key findings from Phase I, in relation to satisfaction and general priorities, include:

- Customer satisfaction has improved relative to 2019 for residential and small business customers.
- Residential and small business customers prioritize very similar general outcomes, with both ranking "maintaining reliable electricity service" as their top priority.
- Commercial and industrial and key account customers have more distinctive prioritizations, with reliable service being important, but outranked by the related and more specific objective of hardening the grid to withstand severe weather. Capacity to meet future demand was also a high-ranked priority of these customer classes.

Phase II

Phase II was conducted from September to October 2024 through an online survey to gauge customer investment preferences across four investment priorities that were identified throughout Phase I. These four priorities are: Growth and Electrification, Aging Infrastructure, Grid Modernization, and Grid Resilience. The majority of customers across all categories supported the proposed plan, with many even encouraging Hydro Ottawa to exceed it. Feedback was obtained from 21,8399 customers during this phase. Table 2 outlines the identified priority rankings by customer class.

Table 2 - Customer Priority Ranking by Category[4]

Investment Priority	Customer Category		
	Residential	Small Business	Commercial & Industrial and Key Account
Grid Resilience	1	1	2[5]
Grid Modernization	2	2	2
Aging Infrastructure (replacing equipment)	3	3	1
Metering Renewal	4	5	5
Growth and Electrification	5	4	4

In Phase II customers reviewed a draft plan outlining the four identified priority investment categories, presenting various options with different paces and cost implications. This allowed customers to directly influence the final plan by providing feedback on their preferences regarding the balance between cost, timing, and system outcomes (i.e. reliability, resilience, renewable integration).

2.3. INVESTMENT PRIORITIES

Through business planning and asset management processes, Hydro Ottawa has identified four

[4] Customer priority ranking was determined by adding support for Accelerated Pace and Draft Plan
[5] Grid Resilience and Grid Modernization received the same ranking

strategic Investment Priorities in this DSP. These priorities have been validated through customer engagement, ensuring that investments address the most pressing needs of both the community and the electricity grid, and are aligned with customer's top concerns: resilience against severe weather, reliability, reasonable rates, and grid capacity expansion. By focusing on these key areas, Hydro Ottawa aims to create a resilient and sustainable electricity system that can meet the evolving demands of the community while ensuring service remains safe, reliable, and affordable.

The four Investment Priorities are:

- **Growth & Electrification:** Powering a Growing Community
- **Renewing Deteriorating Infrastructure**
- **Grid Modernization:** Enabling the Energy Transition
- **Enhancing Resilience**

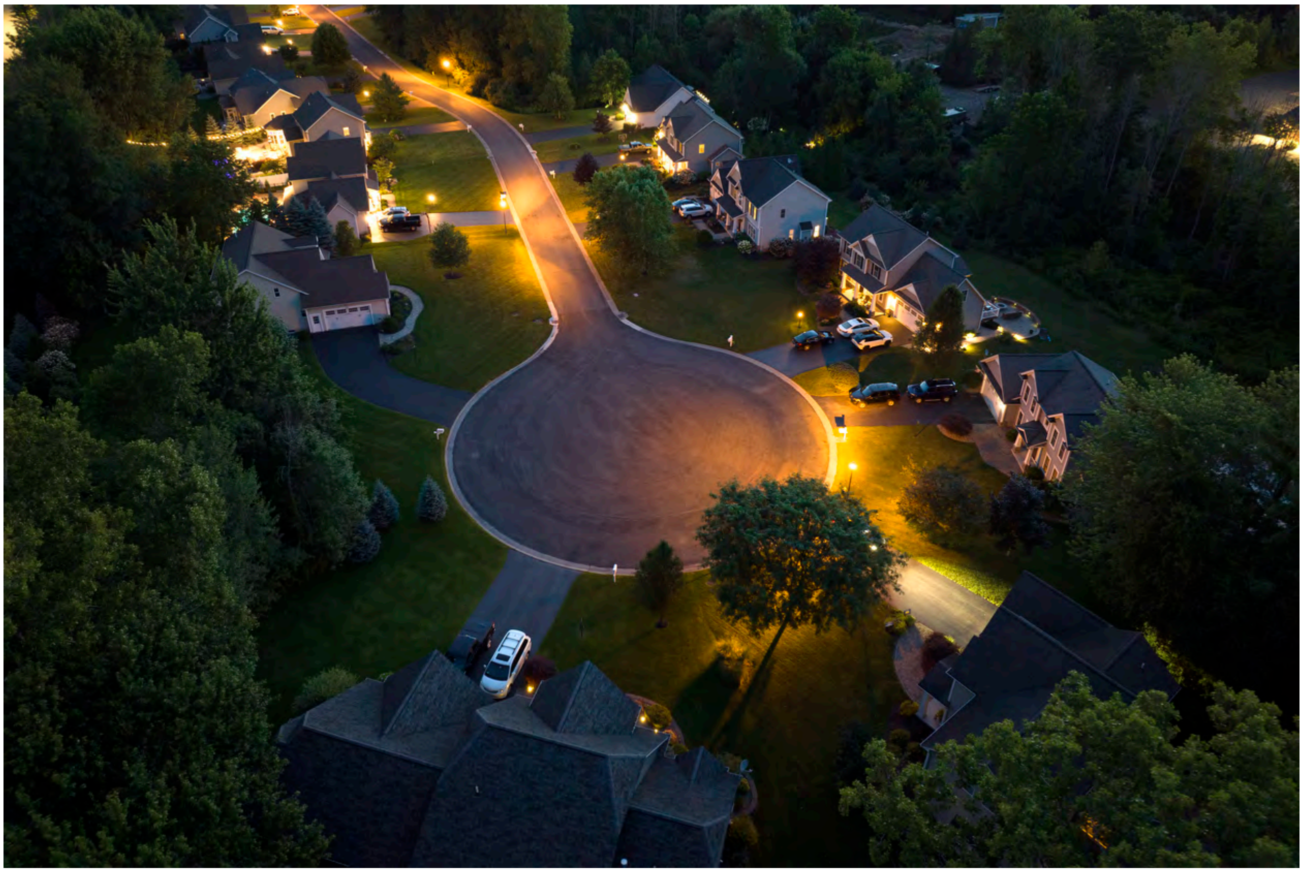
These Investment Priorities are underpinned by two Focus Areas:

- **Managing Rising Costs:** Ensuring customer affordability amidst economic uncertainties.
- **Investing in the Workforce:** Developing a robust and skilled workforce to navigate the evolving energy landscape.

By strategically balancing system upgrades with affordability and investing in its workforce, Hydro Ottawa is building a resilient and sustainable electricity system. Customer surveys, detailed in Section 3.3 of Schedule 2-5-4 - Asset Management Process, demonstrate strong support for the capital plan, confirming the effectiveness of this customer-centric approach.

2.3.1. Growth & Electrification - Powering a Growing Community

Focusing on expanding grid capacity to serve a growing community and ensure a reliable, resilient electricity system capable of meeting increasing demand driven by new customer connections and distributed energy resources (DERs).



To meet Ottawa's growing energy needs driven by electrification and expansion, Hydro Ottawa is strategically evolving its infrastructure and operations through 2030.

The City of Ottawa is experiencing consistent expansion, with ongoing residential development driving increasing demands on Hydro Ottawa. The utility's residential customer connection volumes illustrate this growth. These volumes have increased from a budgeted annual average of 3,190 to actuals of 6,067 over the 2021-2023 period. This upward trend is projected to continue, fueled by the City of Ottawa's forecasted population growth at a rate of 1.3% CAGR[6] over the 2026-2031 period and provincial emphasis on new housing development, as evidenced by the *More Homes Built Faster Act, 2022.*[7] For details on this, see Section 3.5.1, Schedule 2-5-6 - System Access Investments.

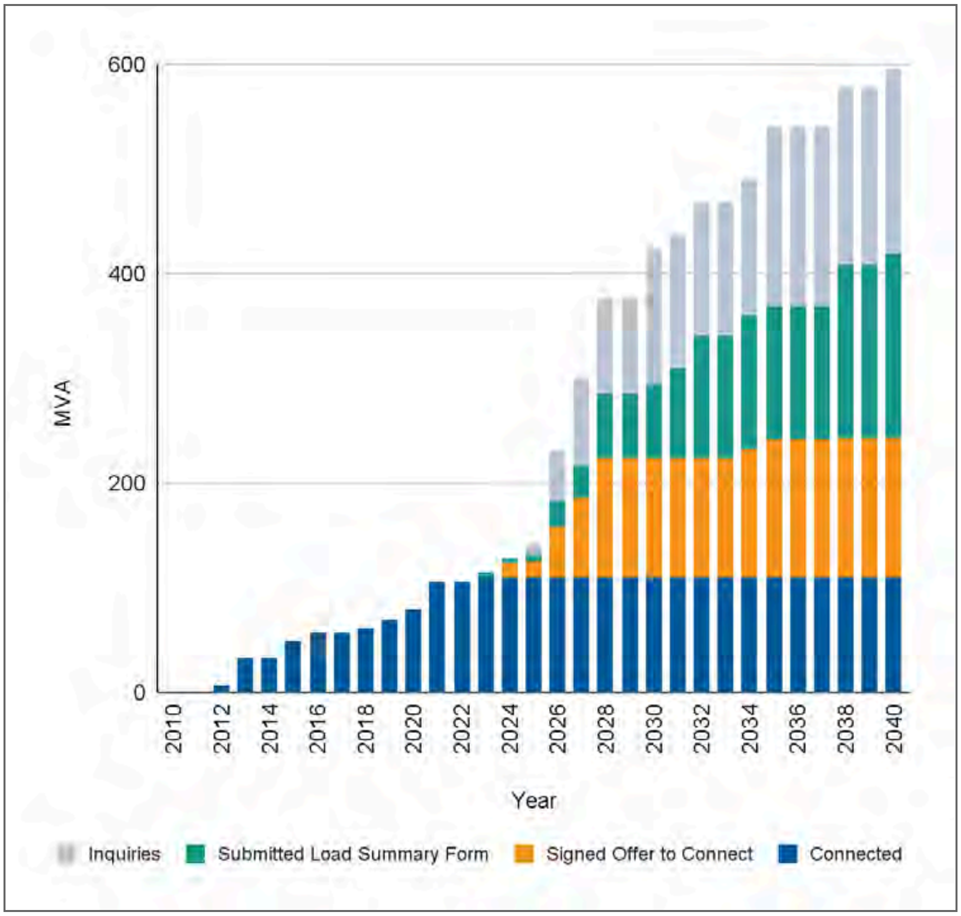
Electrification is also profoundly influencing electricity demand, adding significant pressure to the system. And this trend is expected to continue as Federal Government legislation requires 60% of all light duty vehicles sold in Canada to be electric vehicles by 2030 and 100% by 2035, compared to 9% of vehicles sold in 2021.[8] The increasing adoption of electric vehicles represents a substantial load growth factor, with the electrical demands of EV charging, particularly when concentrated and simultaneous, requiring robust grid reinforcement, especially around public charging facilities. For example, Hydro Ottawa has planned grid infrastructure investments to support the City of Ottawa's plan to procure 354 electric buses by 2027 and a full transition to electric buses by 2036[9]. Refer to Section 4.3.2, Schedule 2-5-6 - System Access Investments for additional details.

Similarly, the growing adoption of electric space heating contributes to increased electricity consumption, particularly during peak winter demand periods. These trends necessitate infrastructure upgrades to accommodate higher loads and maintain system reliability with heat pumps projected to provide more than 50% of residential space heating needs by 2050, up from 6% in 2021.[10]

[6] City of Ottawa, "Growth projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93
[7] Legislative Assembly of Ontario, "Bill 23, *More Homes Built Faster Act, 2022.*"
[8] Statistics Canada, "Watt's up? Electric Vehicles and future electricity generation needs," https://www.statcan.gc.ca/o1/en/plus/5497-watts-electric-vehicles-and-future-electricity-generation-needs
[9] Ottawa-Carleton Transportation, "Zero-Emission Bus," https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/
[10] Canada Energy Regulator, "Canada's Energy Future 2023: Energy Supply and Demand Projections to 2050," https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/

Hydro Ottawa is witnessing a significant escalation in large load requests, exceeding 5 MVA, fueled by the accelerating trend of electrification. Since 2018, the utility has recorded a marked upswing in large load connection requests and inquiries, and the pace of demand notably quickened from 2023 onwards. This burgeoning load profile is clearly depicted in Figure 4, which breaks down 110 MVA of large loads successfully integrated into the grid between 2010 and 2023 (blue), 113 MVA of confirmed customer commitments, secured through signed Offers to Connect and slated for completion by 2028 (orange), and a further 199 MVA of potential load requests, encompassing preliminary inquiries through to formal load summary submissions (grey and green). Should these potential requests materialize by 2030, Hydro Ottawa anticipates an unprecedented 312 MVA increase in its total load demand over the 6 year span of 2024-2030; a three-fold increase from the 110MVA connected in the previous 10 years.

Figure 4 - Large Load Connections, Commitments, Requests & Inquiries



If all these requests materialize, this would represent an increase of 312 MVA by 2030, tripling the amount connected during the previous 14-year period.

Key examples of the projects driving these large load requests include the Ottawa Hospital's New Campus, OC Transpo's Zero Emission Buses, Department of National Defence Dwyer Hill Training Center Upgrade, new laboratory facilities for the Regulatory and Security Science Main Project (located at the Canadian Food Inspection Agency's Ottawa Laboratory), and the TerraCanada National Capital Area project (located at the National Research Council of Canada facilities).

To effectively address these converging challenges—increased residential connections, the electrification surge, and escalating demand from large-load customers—Hydro Ottawa is pursuing strategic and substantial investments, with a focus on:

Capacity Expansion: Investments in new substations, upgrades to existing facilities, and expansion of the distribution network to effectively manage increased load and ensure service reliability.

Grid Modernization: Initiatives to modernize the grid to better accommodate the dynamic load profiles associated with EV charging and electric heating, enhance grid flexibility and responsiveness, and DERs and integrate smart grid technologies.

Non-Wires Solutions (NWSs): Strategic implementation of NWSs, such as utility-owned battery energy storage systems and a Non-Wires Customer Solutions Program, to proactively manage peak demand, defer or avoid traditional infrastructure investments, and enhance grid reliability.

With anticipated growth and rapid rate of change across the City of Ottawa, Hydro Ottawa is committed to collaboration, working with developers and the City of Ottawa through various working groups, including the Utility Coordinating Committee, Energy Evolution, and the Decarbonization Working Group. These partnerships are essential to developing well-informed grid capacity enhancement plans and ensuring the continued provision of reliable electricity services to a dynamic and expanding community. This collaborative approach aims to support ongoing residential and commercial development, facilitate urban intensification initiatives, and enable major infrastructure projects within the community in a cost-effective manner.

2026-2030 Capital Expenditure Overview

Hydro Ottawa's proposed capital investments are driven by the need to adapt to the evolving energy landscape that is being reshaped by Growth & Electrification. The portfolio of investments under Growth & Electrification focuses on expanding the electricity system to accommodate customer connections, forecasted demand and support the integration of DERs. This is achieved through investments in the System Access category, which includes programs like Customer Connections to facilitate new residential and commercial developments, System Expansion to address major infrastructure projects like new stations, and Generation Connections to enable the connection of customer-owned DERs. It is also achieved through investments in the System Service category where although the primary driver is dealing with capacity constraints it also allows efficient investment in programs that prepare the grid for the projected impacts of decarbonization and integration of distributed renewable energy resources. These proactive initiatives are essential to ensure the continued provision of reliable and sustainable electricity services, effectively managing the challenges and opportunities presented by these transformative trends, and ultimately, enabling a robust energy transformation in Ottawa.

2.3.2. Renewing Deteriorating Infrastructure

Focusing on mitigating failure risk by strategically upgrading or replacing deteriorating and critical infrastructure, prioritizing assets with the greatest impact on system reliability and safety based on condition assessments.

To ensure continued, safe, and reliable electricity delivery to its customers, Hydro Ottawa must proactively invest in renewing its deteriorating infrastructure.

Hydro Ottawa's enhanced asset management process, detailed in Section 4.4 of Schedule 2-5-4 - Asset Management Process, includes comprehensive ACAs to determine asset health and facilitate holistic risk assessment. These assessments reveal that 54% of Hydro Ottawa's assets have reached the end of their typical useful life (TUL) as shown in Figure 5 below, and 6% are in degraded (Poor or Very Poor) condition as shown in Figure 6 below.

Without intervention, these figures will worsen significantly. By 2030, the proportion of assets beyond their TUL is projected to increase to 67% as shown in Figure 7, and the percentage in degraded condition will rise to 10%, see Figure 8. This presents a growing and immediate risk of asset failure, with the potential to disrupt electricity service. Hydro Ottawa estimates that replacing all assets projected to be in degraded condition by 2030 would cost $862M, as shown in Table 4.

Figure 5 - 2024 Overall Asset Age Demographics (Current State)

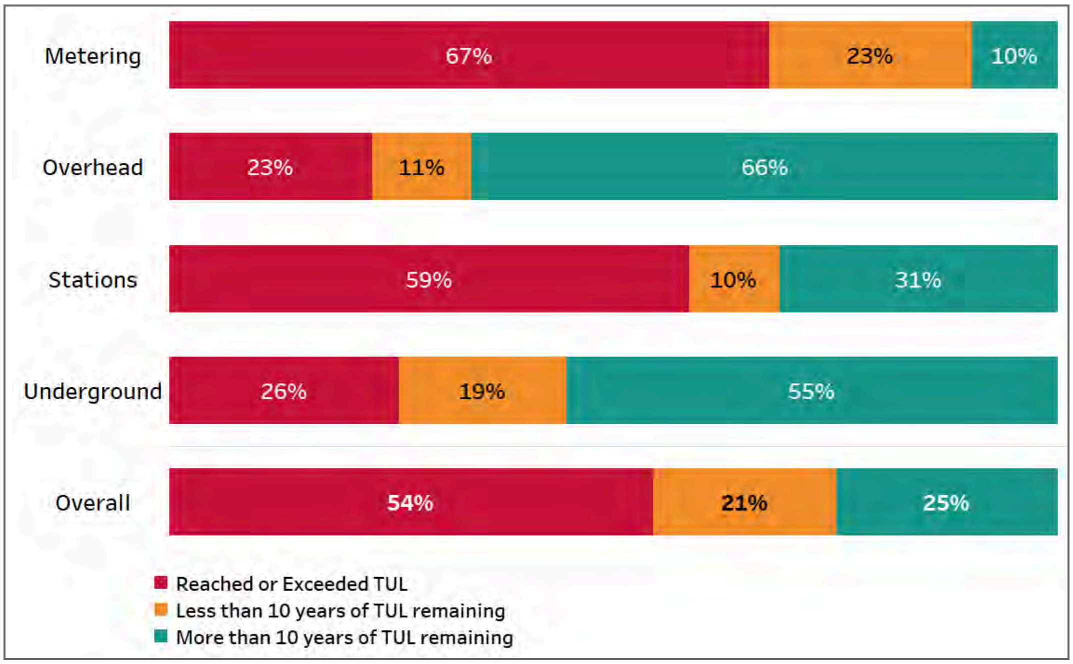
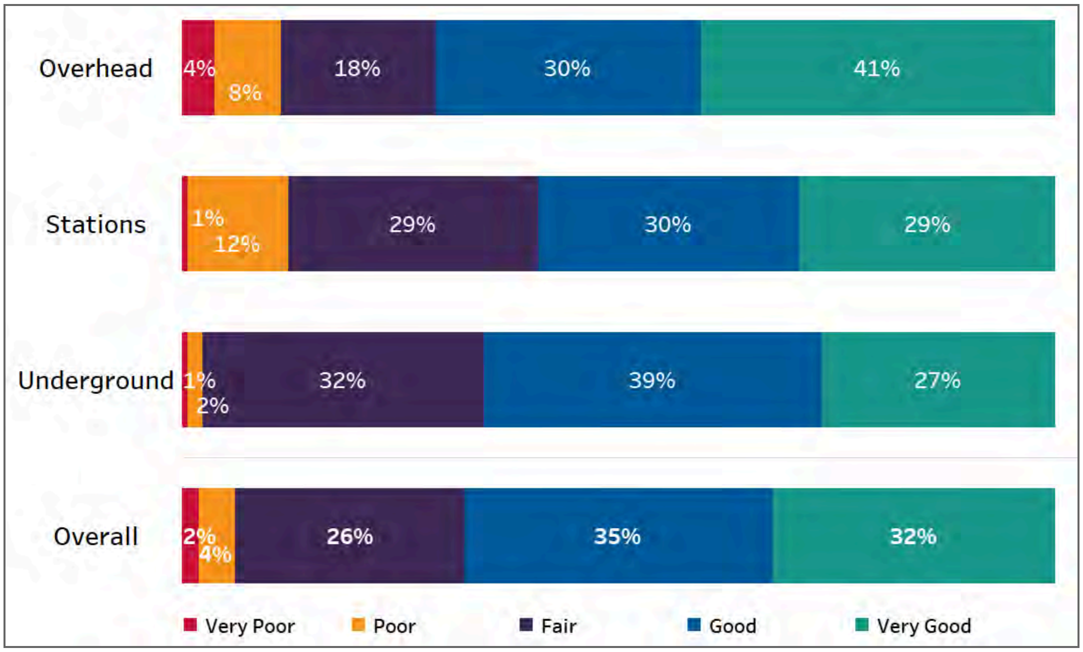


Figure 6 - 2024 Overall Asset Condition Profile (Current State)



1 **Figure 7 - 2030 Overall Projected Asset Age Demographics - 2030 (No Investment)**

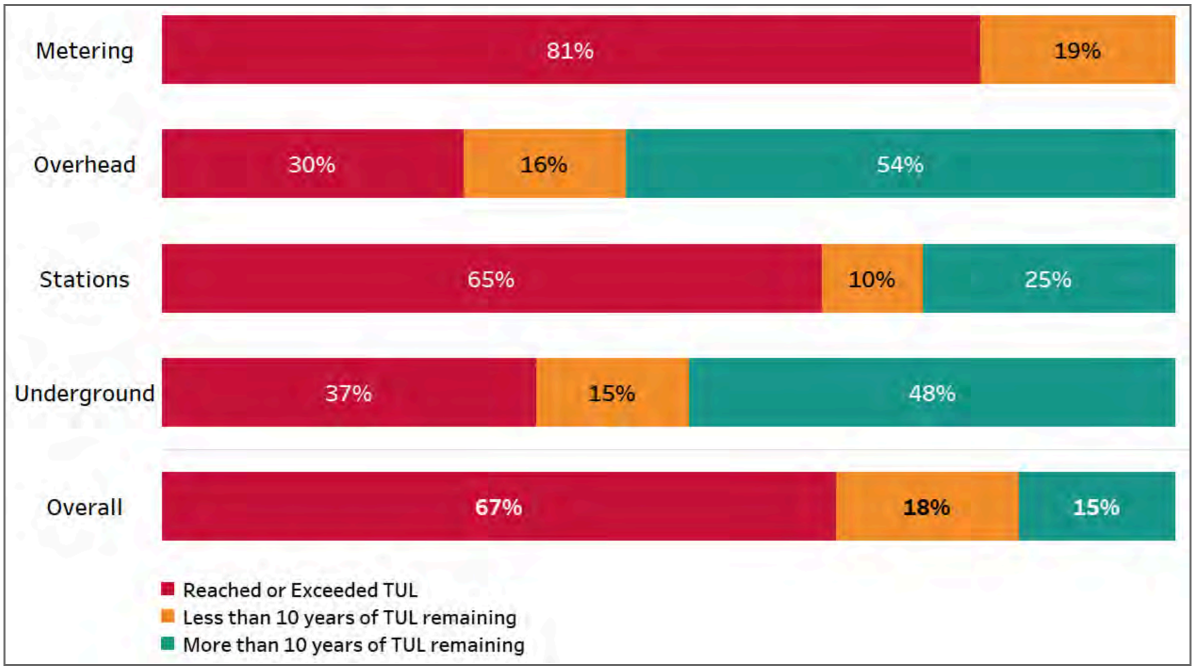


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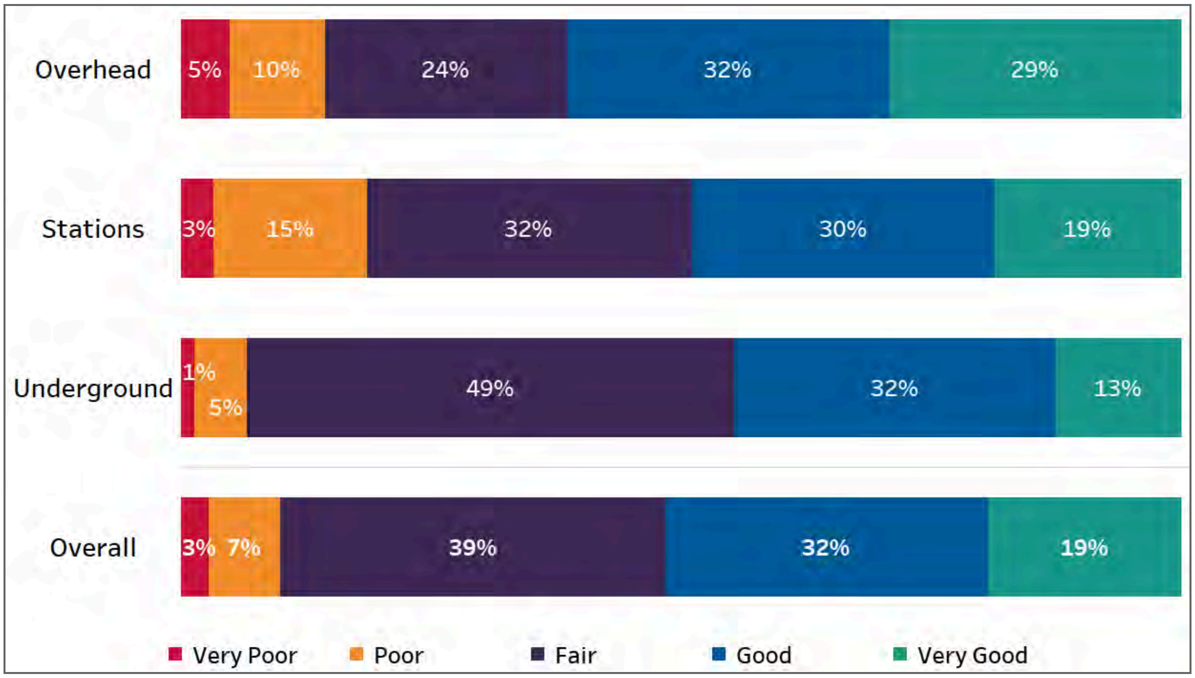
Figure 8 - 2030 Overall Projected Asset Condition Profile - 2030 (No Investment)

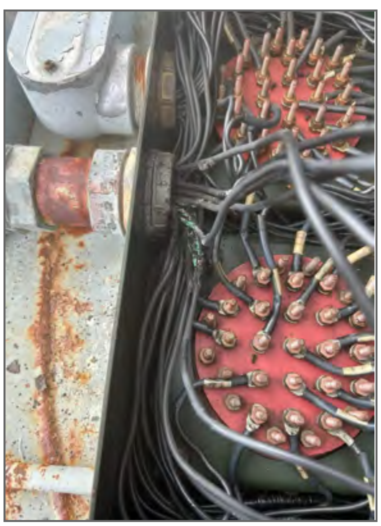


Figures 9 to 11 illustrate examples of deteriorating asset infrastructure found through inspection and maintenance programs.

Figure 9 - Examples of Station Asset Deterioration

(a) Station transformer corrosion and leaks

(b) Switching equipment lubrication leaks



(c) Corroded connections and burnt wiring

(d) Switchgear failure and fire

(e) Station outdoor infrastructure deterioration

(f) Pothead failure connected to station bus

Figure 10 - Examples of Underground Distribution Asset Deterioration

(a) Underground transformer corrosion

(b) Underground cable failure

Figure 11 - Examples of Overhead Distribution Asset Deterioration

(a) Pole decay

(b) Overhead switch operational defect

Hydro Ottawa's asset renewal strategy is to replace assets at a pace which maintains a consistent percentage of assets in degraded condition with the aim of maintaining overall system reliability. Hydro Ottawa prioritizes replacement of assets that pose the highest overall system risk by leveraging Predictive Analytics to forecast asset degradation based on the age and condition of assets. While safety, financial, environmental, and compliance risks are considered, reliability is the primary driver of the overall risk value.

Table 3 demonstrates the outcomes of the risk mitigation approach proposed by Hydro Ottawa for the 2026-2030 period. As outlined in the table, the investment required to replace all assets that are projected to be in degraded condition by 2030 is estimated at $862M - this would effectively reduce the percentage of assets in degraded condition to 0% by 2030. Competing financial priorities, notably growth, electrification, grid modernization, and resilience, render this investment level impractical. Alternatively, Hydro Ottawa is proposing an investment of $261M over the 5-year period, which is projected to result in 8% of the overall assets being in degraded condition by 2030, a 2% increase compared to 2024. Hydro Ottawa has demonstrated strong reliability results through the 2021-2025 period, see Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Despite the increase forecasted in overall percentage of assets in degraded condition, Hydro Ottawa expects to maintain the same level of service over the 2026-2030 period due to the improved risk prioritization stemming from the use of Predictive Analytics and the enhancements to the inspection and maintenance programs. Details of Hydro Ottawa's proposed System Renewal investments are provided in Schedule 2-5-7 - System Renewal Investments.

Table 3 - 2024 and 2030[11] Asset System Renewal Needs by Condition

Asset System	Hydro Ottawa's Current (2024) % of Assets in Degraded Condition	Investment Required to Replace all Assets Projected to be Degraded by 2030 (in 2024 dollars)	Hydro Ottawa's 2026-2030 Proposed System Renewal Investment	Hydro Ottawa's 2030 Projected Outcome for % Assets in Degraded Condition (after investment)
Overhead	12%	80 Overhead (OH) Switches, 5,737 Poles **$199M**	340 OH Switches, 1,975 Poles **$68M**	10%
Stations[12]	13%	53 Station Batteries,177 Station Breakers, 12 Station Transformers **$205M**	14 Station Batteries, 83 Station Breakers, 11 Station Transformers **$90M**	15%
Underground	3%	114 Cable Chambers, 28 Underground (UG) Switchgear, 336 km XLPE Cable, 1,972 Vault Transformers, 18 Vault Switchgear **$458M**	30 Cable Chambers, 30 UG Switchgear, 61 km XLPE Cable, 90 Vault Distribution Transformers, 30 Vault Switchgear **$103M**	6%
Total	**6%**	**$862M**	**$261M**	**8%**

[11] All costs are in 2024 dollars
[12] For Stations, the dollars shown don't consider relays, RTUs, station minor assets, buildings/facilities and transfer trip installations, as these asset types don't have condition information associated with them. These specific station assets follow an age-based replacement criteria and Hydro Ottawa has considered them in the 2026-2030 system renewal investment plans.

Hydro Ottawa's risk-mitigation asset renewal strategy relies heavily upon condition information from maintenance inspections. This necessitates adjustments to both the frequency and scope of the distribution and stations testing, inspection, and maintenance programs. To improve data accuracy, Hydro Ottawa will implement advanced inspection technologies, including drone inspections for overhead assets, enabling targeted maintenance and improved asset health assessments. For underground assets, advanced techniques like Very Low Frequency Tan-Delta, Partial Discharge, and Time Domain Reflectometry will identify vulnerabilities and optimize investments. Cost-effective refurbishment, such as cable accessory replacement, will extend underground asset life. Hydro Ottawa's asset renewal strategy does not prioritize replacing assets that have reached or exceeded their typical useful life (TUL). As such, an increase in the frequency of inspections of assets that have reached TUL is also proposed for certain assets. Details of Hydro Ottawa Operations & Maintenance plans are provided in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

In addition to its distribution assets, Hydro Ottawa relies on a diverse fleet of 237[13] vehicles and 44 other units of transportation equipment to support its operations, maintenance and administration (OM&A) and capital work programs. The vehicles and equipment are essential for providing efficient and reliable customer service including timely power restoration, efficient distribution system construction and maintenance, and ensuring worker and public safety. Of the 281 vehicles and equipment, 154 (55%) will be at or beyond their replacement criteria age in the 2026-2030 rate period. More details on the Fleet strategy and capital investment plan can be found in Section 3.4.5 of Schedule 2-5-4 - Asset Management Process and Section 11 of Schedule 2-5-9 - General Plant Investments.

2026-2030 Capital Expenditure Overview

Recognizing the importance of maintaining a reliable and safe electricity network, Hydro Ottawa prioritizes Renewing Deteriorating Infrastructure. This involves dedicating a substantial portion

[13] As of September 30, 2024

of the capital investment plan to the System Renewal category, which focuses on replacing deteriorating assets and upgrading critical infrastructure components. Key programs within this category include Stations and Buildings Infrastructure Renewal to replace deteriorating station assets, UG Distribution Assets Renewal to address deteriorating underground assets, OH Distribution Assets Renewal to renew deteriorating overhead infrastructure, Metering Renewal to modernize metering infrastructure, and Corrective Renewal to enable rapid response to unexpected failures. The capital investment plan for Fleet is included under the General Plant investment category.

2.3.3. Grid Modernization - Enabling the Energy Transition

Focusing on modernizing the grid through strategic technology adoption and infrastructure upgrades to enable the energy transition, facilitate customer participation, and optimize DER integration, thereby enhancing grid capabilities and efficiency.

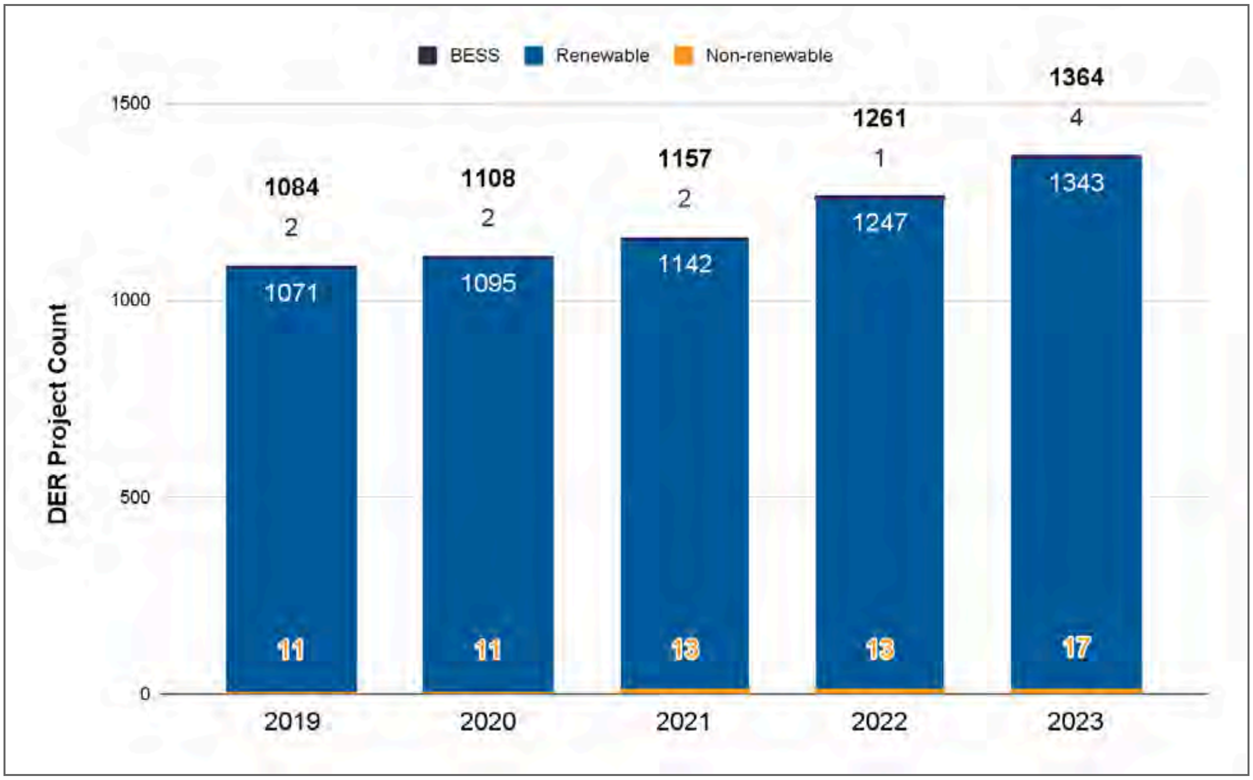
Hydro Ottawa is committed to enabling the energy transition by modernizing the grid to facilitate customer participation, enable widespread electrification, and optimize the penetration and integration of DERs.

Market forces, regulatory drivers, and funding opportunities are converging to create a compelling case for grid modernization to enable the energy transition. This need is underscored by Ontario's own energy policies, such as the recently released *Ontario's Affordable Energy Future: The Pressing Case for More Power,*[14] which explicitly identifies the need to modernize distribution grids to facilitate active monitoring of systems, build better resilience, and provide customers the energy and services they will need into the future.

Customer demand for DERs within Hydro Ottawa's territory is increasing. Electricity Canada engaged Innovative Research Group Inc. to conduct a national Behind the Meter (BTM) Survey in 2021 to explore Canadian attitudes towards new technologies designed to help consumers better manage their energy use and enable the energy transition. The survey showed that 14% of respondents already had, or would actively take steps to acquire solar panels. Please refer to Attachment 1-4-1(F) - Behind the Meter Survey. To illustrate, from 2019 to 2023, the number of connected DERs on Hydro Ottawa's grid increased by over 25% as per Figure 12. See Schedule 2-5-4 - Asset Management Process for more details.

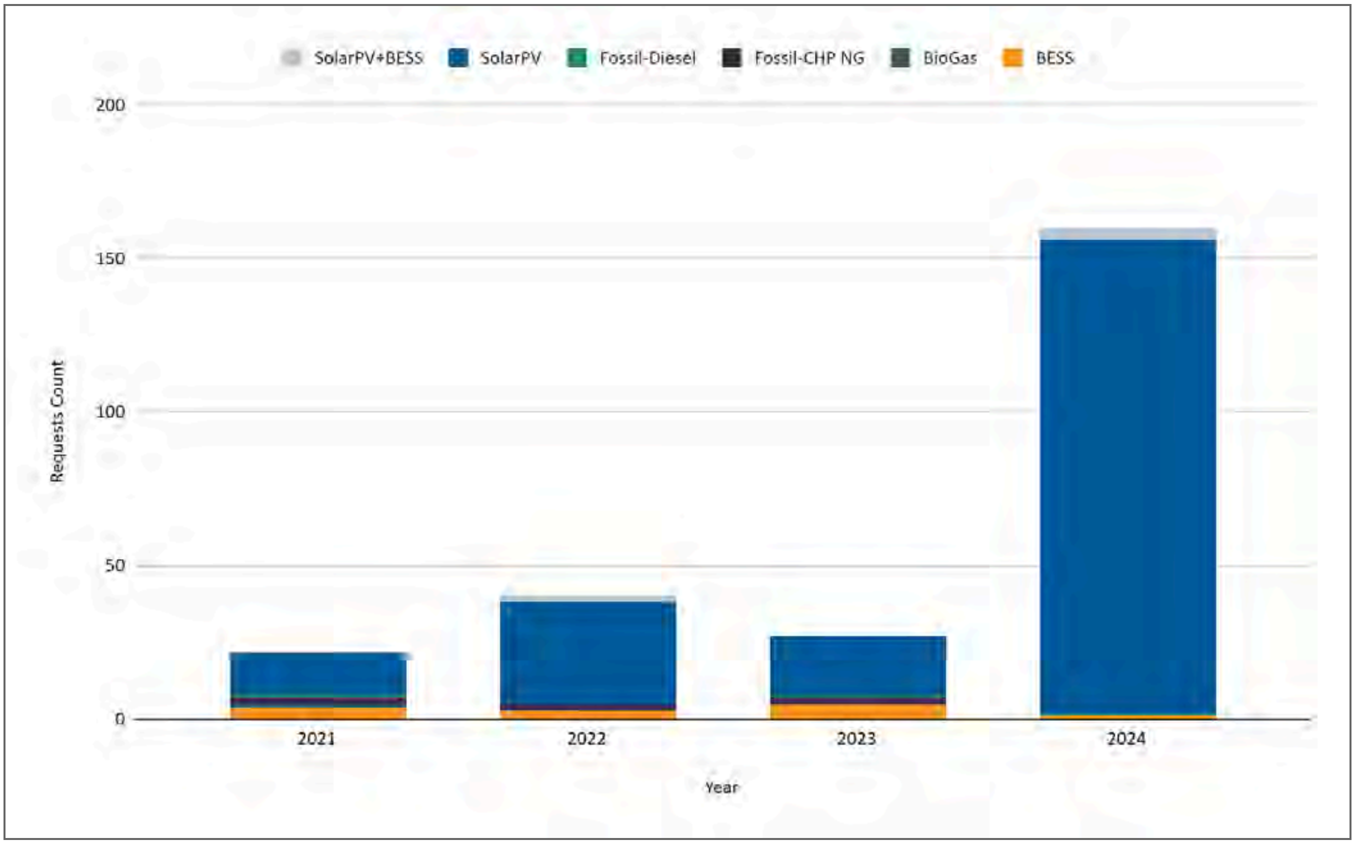
[14] Ministry of Energy and Electrification, *Ontario's Affordable Energy Future: The Pressing Case for More Power*, https://www.ontario.ca/page/ontarios-affordable-energy-future-pressing-case-more-power

Figure 12 - Total System Generator Count 2019-2023



Hydro Ottawa has seen a steady rise in preliminary connection impact assessment requests for DERs, alongside the growing number of annual DER connections. This is particularly evident in 2024, with a significant surge in requests attributed to the IESO's Ottawa DER Large Solar PV Funding Incentive program launched in January 2024, see Figure 13. The program's expansion to province-wide customers in January 2025 suggests that this trend will likely persist, although not all inquiries result in actual projects. These incentive programs are clearly stimulating public interest and participation in DER.

Figure 13 - DER Annual Requests Count 2021-2024



This surge, coupled with customer expectations for enhanced reliability during extreme weather events and a growing interest amongst customers to store energy for their own use and potentially for system benefit, necessitates a more flexible and responsive grid. As outlined in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application, a majority of customers surveyed across all customer classes support Hydro Ottawa's proposed investment plan, citing the need for the utility to prepare its grid for the future.

"Ontario's Affordable Energy Future: The Pressing Case for More Power"[15] and the 2024 Minister of Energy and Electrification's Letter of Direction to the OEB[16] emphasize the critical role of grid modernization in achieving Ontario's energy goals. This includes meeting growing electricity demand, integrating renewable energy, and enabling the energy transition by advancing NWSs, customer enabled solutions, and future utility business models. The OEB, which is also prioritizing grid modernization in its strategic planning,[17] has streamlined DER connection processes, and is encouraging innovation through its regulatory frameworks and Innovation Sandbox. Although policy and regulatory frameworks must continue to adapt to support customer choice, address barriers to DER adoption, and optimize the use of DERs to meet energy demands, the grid modernization investments Hydro Ottawa is implementing are crucial for facilitating this transition to a more distributed grid.

Further bolstering these efforts, Natural Resources Canada (NRCan) has provided substantial financial support to the utility sector through programs like the Smart Renewables and Electrification Pathways Program and the Energy Innovation Program's Smart Grid Call. This confluence of customer needs, provincial policy alignment, OEB regulatory support, and Federal funding creates a clear and compelling market signal supporting strategic investments in grid modernization for a sustainable energy future. By responding to these drivers, Hydro Ottawa is proactively building a grid that can meet the evolving needs of its customers, support the energy transition, and contribute to a more reliable and resilient electricity system.

To achieve this objective, Hydro Ottawa is focusing on:

- **Amplifying Grid Observability:** Increasing visibility and understanding of the grid's operational status, including constraints, to enhance operational decision making and to inform targeted system upgrades. Hydro Ottawa will achieve this by investing in AMI 2.0, advanced sensors, monitoring systems, and data analytics.

[15] https://www.ontario.ca/page/ontarios-affordable-energy-future-pressing-case-more-power
[16] Ministry of Energy and Electrification, *Letter of Direction to the OEB* (December 19, 2024).
[17] OEB, *Strategic Plan 2021/22 - 2025/26* (April 30, 2021).

- **Improving Grid Controllability:** Improved grid controllability will focus on increasing the level of control Hydro Ottawa has over the grid. This will allow for more dynamic operation, facilitating optimized performance and improving reliability and resilience through redundancy. These capabilities will be unlocked by investing in remotely operable control devices, advanced control systems, and observability enhancements.
- **Meeting Electrification Capacity Needs:** Hydro Ottawa has integrated electrification demand projections into its investment planning framework to strategically address the anticipated increase in electricity demand associated with a decarbonized future. This forward-looking approach ensures the efficient deployment of capital to ensure that grid upgrades provide the necessary foundation for growth and a sustainable electricity grid.
- **DER Enablement:** Hydro Ottawa is committed to enabling the widespread adoption and utilization of DERs by connecting customers to available financial incentives, see further details in Section 2.4.3 of Schedule 1-4-1 - Customer Engagement Ongoing, fostering collaborative partnerships, and implementing strategic programs. This increased integration of DERs, NWSs combined with advancements in grid observability and controllability, will allow Hydro Ottawa to accommodate two-way flow of electricity generated by these sources and leverage DERs and other controllable devices to reduce peak load and integrate local renewable energy sources within its service territory, enhancing operational flexibility.

Through strategic investments in grid modernization, Hydro Ottawa is building a foundation for a more sustainable and resilient energy future. This will enable greater customer participation, support the widespread adoption of electric vehicles and other technologies, and facilitate the integration of DERs.

2026-2030 Capital Expenditure Overview

Grid Modernization is a key focus of Hydro Ottawa's investment plan, with initiatives spread across multiple categories. These initiatives aim to leverage technologies and enhance grid capabilities to enable DER connections, improve efficiency, reliability, and resilience. This includes Capacity Upgrades to increase capacity through various means, including NWSs, Distribution Enhancements to improve system observability through initiatives like advanced grid monitoring, Grid Technology to enable enhanced monitoring and control, cyber security and IT Infrastructure to strengthen IT systems and protect against cyber threats, and Data and System Integrations to consolidate data systems and improve decision-making.

2.3.4. Enhancing Resilience

Focusing on enhancing grid resilience by proactively upgrading infrastructure and implementing measures to protect against increasingly frequent and intense severe weather events and cyber threats.

Performing restoration work in the Pineglen neighbourhood post May 2022 Derecho

Extreme Weather

As noted in Hydro Ottawa's Customer Engagement survey, which can be found in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application, Ottawa has become the weather-alert capital of Canada.[18] Extreme weather events such as high heat, high winds, flooding and ice storms are increasingly straining and damaging the electricity grid.

[18] Environment and Climate Change Canada

The City of Ottawa, in partnership with the National Capital Commission and Environment and Climate Change Canada developed climate projections for the National Capital Region which were published within *"The Climate Change Vulnerability & Risk Assessment"*[19]. The report states:

> "People are feeling the impacts of climate change globally and locally. Research predicts these impacts will intensify and affect the National Capital Region for decades to come. As such, the region will experience more extreme weather events like floods, wildfires, droughts, heatwaves, freeze-thaw spells and tornadoes."

The OEB is also addressing climate-related challenges by focusing on enhancing distribution sector resilience, responsiveness, and cost efficiency. Following the Minister of Energy's 2022 Letter of Direction, the OEB released a report on June 29, 2023, outlining actions to mitigate vulnerabilities to severe weather events. The OEB is now implementing these recommendations and pursuing policy consultations, including the Distribution Sector Resilience, Responsiveness & Cost Efficiency (EB-2023-0003), which has led to further work in the Reliability and Power Quality Review (EB-2021-0307) and the Vulnerability Assessment & System Hardening Project (EB-2024-0199).

[19] National Capital Commission, Climate Change Vulnerability & Risk Assessment (June 2022), page i.

City of Ottawa Climate Resiliency - What will Ottawa's climate look like in the future?[20]

Hydro Ottawa has experienced firsthand the impact of these events, with a series of severe storms in recent years causing significant damage and disruption to the electricity grid.

[20] City of Ottawa, "Climate Resiliency," https://ottawa.ca/en/climate-resiliency

The effects of the May 2022 Derecho on Hydro Ottawa equipment

Recent events, as detailed in Table 4 below, include:

- 2017: Freezing rain, heavy snow, flooding, and a severe thunderstorm which impacted thousands of customers.
- 2018: Tornadoes, freezing rain, and high winds caused widespread outages, impacting over 200,000 customers.
- 2019: A flash storm, flooding, lightning strikes, and high winds which caused repeated disruptions throughout the year.
- 2021: Lightning strikes caused further outages.

- 2022: The devastating Derecho, with record-breaking wind speeds, which impacted over 180,000 customers and became the 6th costliest natural disaster in Canada's history. This was followed by a bomb cyclone in December, causing further outages.
- 2023: Tornadoes, an ice storm, freezing rain, and multiple lightning strikes continued the trend of severe weather impacts.

Downed poles after the May 2022 Derecho

Table 4 - Historical Weather Events & Impacts

Year	Severe Weather Event	Description & Impacts
2017	Freezing rain & heavy snow (January)	• 19,130 customers (6% of customer base)
	Flooding (May)	• 1-in-100-year flood levels for Ottawa River
	Thunderstorm (September)	• 11,391 customers (3% of customer base)
2018	Freezing rain (April)	• 55,101 customers (17% of customer base)
	High winds (May)	• 63,869 customers (19% of customer base)
	Tornadoes (September)	• 216,000 customers (65% of customer base) • Class EF-2 and EF-3 tornadoes; 260 km/h winds • 90% of customers restored within 2.5 days
2019	Flash storm (April)	• 44,511 customers (13% of customer base) • Loss of supply and substation flooding
	Flooding (May)	• 1-in-1000-year flood • Highest water levels on record for Ottawa River
	Lightning (July)	• 70,069 customers (21% of customer base) • Four separate loss of supply outages
	High winds (November)	• 14,228 customers (4% of customer base)
2021	Lightning (June)	• 17,441 customers (5% of customer base) • Lightning and loss of supply
2022	Derecho (May)	• 180,946 customers (52% of customer base) • Highest wind speeds on record in Ottawa & Ontario • Severity of wind speeds greatly exceeded forecast • 6th costliest natural disaster in Canada's history • $24M in restoration costs for Hydro Ottawa • 90% of customers restored within seven days
	Bomb cyclone (December)	• 67,710 customers (19% of customer base) • Intense freezing rain and snow; loss of supply
2023	Ice storm and freezing rain (April)	• 163,448 customers (45% of customer base) • 90% of customers restored within two days
	Lightning (June)	• 15,413 customers (4.25% of customer base) • Loss of supply
	Tornados, lightning, hail and wind (July)	• 37,821 customers (10.4% of customer base) • >6,000 total lightning strikes during month of July 2023 (8 times as many as July 2022)

These events have contributed to increased spending on emergency asset replacement and have significantly impacted the system reliability performance, see Figure 14, underscoring the need for proactive investment in grid resilience.

Figure 14 - Weather Related Reliability Impact

To combat the growing risks associated with major events, Hydro Ottawa is focusing on proactive measures such as strategic undergrounding of overhead lines, increasing tree trimming, strengthening the grid through infrastructure upgrades, and hardening assets. These measures are aimed at reducing the likelihood of storm damage, thereby enhancing resilience against extreme weather events.

Cyber security

In response to the rising threat of cybercrime impacting Canadian organizations, and the strategic importance of Ottawa as a G7 capital, Hydro Ottawa maintains a strong focus on strengthening cyber security protections and controls for its essential assets and networks. Moreover, cybercrime is on the rise across Canada. As the capital city of a G7 country which is a high-value target for malicious actors, investing in grid resilience is essential to protect the community's electrical system from the increasing frequency and intensity of cyber threats. This focus is essential to prevent compromises that could impact reliability and put customers at risk. As is highlighted in the National Cyber Threat Assessment 2025-2026 (NCTA) published by the Canadian Centre for Cyber Security, Ransomware is the top cybercrime threat facing Canada's critical infrastructure, including the energy sector[21]. From 2021-2024, Ransomware incidents saw a 26% year-over-year growth with predictions of this to continue to trend upwards.[22] Statista's Market Insight also predicts that from 2024 to 2028, the global cost of cybercrime will rise from $9.22 trillion to $13.82 trillion[23]. The NTCA also emphasizes threats from nation states as geopolitical events will continue to impact critical infrastructure as well as the continued rise of an expanded attack surface that will exponentially grow as more connected devices are brought online and require access to the OT infrastructure. This further enforces the need for a holistic cyber security approach towards key investment priorities such as Grid Modernization and Grid Resilience.

These areas of focus align with industry standards and regulatory requirements for grid resilience, including compliance with the OEB's Vulnerability and System Hardening requirements. Hydro Ottawa is also actively implementing measures outlined as in Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan and Attachment 2-5-4 (E) - Resilience Investment Business Case Report to enhance resilience against future extreme weather events.

[21] Canadian Centre for Cyber Security, "National Cyber Threat Assessment 2025-2026," https://www.cyber.gc.ca/sites/default/files/national-cyber-threat-assessment-2025-2026-e.pdf
[22] *Ibid*
[23] Statista, "Cybercrime Expected To Skyrocket in Coming Years" (February 22, 2024)

By focusing on grid resilience, Hydro Ottawa is taking proactive steps to protect its customers and ensure a reliable and resilient electricity supply for the future, despite the growing challenges posed by a changing climate and increasing cyber threats.

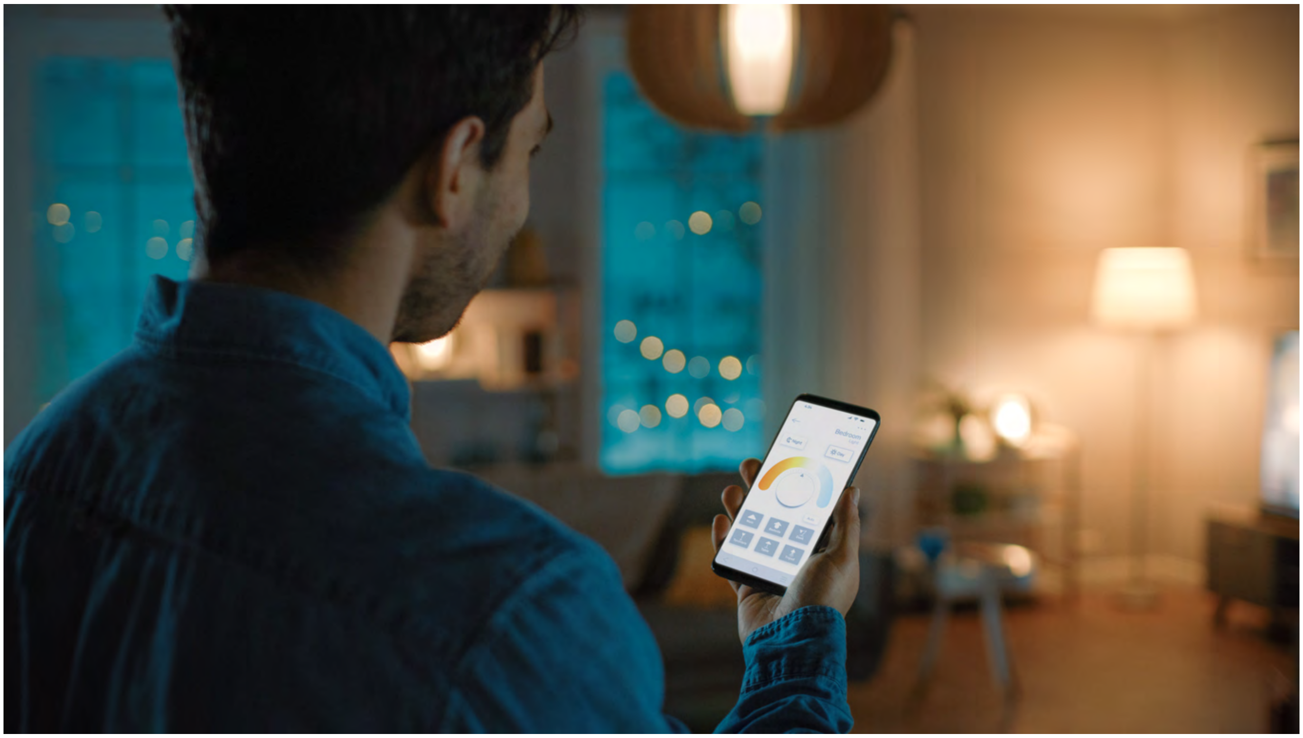
2026-2030 Capital Expenditure Overview

Grid Resilience is a priority embedded throughout Hydro Ottawa's investment plan. Initiatives focus on strengthening the grid against various threats, including extreme weather events, equipment failures, and cyberattacks. This is achieved through System Renewal to replace deteriorating infrastructure and improve reliability, Distribution Enhancements to implement initiatives like strategic undergrounding of overhead lines and storm hardening initiatives, control and optimization to improve grid flexibility through advanced monitoring and control capabilities, cyber security and IT Infrastructure to enhance IT security measures, and Grid Technology to focus on improving resilience to extreme weather events and integrating new technologies.

2.3.5. Focus Areas

Hydro Ottawa's investment planning for the 2026-2030 period is fundamentally anchored in two critical focus areas: ensuring customer affordability amidst economic uncertainties, and investing in a robust and skilled workforce to navigate the rapidly evolving energy landscape. These dual priorities are essential for maintaining service reliability and facilitating the necessary infrastructure upgrades and grid modernization, all while mitigating the impact on customer rates.

Managing Rising Costs



Focusing on managing rising costs to maintain affordability for customers while ensuring a reliable and resilient electricity system to meet growing demand.

Hydro Ottawa is operating within a complex landscape characterized by heightened customer sensitivity to electricity costs, persistent inflationary pressures, elevated interest rates, and an increasing reliance on an uninterrupted power supply. The period from 2021 to 2025 was particularly challenging for Hydro Ottawa, marked by the COVID-19 pandemic, the highest inflation in 40 years, a weakened Canadian dollar, supply chain disruptions, and extreme weather events, including the devastating May 2022 Derecho storm. These compounding factors placed considerable financial strain on the company, yet it prioritized customer affordability by forgoing a Z-factor application which would have allowed Hydro Ottawa to recover approximately $8.7M in OM&A costs and depreciation up to the end of 2025 associated with $15.1M in Derecho capital additions. This decision reflected a commitment to supporting customers during difficult times.

Furthermore, Hydro Ottawa strategically managed its capital expenditures by deferring planned projects, resulting in a $44.2M budget adjustment. Please refer to Table 4 in Section 4.1.2 of Schedule 2-5-5 - Capital Expenditure Plan for additional information. This proactive approach mitigated further financial variances and demonstrated a commitment to responsible fiscal management despite these challenging circumstances. To achieve this outcome, Hydro Ottawa relied heavily upon its robust asset management framework for decisions around investment priorities. The company's strong project and program oversight, alongside stringent budgetary controls refined during the 2021-2025 period, will continue to guide the company in mitigating rising costs and optimizing capital expenditures throughout the next rate period. Furthermore, the operational efficiencies achieved through targeted process improvements and digital transformation will be systematically maintained, ensuring sustained service reliability and cost-effectiveness for customers. Please refer to Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement, for details on these efficiencies and improvements.

Looking ahead to the 2026-2030 period, Hydro Ottawa faces continued economic uncertainties, including high inflation and the general tariff related uncertainty, and must address the urgent need to renew deteriorating infrastructure, modernize the grid, and add significant capacity due to increased growth and electrification and ensure the resilience of the system. To address these challenges while maintaining customer affordability, Hydro Ottawa has implemented a comprehensive cost management strategy that includes:

- **Advanced Asset Management:** Implementing an Enterprise Asset Management (EAM) system to further optimize investment prioritization through integrations with Predictive Analytics and to optimize maintenance schedules through Condition-Based Monitoring.
- **Proactive Risk Management:** Implementing strategies to minimize project delays and disruptions.

- **Benchmarking:** Conducting comparative analysis to identify improvement opportunities.
- **Continuous Improvement and Innovation:** Modernizing the grid and operations by leveraging digital tools and automation.
- **Digital Transformation:** Enhancing service delivery through technology.
- **Infrastructure Efficiencies:** Optimizing asset utilization and leveraging NWSs.
- **Process Improvements:** Investing in workforce development and operational effectiveness.

Hydro Ottawa is also actively considering the impact on costs and affordability by increasing System O&M programs with more frequent inspections, testing, and maintenance to mitigate the risk associated with the deferral of near-term capital investments.

Hydro Ottawa's planning is rooted in a thorough analysis of the risks posed by deteriorating infrastructure, increasing electricity demand, and the imperative for grid modernization and resilience. Recognizing the critical importance of aligning with customer priorities, the utility proactively sought feedback through a comprehensive engagement survey. The survey confirmed that, even with a clear understanding of the associated bill impacts, customers overwhelmingly support the proposed plan for essential grid investments and infrastructure renewal as outlined in Section 2.2 - Customer Priorities. This valuable insight directly informs our investment decisions, reinforcing our commitment to balancing necessary upgrades with affordability. Cost control and efficiency remain paramount, with a focus on continuous improvement across all operations and capital projects. To minimize rate impacts, Hydro Ottawa will carefully prioritize and phase investments, addressing the most critical system risks first. This approach ensures that all decisions are guided by cost consciousness, customer value, and the long-term reliability of our electrical system.

Investing in the Workforce

Focusing on workforce development and safety to ensure a skilled and secure energy future.

While maintaining a relatively stable headcount over the past two rate periods, Hydro Ottawa now faces a confluence of escalating operational demands, rapid technological advancements, and the intensifying impacts of climate change, necessitating a strategic and significant investment in its workforce. This investment is not merely a reactive measure to address immediate pressures, but a proactive and crucial step to ensure long-term resilience, maintain service reliability, and effectively navigate the complex and evolving energy landscape. The need for specialized skills, expanded capacity, and enhanced responsiveness is paramount to meet the growing demands of the customer base and to safeguard the critical infrastructure upon which the community depends.

Hydro Ottawa recognizes that investments in both assets and a skilled workforce are paramount. While investments in infrastructure and maintenance are critical, the company acknowledges that during challenging times – such as storms, pandemics, and labour disruptions – it is the dedication and expertise of its workforce that is essential to maintain reliable service and ensure the continued provision of electricity to its customers. The challenges of recent years have underscored the critical importance of a well-resourced and resilient workforce. Hydro Ottawa has faced an unprecedented series of challenges, including:

- A near-strike in 2021 and an 84-day strike in 2023, which disrupted operations and highlighted the need for robust contingency planning and workforce stability. These disruptions also reflected, among other factors, underlying staffing concerns.
- Increasingly frequent and severe weather events, with storm after storm demonstrating the vulnerability of the electricity grid and the essential role of skilled personnel in rapid restoration efforts.
- Deteriorating infrastructure and evolving customer energy demands are driving the need for grid modernization, enhanced resilience, and the integration of new technologies.

In addition to the aforementioned, in 2021-2023, Hydro Ottawa experienced an unforecasted surge in customer-driven growth projects, encompassing unforeseen large-scale developments and a residential subdivision boom. This growth significantly amplified the demand for technical and trade staff. Concurrently, engineering resources faced escalating pressure due to the rising complexity and volume of large load and Distributed Energy Resource (DER) connection requests, requiring specialized engineering expertise. Moreover, the implementation of the Advanced Distribution Management System (ADMS) and the broader Grid Modernization Strategy highlighted the need for new engineering roles to manage advanced technologies. Finally, the need for enhanced oversight of larger, more complex projects, combined with a less tenured workforce, strained Hydro Ottawa’s leadership and data analytics capabilities. In response to these immediate and escalating pressures, Hydro Ottawa could not defer action and added 50 new positions to its workforce in 2024.

Looking ahead to 2026-2030, in order to support the proposed capital and OM&A program investments, and to navigate the rapidly evolving utility landscape driven by grid modernization and the energy transition, Hydro Ottawa must continue to strategically expand its workforce. To determine headcount needs for its direct-labour workforce, Hydro Ottawa's employed a robust, data-driven workforce planning model, ensuring staffing levels are strategically aligned with operational needs and objectives. This model, detailed in Attachment 4-1-3(B) - Workforce Planning Strategy, systematically analyzes current and projected workloads, including capital project volumes, maintenance requirements, and customer growth, to identify required skills and competencies. By assessing the existing workforce and identifying gaps, the model facilitates the development of targeted hiring, training, and development initiatives. This comprehensive approach ensures that workforce needs are addressed proactively, rather than reactively.

For workforce needs not directly attributed to the capital and OM&A projects, Hydro Ottawa took the approach of engaging senior leadership to assess current and future skill requirements, particularly in emerging technological areas. All identified needs were then consolidated, rigorously reviewed, and challenged by executive management. This systematic approach ensures that workforce needs are not addressed in an ad hoc manner, but rather through a comprehensive and data-driven process. The combination of these assessments resulted in a proposed staffing plan that includes the addition of 127 new headcount over the 2026-2030 period. The increased headcount is primarily driven by the following key factors:

Significant Capital Program Growth: A near doubling of capital investment necessitates a substantial increase in skilled trades and technical staff to execute projects related to growth and electrification, infrastructure renewal, grid modernization, and resilience. This includes additional workforce to substantiate substation construction, battery energy storage system installations, and the replacement of deteriorating assets.

Increased Complexity and Volume of Projects: The rising complexity of projects, especially those involving grid modernization and the integration of Distributed Energy Resources (DERs), demands specialized engineering and technical expertise. This includes roles focused on new technologies, standards development, and advanced grid operations.

Deteriorating Infrastructure and Enhanced Maintenance: The need to renew deteriorating infrastructure and implement enhanced testing, inspection, and maintenance programs requires additional resources, particularly in skilled trades and technical positions.

Enhanced Oversight and Support Functions: The growth in project volume and workforce size requires strengthening support functions such as system operations, contractor management, project execution planning, and leadership to ensure efficient and safe operations.

Technological Advancement and Digital Transformation: The increasing complexity of IT and OT systems, cyber security needs, and digital customer experience enhancements drive the demand for specialized IT expertise.

Increased Regulatory and Compliance Demands: Growing safety training, business continuity, sustainability initiatives, and complex regulatory requirements necessitate dedicated compliance and policy resources.

Strengthening Internal Support Structures: Increased recruitment, HR technology evolution, and complex financial reporting drive the need for expanded HR and finance support.

As highlighted in Schedule 4-1-3 - Workforce Staffing and Compensation, the percentage of work being completed by external contractors has remained relatively stable at 44-46% of total gross capital expenditures, from 2021-2025 through to the 2026-2030 projections. This consistency indicates that Hydro Ottawa is effectively managing its contractor usage while prioritizing the addition of permanent staff to address both immediate and long-term needs. It is anticipated that this increased staffing will be necessary not only for the next few rate cycles, but also in the decades beyond, as these challenges are expected to persist and evolve.

3. CAPITAL EXPENDITURE PLAN

Hydro Ottawa is embarking on a period of transformative growth, with a proposed capital expenditure plan for 2026-2030 that nearly doubles the investment of the previous five years. This plan prioritizes system capacity enhancements, the renewal of deteriorating infrastructure, grid modernization, and bolstering overall resilience. Please refer to Table 5 for details on the historical Capital Expenditure Plan and Table 6 for details of the 2026-2030 proposed Capital Expenditure plan. Refer to Schedule 2-5-5 - Capital Expenditure Plan for further details on the historical and planned capital expenditures. The $102.8M variance between Hydro Ottawa's expected net capital expenditures and the OEB-Approved amounts is explained in Section 4 of Schedule 2-5-5 - Capital Expenditure Plan.

Table 5 - Capital Expenditure Historical Year Summary ($'000 000s)

Investment Category	Historical Years			Bridge Years		Total
	2021	2022	2023	2024	2025	2021-2025
System Access	$ 48	$ 47	$ 53	$ 69	$ 76	$ 293
System Renewal	$ 43	$ 65	$ 40	$ 42	$ 41	$ 232
System Service	$ 24	$ 14	$ 17	$ 47	$ 60	$ 161
General Plant	$ 24	$ 11	$ 13	$ 15	$ 13	$ 76
TOTAL CAPITAL EXPENDITURES	**$ 139**	**$ 138**	**$ 123**	**$ 173**	**$ 189**	**$ 762**
Capital Contributions	$ (27)	$ (28)	$ (29)	$ (37)	$ (41)	$ (162)
NET CAPITAL EXPENDITURES	**$ 112**	**$ 110**	**$ 94**	**$ 136**	**$ 148**	**$ 600**

Table 6 - Capital Expenditure Test Year Summary ($'000 000s)

Investment Category	Test Years					Total
	2026	2027	2028	2029	2030	2026-2030
System Access	$ 86	$ 79	$ 66	$ 67	$ 71	$ 369
System Renewal	$ 85	$ 83	$ 81	$ 87	$ 95	$ 432
System Service	$ 99	$ 125	$ 76	$ 86	$ 87	$ 473
General Plant	$ 38	$ 24	$ 33	$ 28	$ 11	$ 134
Total Capital Expenditures	**$ 309**	**$ 311**	**$ 256**	**$ 268**	**$ 265**	**$ 1,409**
Capital Contributions	$ (51)	$ (51)	$ (38)	$ (32)	$ (41)	$ (213)
Net Capital Expenditures	**$ 258**	**$ 260**	**$ 218**	**$ 235**	**$ 224**	**$ 1,195**

The largest variance between the 2021-2025 and 2026-2030 plans is seen in the increased investment in System Service, driven primarily by capacity upgrades. This is followed by increased investment in System Renewal, primarily for station equipment renewal. System Access also sees increased investment, driven by rising customer connections. Finally, General Plant expenditures are higher, primarily due to Connection and Cost Recovery Agreements for capacity upgrades and Fleet Replacement. The following sections provide a detailed breakdown of the changes in expenditures, summarizing the investment by category and capital program.

3.1. SYSTEM ACCESS

Spending on System Access, necessary to support growth and electrification, is expected to increase during the 2026-2030 period by 26% compared to the 2021-2025 timeframe. Projected capital investments are expected to rise from $293M in the 2021-2025 period to $369M in the 2026-2030 period, excluding Capital Contributions as shown in Table 7. This increase is primarily attributed to the growing number and complexity of customer connections, reflected in the higher expenditures for the Customer Connections and System Expansion Capital programs. This growth in expenditures is partially offset by a projected decrease in Plant

Relocation costs. See Schedule 2-5-5 - Capital Expenditure Plan and Schedule 2-5-6 - System Access Investments for further breakdown of the System Access capital investments.

Table 7 - System Access Capital Expenditure Variance by Capital Program 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)

Capital Program	Historical / Bridge Years	Test Years	Variance
	2021-2025	2026-2030	
Plant Relocation	$ 45	$ 35	$ (10)
System Expansion	$ 89	$ 108	$ 19
Customer Connections	$ 157	$ 221	$ 64
Generation Connections	$ 1	$ 4	$ 4
Metering	$ 2	$ 2	-
Total Capital Expenditures	**$ 293**	**$ 369**	**$ 77**
Capital Contributions	$ (158)	$ (196)	$ (38)
Net Capital Expenditures	**$ 134**	**$ 173**	**$ 39**

The Capital Programs encompassed within the System Access investment category are detailed below.

Plant Relocation & Upgrade

The capital investment for this program is detailed in Section 2 of Schedule 2-5-6 - System Access Investments. This program funds the relocation or upgrade of Hydro Ottawa-owned or joint-use overhead or underground equipment for third-party infrastructure projects, primarily by the City of Ottawa. This is driven by road widening and other development projects that conflict with existing Hydro Ottawa infrastructure. The program aims to meet regulations, improve system efficiency, and enable economic development. Spending from 2026-2030 is projected to decrease relative to 2021-2025, due to the completion of the City of Ottawa's Light Rail Transit

Phase II project. The 2026-2030 program is budgeted based on planned road widening projects outlined in the City of Ottawa's Transportation Master Plan[24].

System Expansion

The capital investment for this program is detailed in Section 4 of Schedule 2-5-6 - System Access Investments. System expansions are initiated when capacity constraints in Hydro Ottawa's infrastructure necessitate upgrades or additions to accommodate new customers or support existing customer service upgrades. Investments may involve upgrading feeders, transformers, or substations to ensure reliable power supply. Driven by customer service requests, particularly the growing number of large load requests, and Hydro Ottawa's legal obligation to fulfill connection requests, this program aims to ensure timely and efficient customer connections.

The System Expansion program is experiencing significant growth due to the current expansion efforts focused on major infrastructure projects such as the Hydro Road substation for OC Transpo's Zero Emission Buses, the Richmond South substation upgrade to support the DND Dwyer Hill Training Center, and feeder expansions for projects including the Ottawa Hospital's new campus, among others. These projects highlight the growing complexity and scale of distribution system expansion required to meet community energy demands.

Customer Connections

The capital investment for this program is detailed in Section 3 of Schedule 2-5-6 - System Access Investments. This program ensures new and modified customer connections, including residential subdivisions (townhomes, semi-detached, singles, or mixed), commercial developments (underground or vault equipment service), and infill services, are seamlessly integrated into the distribution grid, fulfilling mandated service obligations. The program involves

[24] City of Ottawa, "Transportation Master Plan, Exhibit 7.2: 2031 Affordable Road Network- Project By Phase- https://documents.ottawa.ca/sites/default/files/documents/tmp_en.pdf

installing transformers, lines, switchgear, and metering infrastructure, and may require roadwork and civil works.

The projected increase in this program is a direct result of sustained regional growth and development. This growth is fueled by residential subdivision expansion, commercial development aligned with transit-oriented projects and large load requests, and ongoing infill projects. Key factors to the increase include the City of Ottawa's intensification policies, the energy transition, and the rise of large-scale laboratory developments, all contributing to more complex and larger connection requests. The program focuses on meeting customer connection timelines while adhering to regulations. Two examples of budgeted large and complex commercial customer connections are the Regulatory and Security Science main project at the CFIA facility and the TerraCanada National Capital Area project at the National Research Council facilities.

Generation Connections

The capital investment for this program is detailed in Section 5 of Schedule 2-5-6 - System Access Investments. Hydro Ottawa's Generations Connections program facilitates integrating customer owned DERs into the distribution grid, complying with regulations and ensuring system reliability and safety. The program covers infrastructure upgrades and streamlined connection processes.

The increase in spending is planned to support the anticipated rise in DER adoption driven by enablement programs between 2026 and 2030 as well as the growing number of committed and planned customer generation projects. Notably, there is one large DER connection (over 500 kW) forecasted each year from 2026-2030 in support of the increasing trend of DER connections, see Figure 13 - DER Annual Requests Count 2021-2024. The IESO's DER Market Vision and Design Project[25] is expected to explore, design and implement foundational

[25] DER Market Vision and Design Project, https://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Distributed-Energy-Resources-Market-Vision-and-Design-Project

participation models for DERs in Ontario's electricity market and other IESO programs, such as the Save On Energy Home Renovation Savings Program[26] and the Save On Energy Retrofit Program[27] now include incentives for DERs. All these initiatives are expected to contribute to DER growth. The projected trend of accelerated DER adoption is further detailed in Section 9.3.2 of Schedule 2-5-4 - Asset Management Process.

Metering

The capital investment for this program is detailed in Section 6 of Schedule 2-5-6 - System Access Investments. Hydro Ottawa's Metering Program invests in metering technology, including Suite Metering for multi-unit buildings. The projected investment in revenue meter installations and retrofits is consistent with historical investment levels. Hydro Ottawa anticipates no substantial alterations to customer-initiated installations of new and retrofitted suite metering.

3.2. SYSTEM RENEWAL

The System Renewal investment category allocates spending to mitigate critical system risks stemming from aging and deteriorating assets. This includes replacing assets that pose significant reliability risks, upgrading systems, and replacing obsolete equipment to maintain system reliability, enhance efficiency and resilience, and ensure the continued delivery of safe and reliable electricity service.

Projected capital investment for System Renewal is expected to increase by 86% compared to the $232M in the 2021-2025 period, vs. $432M in the 2026-2030 timeframe. The significant increase in capital investment is primarily driven by the investments in station equipment renewals, guided by Predictive Analytics-driven risk assessments and the strategic replacement of the obsolete metering fleet.

[26] Save On Energy, "Home Renovation Savings Program, "https://www.saveonenergy.ca/For-Your-Home/Home-Renovation-Savings
[27] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

The implementation of Predictive Analytics and improved asset failure curves have resulted in a more comprehensive assessment of system risk associated with the deteriorating asset condition, please refer to Section 4.4 of Schedule 2-5-4 - Asset Management Process for additional information. This has informed the need for increased investment to renew high-risk station assets, followed by underground and overhead assets. The staged renewal of the obsolete metering population is the second highest contributor to the increased investment under System Renewal. Table 8 outlines the System Renewal program expenditures by the five associated capital programs. See Schedule 2-5-5 - Capital Expenditure Plan and Schedule 2-5-7 - System Renewal Investments for further breakdown of the System Renewal capital investments.

Table 8 - System Renewal Capital Expenditure Variance by Capital Program 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)

Capital Program	Historical / Bridge Years	Test Years	Variance
	2021-2025	2026-2030	
Stations & Bldgs Infra Renewal	$ 31	$ 108	$ 76
OH Distribution Asset Renewal	$ 43	$ 68	$ 25
UG Distribution Assets Renewal	$ 63	$ 103	$ 40
Corrective Renewal	$ 83	$ 67	$ (16)
Metering Renewal	$ 12	$ 86	$ 75
Total Capital Expenditures	**$ 232**	**$ 432**	**$ 199**
Capital Contributions	-	-	-
Net Capital Expenditures	**$ 232**	**$ 432**	**$ 199**

The Capital Programs encompassed within the System Renewal investment category are detailed below.

Stations and Buildings Infrastructure Renewal

The capital investment for this program is detailed in Section 2 of Schedule 2-5-7 - System Renewal Investments. Hydro Ottawa's Station and Buildings Infrastructure Renewal Program invests in upgrading and replacing deteriorating assets for stations and station buildings to maintain system reliability and safety. These assets include station transformers, station switchgear, batteries, protection and control systems (Relays and Remote Terminal Units (RTUs)), and other minor assets such as reclosers, insulators, arresters, online monitoring equipment and station building roofs. The Stations and Buildings Infrastructure Renewal program investments are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

The primary cost driver for the 2026-2030 Stations and Buildings Infrastructure Renewal program is the decommissioning of five high-risk 4kV substations through voltage conversion, undertaken to accommodate anticipated system growth. A secondary, yet significant, cost driver is the renewal of high-risk station breakers at four locations, identified through Predictive Analytics. Deteriorating substation assets within the Stations and Buildings infrastructure represent the most substantial risk to system performance. These critical assets serve a large customer base and provide essential system flexibility and backup capacity. Proactive asset replacement is therefore imperative to mitigate the elevated costs and risks associated with reactive repairs. This is particularly crucial within the 4kV system, where the radial distribution network configuration severely limits restoration capabilities in the event of substation asset failures.

OH Distribution Assets Renewal

The capital investment for this program is detailed in Section 3 of Schedule 2-5-7 - System Renewal Investments. This program focuses on the renewal of overhead distribution infrastructure, which encompasses poles, OH transformers, OH switches and OH reclosers. The investments in the Overhead Distribution Assets Renewal program are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics, as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

The expected increase to the pole renewal cost supports the annual replacement of 395 poles, aligning with the 2021-2025 period replacement rate of 400 poles. This projection reflects the increased cost per pole observed in the previous period and incorporates system resilience improvements within the renewed design. Overhead transformer replacement costs are also included in this program.

The expected costs for OH Switch/Recloser Renewal is a direct response to the deteriorating infrastructure, which has resulted in elevated outage rates and corrective maintenance costs during the 2021-2025 period, as detailed in Section 3.3.4 of Schedule 2-5-7 - System Renewal Investments. Project scoping within the OH Switch Renewal Program will also contemplate incremental investments that enhance the observability of the system.

UG Distribution Assets Renewal

The capital investment for this program is detailed in Section 4 of Schedule 2-5-7 - System Renewal Investments. This program replaces deteriorating underground distribution assets, including cables, UG transformers, and UG switchgear, civil infrastructure and vault equipment. Investments in this area are essential for maintaining the reliability and resilience of the underground network and are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

The increased capital investment within this program is primarily attributed to escalating per-unit costs associated with the cable replacement program. Despite a slight decrease in the projected cable units to be replaced compared to the previous period, significant price increases are anticipated due to forecasted material and external service costs. The impacts of the inflationary pressures on Hydro Ottawa are detailed in Schedule 1-2-5 - Impacts of Inflationary Pressure.

Corrective Renewal

The capital investment for this program is detailed in Section 6 of Schedule 2-5-7 - System Renewal Investments. This program addresses the replacement of assets that have degraded to a point of functional failure and pose an imminent failure risk, or have been damaged by third parties. While prioritizing proactive renewal, Hydro Ottawa also recognizes the need for reactive measures to maintain system integrity and address unexpected failures.

The drastic variance in capital investment for the 2026-2030 period compared to the actual expenditures in 2021-2025 period, is primarily attributed to the unusually high number and severity of Major Event Days (MEDs) experienced in the 2021-2025 period. It is assumed that the 2021-2025 MED frequency and intensity represents an anomaly. Therefore, the 2026-2030 forecast is more accurate compared to the 2021-2025 OEB-Approved amount.

A net increase in spending is observed in the 2026-2030 budget relative to the 2021-2025 OEB-Approved budget, due to cost escalations and the increasing impact of climate change on the electrical distribution system. While a discrete event of the magnitude of the 2022 Derecho is not explicitly forecast, the growing frequency and intensity of severe weather events necessitate sustained and strategic investment in infrastructure resilience. This imperative is reflected in the 2026-2030 forecasted capital investment in this program.

Metering Renewal

The capital investment for this program is detailed in Section 5 of Schedule 2-5-7 - System Renewal Investments. This program involves upgrading and replacing functionally obsolete metering infrastructure to support advanced metering functionality and improve system monitoring capabilities. The increase in spending in this category as compared to the previous period is to begin upgrading the metering fleet to Advanced Metering Infrastructure (AMI) 2.0 meters.

Hydro Ottawa's AMI 2.0 Metering Renewal Project aims to replace end-of-life meters with technology to empower customers with data-driven insights and tools for greater engagement and control over their energy usage. This initiative aligns to grid modernization objectives by facilitating improved grid visibility and interoperability, which is a key to enhancing reliability and efficiency. The project encompasses the replacement of existing meters, upgrades to the head-end system and data management platform, and potential deployment of complementary grid-edge devices. Phased over 2026-2035, the project begins with comprehensive planning and vendor selection, emphasizing open standards and interoperability. Rigorous testing and cyber security measures will ensure a smooth transition. Deployment will be phased, integrating with existing systems and prioritizing staff training. Ongoing evaluation will identify optimization opportunities, maximizing the system's benefits while ensuring cost-effectiveness. Risk mitigation strategies addressing reliability, safety, financial, environmental, and compliance concerns will be implemented throughout the project.

3.3. SYSTEM SERVICE

The System Service investment category allocates spending to increase capacity of the distribution system to meet forecasted demand, improve system reliability and resilience, and increase grid modernization in the distribution system.

Spending under this investment category is escalating by 194% from $161M in the 2021-2025 period to $473M in the 2026-2030 timeframe. The increase is primarily driven by the Capacity Upgrades program, which addresses growing capacity needs due to customer growth and electrification. Increased spending in the Distribution Enhancements program also contributes, with a focus on two new budget programs for Distribution System Observability and Distribution System Resilience. Finally, the Field Area Network Program drives further increases with investments in fiber extensions and wireless communication, as detailed in Table 9. See

Schedule 2-5-5 - Capital Expenditure Plan and Schedule 2-5-8 - System Service Investments for further breakdown of the System Service capital investments.

Table 9 - System Service Capital Expenditure Variance by Capital Program 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)

Capital Program	Historical / Bridge Years	Test Years	Variance
	2021-2025	2026-2030	
Capacity Upgrades	$ 108	$ 347	$ 239
Stations Enhancements	$ 3	$ 3	$ 0
Distribution Enhancements	$ 28	$ 93	$ 65
Grid Technologies	$ 21	$ 6	$ (14)
Control and Optimization	-	$ 4	$ 4
Field Area Network	$ 2	$ 21	$ 19
Total Capital Expenditures	**$ 161**	**$ 473**	**$ 312**
Capital Contributions	-	$ (4)	$ (4)
Net Capital Expenditures	**$ 161**	**$ 469**	**$ 308**

The Capital Programs encompassed within the System Service investment category are detailed below.

Capacity Upgrades

The capital investment for this program is detailed in Section 2 of Schedule 2-5-8 - System Service Investments. The capacity upgrades program addresses system capacity needs through station capacity, distribution capacity and non-wire capacity upgrades. System capacity needs and required upgrades are determined through the System Capacity Assessment as outlined in Section 9 of Schedule 2-5-4 - Asset Management Process and Integrated Regional Resource Planning as detailed in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Station capacity upgrades, designed to meet forecasted demand, focus on expanding existing Hydro Ottawa substations or the construction of new facilities. The primary reason for the increase to the Capacity Upgrades program capital budget is the planned investment in Station Capacity Upgrades for the 2026-2030 period. This need has been identified through Regional Planning, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties, and is based on forecasted system requirements. The 2026-2030 plan includes the construction of four new stations: Piperville, Mer Bleue, Greenbank, and Kanata North, and upgrading three existing stations: Riverdale, Cyrville, and Bronson.

To fully utilize the increased capacity provided by the station projects, the distribution capacity upgrades program will enhance the electrical distribution network through feeder expansion and upgrades. This program accounts for the second largest increase in the Capacity Upgrades program budget for 2026-2030. This increase is primarily driven by a greater number of feeder integration projects required to support the planned construction of the four new stations and the planned upgrade of three existing stations identified previously.

The Non-Wires Capacity Upgrade is a new program which accounts for the remaining expected increase in the Capacity Upgrades program for 2026-2030. It aims to improve grid capacity and reliability by implementing alternatives to traditional infrastructure upgrades, such as utility owned battery energy storage solutions (BESS) and Non-Wires Customer Solutions Program. The program's primary focus is on five constrained regions utilizing four BESS in combination with the Non-Wires Customer Solutions Program. These solutions are being strategically deployed in areas that meet one of the following criteria: stations requiring near-term capacity risk mitigation, distribution-connected stations with forecasted overloads of less than 7.5MVA by 2030, or areas projected to exceed capacity by 2030 and are experiencing transmission system constraints, please see Section 9.2 of Schedule 2-5-4 - Asset Management Process.

Based on a thorough analysis of the needs identified for each of the Hydro Ottawa planning regions described in Section 9.1.4 of Schedule 2-5-4 - Asset Management Process it has been determined that the majority of these needs will require wire solutions, meaning upgrades and expansions to the physical grid infrastructure. While NWSs are not expected to cause substantial avoidance or deferral of the identified wire capacity investment needs, they will play a crucial role in moderating the pace of system demand growth and enhancing reliability in the 2026-2030 period, while continuing to support the grid in the long term. This moderation will provide Hydro Ottawa with the lead time to construct the necessary long-term grid infrastructure solutions that are in harmony with the evolving system demand. There are three scenarios identified where NWSs would have the greatest potential in supporting capacity needs: please refer to Section 9.2 of Schedule 2-5-4 - Asset Management Process for more information.

Stations Enhancements

The capital investment for this program is detailed in Section 4 of Schedule 2-5-8 - System Service Investments. This program will improve distribution system observability and operability through cyber security investments and station modifications, including enhanced monitoring. Specifically, online transformer monitoring will proactively identify faults, improving asset observability and reliability by reducing unexpected failures. Addressing vulnerabilities, the program will also bolster cyber security at substations, improving threat detection and response to prevent disruptions and maintain reliable power delivery.

Distribution Enhancements

The capital investment for this program is detailed in Section 3 of Schedule 2-5-8 - System Service Investments. The Distribution Enhancement program modernizes the grid and addresses climate change risks through four programs: Distribution System Reliability, Distribution System Enhancements, Distribution System Resilience and Distribution System Observability. The Distribution System Reliability program improves efficiency and reliability through feeder reconfiguration and phase balancing. The Distribution System Enhancements program supports DER integration through infrastructure upgrades and pilot projects, leveraging federal funding for innovation. The Distribution System Resilience program strengthens weather resilience with strategic undergrounding, storm hardening, and line relocation, aligning with the

OEB's VASH initiative. The Distribution System Observability program enhances grid management through real-time data and remote switching improving reliability and flexibility.

The increased investment compared to the total in the 2021-2025 period is driven by the creation of the new Distribution System Observability and Distribution System Resilience programs. The Distribution System Observability program aims to enhance system reliability and reduce outage times by investing in new assets that provide real-time data on system conditions, loading, and fault locations, enabling proactive maintenance and faster response to issues. The Distribution System Resilience program focuses on mitigating the impact of adverse weather events through strategic undergrounding of lines, reinforcement of existing infrastructure, reconfiguration of feeders, and relocation of lines to less vulnerable areas.

Grid Technologies

The capital investment for this program is detailed in Section 5 of Schedule 2-5-8 - System Service Investments. This program modernizes grid management by enhancing observability and controllability through data acquisition, monitoring, and control capabilities. Focusing on ADMS, it enhances grid troubleshooting and asset monitoring, supporting data-driven decisions for preventative and predictive maintenance, and integrating with other systems. Driven by system efficiency, it addresses integration complexities, optimizes data handling, enhances reliability and security, and improves performance through a unified platform, seamless data exchange, and simplified maintenance. This upgrade reduces single points of failure, strengthens cyber security, and enables advanced analytics for better grid management.

Control and Optimization

Capital investment details are available in Section 7 of Schedule 2-5-8 - System Service Investments. This program focuses on Distributed Energy Resources Management Systems (DERMS) implementation to manage the growing complexity of DERs, improving grid stability, reliability, efficiency, and resilience. This program aims to improve operational effectiveness by increasing DER visibility and control, and improving grid efficiency. The Control and

Optimization program is a new capital program under System Service supporting grid modernization efforts by enhancing the Advanced Distribution Management System (ADMS) with new modules like the Distributed Energy Resource Management System (DERMS). These upgrades enable several grid modernization functionalities in tandem with observability and controllability devices facilitating the improvement of grid stability, efficiency, and resilience, enabling better grid management and real-time outage restoration.

Field Area Network

The capital investment for this program is detailed in Section 6 of Schedule 2-5-8 - System Service Investments. The Field Area Network (FAN) program is essential for Hydro Ottawa's digital and grid modernization, providing the communication backbone for grid devices and central systems.

Four key initiatives—Optical Transport Network (OTN) Fiber Network Resilience, Wireless Communication Private Long-Term Evolution (PLTE) pilot), Intelligent Electronic Device Management, and OTN cyber security—enhance reliability, security, and efficiency. Driven by system efficiency, the FAN enables real-time data access for grid modernization and DER integration, strengthens cyber security, and improves outage response by providing grid visibility and control.

3.4. GENERAL PLANT

The General Plant category encompasses a diverse set of capital programs essential for maintaining and advancing Hydro Ottawa’s IT and facility infrastructure, operational capabilities, and customer service excellence. These investments address areas such as facility infrastructure, fleet renewal, IT and cyber security infrastructure, and customer engagement. By upgrading deteriorating systems, introducing advanced technologies, and enhancing operational facilities, these programs ensure Hydro Ottawa remains well-equipped to meet evolving industry demands, regulatory requirements, and customer expectations. The planned initiatives support strategic goals like grid modernization, sustainability, and workforce readiness while promoting efficiency, innovation, and resilience in Hydro Ottawa's operations.

Expenditure under this investment category is increasing by 75% from $76M in the 2021-2025 period to $134M the 2026-2030 period. The primary driver for this increase is due to increased funding under the Connection Cost Recovery Agreement (CCRA) program required to support the increased number of transmission upgrades required to service new and upgraded stations. An increase in the Fleet Replacement program is driven by the need to replace vehicles that have reached end of useful life and for additional vehicles required to support the increase in planned workforce, as indicated in Table 10. See Schedule 2-5-5 - Capital Expenditure Plan and Schedule 2-5-9 - General Plant Investments for further breakdown of the General Plant capital expenditure program.

Table 10 - General Plant Capital Expenditure Variance by Capital Program 2021-2025 DSP vs. 2026-2030 DSP ($'000 000s)[28]

Capital Program	Historical / Bridge Years 2021-2025	Test Years 2026-2030	Variance
CCRA	$ 17	$ 46	$ 29
Fleet Replacement	$ 18	$ 41	$ 23
Tools Replacement	$ 3	$ 5	$ 2
Buildings - Facilities	$ 7	$ 7	$ (1)
Grid Technology	$ 2	$ 4	$ 2
Meter to Cash	$ 4	$ 9	$ 5
Customer Engagement Platform	$ 7	$ 3	$ (5)
Enterprise Solutions	$ 6	$ 1	$ (4)
Infrastructure and Cyber Security	$ 11	$ 15	$ 4
Data and System Integrations	$ 2	$ 3	$ 2
Total Capital Expenditures	**$ 76**	**$ 134**	**$ 57**
Capital Contributions	$ (4)	$ (13)	$ (9)
Net Capital Expenditures	**$ 73**	**$ 121**	**$ 48**

The Capital Programs encompassed within the General Plant investment category are detailed below.

CCRA - Connection Cost Recovery Agreement

The capital investment for this program is detailed in Section 7 of Schedule 2-5-9 - General Plant Investments. The CCRA program funds Hydro Ottawa's share of transmission infrastructure upgrades, determined through system capacity assessments. These upgrades include connections for new and upgraded stations and addressing equipment limitations at Hydro One Networks Inc. (Hydro One)-owned stations. Hydro Ottawa contributes to the costs of these upgrades, ensuring grid reliability and supporting growth. Key projects include new

[28] Totals may not sum due to rounding.

stations (Hydro Road, Mer Bleue, Kanata North, Greenbank) and upgrades to existing stations (Cyrville, Bronson, Carling, King Edward, Hinchey). This investment will increase station capacity by over 811MVA, improving DER hosting capacity and reliability, and supporting customer growth. Driven by the need to address capacity constraints, the CCRA program responds to load requests and without these investments Hydro Ottawa may not be able to meet future demand.

Fleet Replacement

The capital investment for this program is detailed in Section 11 of Schedule 2-5-9 - General Plant Investments. This program plans for additional vehicles required for increased staffing needs as well as replacing aging vehicles with modern, efficient alternatives to support safety and operational needs and to reduce carbon emissions. Over the 2026-2030 rate period, a total of 140 vehicles at a cost of $41M are planned to be purchased in order to replace vehicles at the end of their useful lives and account for additional vehicles required to support workforce growth.

Tools Replacement

The capital investment for this program is detailed in Section 9 of Schedule 2-5-9 - General Plant Investments. This program updates and replaces outdated equipment and tools to enhance operational efficiency, support field staff, and improve safety. The program ensures workforce readiness and aligns with modern operational standards.

Buildings - Facilities

The capital investment for this program is detailed in Section 10 of Schedule 2-5-9 - General Plant Investments. This program focuses on maintaining and upgrading office and administrative facilities to support workforce needs, improving energy efficiency, and providing a safe working environment. These investments also align with Hydro Ottawa's sustainability goals and level of organizational growth.

Grid Technology

The capital investment for this program is detailed in Section 6 of Schedule 2-5-9 - General Plant Investments. This program addresses the maintenance and upgrade of tools and software that support modernization of grid operations, integrate new technologies like DERs and support grid planning. The program focuses on network visualization and management, data collection and network modelling and simulation.

Meter to Cash

The capital investment for this program is detailed in Section 2 of Schedule 2-5-9 - General Plant Investments. This program supports critical business functions such as billing, meter reading, collections, and reporting. Upcoming upgrades to systems like Oracle's Customer Care & Billing (CC&B) and AMI aim to ensure compliance, improve customer self-service options, and address end of life infrastructure.

Customer Engagement Platform

The capital investment for this program is detailed in Section 3 of Schedule 2-5-9 - General Plant Investments. This program encompasses tools such as MyAccount, outage communication systems, Hydro Ottawa's website, and energy management tools. It prioritizes enabling intuitive self-service, delivering detailed energy insights, and enhancing customer satisfaction through seamless digital experiences. Furthermore, these digital platforms enable Hydro Ottawa to gather valuable customer insights that can also be used to enhance customer experience, inform grid planning, and identify opportunities for future NWSs and customer programming.

Enterprise Solutions

The capital investment for this program is detailed in Section 4 of Schedule 2-5-9 - General Plant Investments. This program focuses on maintaining and upgrading applications such as Enterprise Resource Planning (ERP) and IT Service Management systems. These enhancements ensure business continuity, streamline workflows, and reduce cyber security risks. Over the rate period, the program includes business continuity software and expanding self-service HR capabilities.

Infrastructure & Cyber security

The capital investment for this program is detailed in Section 8 of Schedule 2-5-9 - General Plant Investments. This program invests in strengthening IT systems to protect against cyber threats, maintain data integrity, and support business continuity. The program aims to ensure systems are secure, scalable, and aligned with industry best practices to safeguard critical infrastructure.

Data and System Integrations

The capital investment for this program is detailed in Section 5 of Schedule 2-5-9 - General Plant Investments. This program consolidates fragmented data systems to create an integrated, reliable, and efficient framework. It aims to reduce manual interventions, enable real-time decision-making, and ensure compatibility across platforms to support both operational and strategic initiatives.

4. OUTCOMES AND PERFORMANCE MEASURES

Hydro Ottawa's proposed performance framework for the 2026-2030 DSP emphasizes a direct and transparent approach to monitoring and reporting. The framework aligns with the OEB performance outcomes:

- **Customer Focus:** Prioritizing connection efficiency, grid reliability, customer engagement, and technological advancements to enhance customer satisfaction.
- **Operational Effectiveness:** Leveraging grid modernization, asset management, customer-centric operations, and workplace safety to optimize performance.
- **Public Policy Responsiveness:** Ensuring regulatory compliance, grid modernization planning, safety, and reliability to meet public policy goals.

- **Financial Performance:** Focusing on resource optimization, grid reliability with integrated DERs, data-driven decision making, and long-term financial sustainability.

Hydro Ottawa will measure performance through specific outcomes linked to Material Investment Plans (MIPs) in four investment categories: System Access, System Renewal, System Services, and General Plant. This approach ensures that investments and initiatives are strategically aligned, customer-focused, and financially responsible. The framework will enable Hydro Ottawa to effectively track progress, evaluate planning, improve operations, and identify areas for enhancement, ultimately delivering better service to customers. Refer to Schedule 2-5-3 - Performance Measurement for Continuous Improvement for full details on outcomes and performance measures.

5. OVERVIEW OF DOCUMENTS

The complete 2026-2030 DSP is included in Schedules 2-5-1 to 2-5-9 of this Application submission. It consists of nine schedules, which are outlined below and mapped back to the Chapter 5 Filing Requirement as shown in Table 11.

Table 11 - DSP Schedules Mapping to OEB Chapter 5 Filing Requirements

OEB Chapter 5 Filing Requirements- Sections	DSP Schedule
5.2.1 – Distribution System Plan Overview	2-5-1
5.2.2 – Coordinated Planning with Third parties	2-5-2
5.2.3 – Performance Measurement for Continuous Improvement	2-5-3
5.3 – Asset Management Process	2-5-4
5.4 – Capital Expenditure Plan	2-5-5 2-5-6 2-5-7 2-5-8 2-5-9

DSP Schedules:

- **Schedule 2-5-1 - Distribution System Plan Overview**
  This schedule provides a comprehensive overview of the DSP, including an outline of the key elements of the plan, and highlights important changes. It also details the 2026-2030 capital expenditure plan, aligned with Investment Priorities, and how customer preferences and expectations were incorporated into forming the Focus Areas and validating the Investment Priorities. The chapter also provides an overview of the outcomes and performance measures used to track the plan's progress and outlines the structure of the DSP documents, period, and vintage of information.

- **Schedule 2-5-2 - Coordinated Planning with Third Parties**
  This schedule examines how the DSP coordinates with customers and stakeholders. It covers:

- Customer Coordination: Outlines the various methods of customer engagement, including consultations, requests, and open houses, used to inform investment planning and ensure the DSP reflects customer priorities.
- Regional Planning: Details the collaborative regional planning process among the IESO, Hydro Ottawa, and Hydro One to ensure a reliable, cost-effective, and sustainable electricity supply for the region.
- Telecommunication Entities: Explains Hydro Ottawa’s relationship with telecommunication companies, focusing on the attachment process and agreements for infrastructure sharing.
- Other Utility and Stakeholder Coordination: Describes Hydro Ottawa’s coordination with various utilities and stakeholders, including the City of Ottawa, contractors, and industry groups, to ensure efficient and safe operations.
- Planning Coordination Effects on DSP: Discusses how effective planning coordination among various stakeholders is crucial for the successful planning of the distribution system, ensuring alignment, minimizing conflicts, and addressing diverse needs.

- **Schedule 2-5-3 - Performance Measurement for Continuous Improvement**

  This schedule outlines Hydro Ottawa's performance measurement framework, aligned with the OEB guidelines. It covers:

  - Historic (2021-2025) DSP Performance: Presents historical KPI data and explains the results of performance across customer, costs, asset, and system operations.
  - Historical Reliability Performance: Provides a detailed analysis of Hydro Ottawa’s reliability performance trends, including SAIDI and SAIFI.
  - Continuous Improvement: Discusses ongoing efforts to enhance performance based on data analysis and feedback.

- Performance Measurement Framework: Details the framework used to measure and monitor the performance across various system areas of the DSP.

- **Schedule 2-5-4 - Asset Management Process**

  This schedule provides an in-depth look at asset management within the DSP. It covers:

  - Planning Process: Describes Hydro Ottawa's integrated business planning process, including strategic objectives, customer engagement, and the development of core business strategies that guide investment plans.
  - Asset Management Overview: Presents Hydro Ottawa's Asset Management System, its certification, scope, strategy, objectives, process overview, and process enhancements.
  - Asset Management Process: Explains the detailed, four-stage asset management process (prepare, plan, optimize, execute) used by Hydro Ottawa to manage its assets and planned expenditures.
  - Overview of Assets Managed: Details the various assets managed by Hydro Ottawa, including their demographics, condition, failure rates, risk profiles, and system utilization.
  - Asset Lifecycle Optimization: Describes the policies and practices used by Hydro Ottawa to optimize asset lifecycles, including typical useful life (TUL), replacement/refurbishment policies, and testing inspection and maintenance programs.
  - System Capacity Assessment: Presents Hydro Ottawa's comprehensive assessment of system capacity needs, including load forecasting, NWSs, and the integration of renewable energy resources.

- **Schedule 2-5-5 - Capital Expenditure Plan**

  This schedule provides a comprehensive analysis of capital investments within the DSP, focused on the 2026-2030 period. It covers:

  - Forecast Expenditure: Presents the 2026-2030 forecasted expenditures by investment category, driven by Hydro Ottawa's investment strategy.
  - Historical and Forecast Expenditure Overview: Outlines the variance between the total of 2021-2025 timeframe vs. OEB-Approved amounts, and compares them to the 2026-2030 Capital Expenditure plan.
  - Capital Expenditure Summary: Details the historical performance and forecasted expenditures by investment category, further divided by Capital Program and Budget Program.
  - Impact on Operation and Maintenance Costs: Discusses how capital expenditures affect routine system operation and maintenance costs, including cost reductions.

  Additionally, Capital Programs are described under the following schedules for each Investment Category:

  - Schedule 2-5-6 - System Access Investments
  - Schedule 2-5-7 - System Renewal Investments
  - Schedule 2-5-8 - System Service Investments
  - Schedule 2-5-9 - General Plant Investments

6. DSP PERIOD

The DSP provides capital expenditure plans and supporting information for the 2026-2030 Test Year period, along with Historical and Bridge Year information for 2021-2023 and 2024-2025, respectively.

7. VINTAGE OF INFORMATION

Unless otherwise stated, the information and details provided are based on actual numbers as of December 31, 2023.

COORDINATED PLANNING WITH THIRD PARTIES

1. OVERVIEW

Hydro Ottawa's Distribution System Plan (DSP) relies heavily on input achieved through collaboration. The utility prioritizes integrated planning, ensuring alignment with customers, the transmitter and IESO through regional planning, and the community. Customer engagement on an ongoing basis is achieved through open houses, presentations, and a formal consultation process that directly shaped the DSP's strategic focus and investment priorities. Hydro Ottawa works with the IESO and Hydro One Networks Inc. (Hydro One), providing planning forecasts and exploring solutions to address capacity needs, with a particular focus on the complexities of decarbonization and electrification. Hydro Ottawa also coordinates with telecommunication companies regarding infrastructure attachments, the City of Ottawa on development and utility projects (including the LRT and "Energy Evolution" strategy), and contractors and developers to streamline projects. Participation in industry working groups provides access to shared knowledge and cost-effective technology. This multi-faceted coordination is crucial for a successful and responsive DSP.

2. INTRODUCTION

This Schedule of the DSP explains how Hydro Ottawa coordinates its plans with third parties and how the results of this planning have been factored into the proposed DSP.

Hydro Ottawa operates within the majority of the City of Ottawa and the Municipality of Casselman, and has effectively coordinated with third party stakeholders, grouped in three major categories in regards to coordinated planning:

1. **Customers:** Grouped by residential, small commercial, commercial & industrial (C&I), and key accounts customers;
2. **Regional Planning Authorities:** IESO and Hydro One; and

3. **Community Stakeholders:** Including Telecommunication Entities, Enbridge Inc. (Enbridge), City of Ottawa, City of Ottawa Utilities Committee, and Ottawa Light Rail Transit (LRT).

Coordination with third-party stakeholders has resulted in a comprehensive, efficient, and well-integrated DSP. This integrated planning process ensures that Hydro Ottawa's strategy is aligned with its customers' needs, the plans and objectives of the regional electrical system, and the needs of other stakeholders in the community. This approach fosters optimized resource allocation, streamlined processes, shared infrastructure, and the avoidance of redundant investment, contributing to a cost-effective plan. Ultimately, this strategy enables Hydro Ottawa to deliver reliable and resilient access to electricity and meet the ever-growing needs of customers in Ottawa and Casselman.

3. CUSTOMER COORDINATION

Customer coordination is a key input into the planning process. Hydro Ottawa utilizes a mix of ongoing and specific engagements with customers to inform investment planning and coordinate the work undertaken within its plans. For example, Hydro Ottawa regularly conducts customer engagement through open houses and community presentations. These meetings give customers and Hydro Ottawa employees a chance to discuss upcoming projects, emergency preparedness, and other topics of interest or concern. Additionally, customers are engaged through their many daily interactions with company staff. Schedule 1-4-1 - Customer Engagement Ongoing outlines a comprehensive summary of the tools, activities, and interactions which comprise Hydro Ottawa's customer engagement as part of its normal course of business. In addition, a two-phase customer consultation was conducted as a part of the 2026-2030 Rate Application planning process, as described in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

This multi-faceted approach to customer coordination ensures that Hydro Ottawa's DSP reflects the needs and priorities of its customers.

3.1. CUSTOMER CONSULTATION

Customer consultation is crucial to Hydro Ottawa’s business strategies and investment plans. Accordingly, Hydro Ottawa has implemented several methods of engaging customers related to its Asset Management Process, including activities that are integrated into normal business operations. Feedback from customers has been instrumental in shaping this DSP, demonstrating Hydro Ottawa's commitment to understanding and meeting customer needs and preferences. Customer consultations related to Asset Management which are part of Hydro Ottawa’s ongoing customer engagement activities are described in more detail in Schedule 1-4-1 - Customer Engagement Ongoing. Three main categories of this customer engagement are as follows and described below:

1. Customer Requests and Engagement
2. Keeping Ottawa Connected
3. Project Open Houses

3.1.1. Customer Requests and Engagement

Hydro Ottawa handles a wide range of customer requests daily, from new service connections and upgrades to major infrastructure relocations. The utility uses online service request forms to efficiently manage these requests and ensure they reach the appropriate team. In addition, in 2024, Hydro Ottawa established a project intake group responsible for ensuring customer requests are more effectively tracked, that resources are appropriately assigned and that service levels related to responses are adhered to. Additional information related to the intake initiative is provided in Section 4 of Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement.

For smaller requests, like connecting a new home or upgrading an existing service, Hydro Ottawa's service desk and layout groups work collaboratively to review the request and create a design if needed. Larger projects, such as those involving significant new loads or relocating existing equipment, are handled by the distribution design group, which conducts a more in-depth review to assess the impact on the electrical grid.

When these larger projects require upgrades to Hydro Ottawa's infrastructure, the utility looks for opportunities to integrate them with planned system expansions. This approach allows Hydro Ottawa to share costs and use resources more efficiently, ultimately benefiting all of its customers.

For major projects involving large commercial or Key Account customers, such as the LRT, or Ottawa Community Housing, Hydro Ottawa assigns dedicated contacts within its project management teams, and utilizes existing relationships with the Key Accounts team. This provides these customers with personalized support and coordination throughout their projects.

Hydro Ottawa's goal is to provide a seamless and responsive experience for all its customers, whether they're connecting a new home or undertaking a major development project. The utility is committed to meeting customer needs efficiently and effectively while ensuring the reliability, safety, and sustainability of the electrical grid.

The outcomes and feedback from external requests are integrated into Hydro Ottawa operations to support continuous learning, and the number and scope of requests are used to support growth forecasting in the DSP.

3.1.1.1. *Key Accounts*

As outlined in Section 2.3 of Schedule 1-4-1 - Customer Engagement Ongoing, Hydro Ottawa's Key Accounts team regularly and proactively engages with Hydro Ottawa's largest customers. One key function of this engagement is identifying upcoming work that might impact the utility, such as large load requests, customer distributed energy resource (DER) projects, and electrification goals. Identifying large and potentially impactful projects early on helps Hydro Ottawa's planning and forecasting. The Key Accounts team is also able to guide customers on the proper process to submit formal requests, helping ensure that the required and correct information is provided to Hydro Ottawa in a timely manner.

3.1.2. Keeping Ottawa Connected

After the 2022 Derecho storm, Hydro Ottawa developed "Keeping Ottawa Connected," a community presentation focusing on emergency preparedness, power restoration, vegetation management, and generator safety. Since launching in 2023, Hydro Ottawa has delivered 20 of these presentations to nearly 750 people. Participants come away with a better understanding of their role in emergency preparedness, Hydro Ottawa's restoration process, efforts to enhance grid resilience, and the communication tools available. Customer engagement during these sessions has also provided the company with insights into evolving customer needs, informing future services and delivery. The outcomes and feedback of Keeping Ottawa Connected are integrated into Hydro Ottawa operations to support continuous learning. Although the outcomes of these consultations do not directly impact the DSP, they are factored into Hydro Ottawa’s day to day processes.

3.1.3. Project Open Houses

Hydro Ottawa regularly holds open houses to consult with customers regarding major projects. In 2021, due to the pandemic, Hydro Ottawa moved to a virtual format to ensure public safety. This shift allowed for greater flexibility in scheduling and resulted in increased customer participation. As restrictions eased, Hydro Ottawa adopted a hybrid approach, offering both virtual and in-person sessions.

Open houses cover a range of topics, including the project overview, rationale, anticipated benefits, impacted areas, timelines, scope of work, and site restoration plans. Customers are given the opportunity to ask questions and provide feedback directly to the Hydro Ottawa employees that are involved in the project. This direct engagement strategy has often led to improvements in project design and scheduling. For more information regarding the open house process and examples of integrated customer feedback, please refer to Section 2.5.1 of

Schedule 1-4-1 - Customer Engagement Ongoing. The outcomes of project open houses are constantly reviewed and integrated into Hydro Ottawa operations to support continuous learning, although the outcomes of these consultations do not directly impact the DSP, they are factored into Hydro Ottawa's day-to-day processes.

4. REGIONAL PLANNING

The IESO regional planning process in the Greater Ottawa Area involves collaboration among the IESO, Hydro Ottawa, and Hydro One. This collaborative effort helps identify the current and future capacity needs of the electrical system and ensures a reliable, cost-effective, and sustainable electricity supply for the region.

As part of this planning process, Hydro Ottawa provides a comprehensive long-term planning load forecast, the Integrated Regional Resource Planning (IRRP) forecast, for its service territory. For more information, please refer to Section 9.4.2 of Schedule 2-5-4 - Asset Management Process. This planning forecast aids in identifying transmission lines and distribution stations reaching or exceeding their capacity limits in the short, medium, and long term. Hydro Ottawa also provides information on limitations within the planning area that might not be readily apparent to the working group.

The IRRP process identifies cost-effective and sustainable solutions to ensure efficient and reliable energy distribution. The solutions include "wire" options such as: new transmission lines, autotransformers, step-down transformer stations, voltage control devices, upgrades to existing infrastructure, or control actions or protection schemes that influence how the system is operated to avoid or mitigate certain reliability concerns. Capacity needs that would be best suited for a more detailed assessment for Non-Wires Solutions (NWSs) are also identified. This includes local utility-scale generation or storage, DERs (including distribution-connected generation and demand response), CDM or electricity Demand-Side Management (eDSM), or distribution-level load transfers.

The main stages of the IESO regional planning process are:

- Needs Assessment, please refer to Section 4.1 - Needs Assessment
- Scoping Assessment, please refer to Section 4.2 - Scoping Assessment
- IRRP, please refer to Section 4.3 - Greater Ottawa Integrated Regional Resource Planning
- Regional Infrastructure Plan (RIP), please refer to Section 4.4 - Greater Ottawa Regional Infrastructure Plan

Results from the regional planning process are incorporated into Hydro Ottawa's investment plan to meet the capacity needs of the system and play a pivotal role in shaping Hydro Ottawa's investment plan. By incorporating these insights, Hydro Ottawa can strategically allocate resources to ensure the system's reliability, resilience, and ability to meet the growing energy demands of the Ottawa region.

Government decarbonization initiatives have added increased complexity to the regional planning process due to the impacts of decarbonization and the uncertainty of associated electrification rates at the community level. To address this a Decarbonization Sub-Working Group was created to support the IRRP. In support of this sub-working group, Black & Veatch was engaged to create a variety of load scenarios for 2025 to 2050 based on varying regional and local factors with refinement from the Decarbonization Sub-Working Group. Details of the working group are summarized in Section 4.3.1 - Decarbonization Sub-Working Group.

A key finding of the IESO regional planning process was the need for investment to support the region's electrification strategy. This includes accommodating increased electricity consumption and demand from new homes and businesses, as well as supporting the transition to electric vehicles (EVs) and other clean energy technologies. Hydro Ottawa's investment plan reflects these findings, ensuring the electricity grid can handle the increased demand and contribute to a sustainable energy future for the region.

4.1. NEEDS ASSESSMENT

A Needs Assessment is conducted at least every five years, or more frequently if one of the parties to the process raises a regional reliability or delivery performance issue, or if there are concerns with respect to the system's ability to handle a customer load request. The transmitter leads this analysis, with data provided by the IESO and the local distribution companies (LDCs). This assessment examines changes in demand within a specific area and conducts an initial screening to identify regional or sub-regional needs.

Due to increased load growth in the region, the third regional planning cycle was triggered in advance of the 5-year period. In 2022, an assessment was conducted by Hydro One Transmission to evaluate the needs of the Greater Ottawa region. The following asset renewal needs were identified by Hydro One over the planning horizon based on asset condition assessment:

- Lisgar TS: Replace transformer T1
- South March TS: Replace transformers T1/T2
- S7M Line Refurbishment

In terms of transformation capacity, many stations were found to be near or exceeding their limits. While load transfers can mitigate the need in the near term, station capacity was recommended to be reviewed as part of this regional planning cycle. The assessment's findings highlighted the necessity for enhanced regional collaboration, prompting the initiation of a Scoping Assessment.

4.2. SCOPING ASSESSMENT

During this phase, the IESO collaborates with the transmitter and LDCs to determine the most suitable planning strategy, as follows:

- If there is potential for integrating options such as conservation, generation, distribution, or emerging technologies, an IRRP will be recommended.

- If needs can be met solely through enhancements to transmission lines or infrastructure, a RIP led by the transmitter will be recommended.
- Alternatively, it may be recommended that the LDC and transmitter jointly plan for the necessary local infrastructure investments.

In the Scoping Assessment phase, the progress on recommendations from the previous IRRP, which was completed in March 2020 was reviewed. A summary of the recommendations and updates on progress made for completions are listed below:

Kanata-Stittsville

- Implement the North Kanata Retrofit Top-Up Program and the North Kanata Smart Thermostat Program, targeted commercial and residential energy efficiency programs.
- Improve distribution load transfer capability at the heavily loaded stations Marchwood MTS and Kanata MTS – Ongoing.

Southeast Ottawa

- Construction of a new 230kV connected supply station in southeast Ottawa. Construction of the new Piperville Station by Hydro Ottawa is ongoing and planned for energization in 2026. Please refer to Section 2 of Schedule 2-5-8 - System Service Investments for further detail.

Central Ottawa

- Replacement of transformers T2 and T3 at Slater TS due to end-of-life, with larger transformers, approximately 100 MVA, as was done for the recent replacement of T1 – work was completed by Hydro One in 2024.
- Replacement of transformers T1 and T2 at Lincoln Heights due to end-of-life – work completed by Hydro One in 2024.
- Replacement of transformers T1 and T2 at Albion TS due to end-of-life – planning

underway with an expected completion in 2031-2033. Hydro Ottawa has requested incremental capacity at the time of the replacement of these transformers.

Orleans

- The refurbishment and expansion of Bilberry Creek TS was cancelled due to increased forecasted demand in the Ottawa Area Sub-region. Instead, the working group considered decommissioning Bilberry Creek TS and transferring the loads to a new 230 kV connected supply station. Additionally, the existing Orleans TS will be upgraded to provide additional supply capacity. Hydro Ottawa is planning to energize the new Mer Bleue station in 2028. For further details, please refer to Section 2 of Schedule 2-5-8 - System Service Investments.

Regional 115 kV System

- The smaller Merivale autotransformer replacement need was identified, and the addition of a third 230-115 kV autotransformer at Merivale TS was evaluated. The Hydro One project includes replacing autotransformer T22, six 230 kV circuit breakers, four 115 kV circuit breakers, and installing a new autotransformer T23. This project is currently underway with a planned in-service date of 2029.

The Greater Ottawa Scoping Assessment Outcome Report[1] was completed and published in March 2023. The report recommended that an IRRP be undertaken to identify, evaluate and recommend solutions to address the needs identified for the Ottawa sub-region.

4.3. GREATER OTTAWA INTEGRATED REGIONAL RESOURCE PLANNING

When the Scoping Assessment Outcome Report concludes that an IRRP is necessary, the IESO, transmitter, and LDCs collaborate to develop the IRRP.

[1] Independent Electricity System Operator, *2023 Greater Ottawa Scoping Assessment Outcome Report*, (March 21, 2023).

The IRRP considers various resource options to address regional electricity needs, including:

- Conservation measures and demand management;
- Distributed generation;
- Large-scale generation;
- Transmission enhancements;
- Distribution upgrades; and
- Innovative solutions, including DERs, such as: renewable generation, energy storage, combined heat and power, and microgrids.

The IRRP evaluates these options based on their feasibility, cost, reliability, alignment with government policies (e.g., Conservation First Framework and Long-Term Energy Plan), environmental performance, and community preferences. The resulting plan will propose ways to meet the identified electricity needs, along with implementation and monitoring strategies.

Although IRRPs cover a 20-year planning horizon, they prioritize actions for the near term (0-5 years) and medium term (5-10 years), with long term (10-20 years) options being deferred for future consideration.

Community and stakeholder engagement remain crucial throughout the IRRP development phase. Ongoing dialogue facilitates an understanding of regional planning processes, allowing for local input and a successful implementation.

The completion of the Greater Ottawa Region IRRP is planned for Q1 2025. A Planning Status Letter has been provided by the transmitter to confirm the alignment of Hydro Ottawa's investment plans with the preliminary findings of the Regional Planning Process, refer to Attachment 2-5-2(A) - Planning Status Letter. As part of the IRRP process, a Decarbonization sub-working group was established to review plans and priorities of communities around electrification to understand the impact.

4.3.1. Decarbonization Sub-Working Group

The initial 20-year demand forecast provided in early 2023 for the IRRP lacked impact from electrification. The Decarbonization Sub-Working Group was asked to develop forecast scenarios that reflected local community energy plans and priorities around electrification. A High Growth Scenario, reflecting a full decarbonization of the region, was discussed through meetings with the sub-working groups. The IESO led six meetings between March 2023 to December 2023 with representatives from the City of Ottawa, Hydro Ottawa and Hydro One Distribution to develop the new scenario. Hydro One Transmission and Enbridge participated in the meetings as observers. In the Toronto and Ottawa IRRPs, the IESO included Enbridge as an observer on a pilot basis. The role of the observer is limited to providing feedback on areas where they are the subject matter experts. Electrification forecasting was difficult due to a lack of specific, localized targets. This disconnect between broad policy goals and practical implementation created uncertainty and hindered stakeholder engagement. A more robust framework with regional and local considerations was needed for effective electrification planning. To this end, Hydro Ottawa engaged Black and Veatch in April 2023 to evaluate the implications of the decarbonization initiatives on its system.

To determine the potential implications of decarbonization initiatives on Hydro Ottawa's distribution network from 2024 to 2050, Black and Veatch developed load scenarios. Each scenario incorporated different assumptions about decarbonization factors such as energy efficiency, population growth, EV adoption, and building heating.

Black and Veatch presented the details of the scenario assumptions to the Decarbonization sub-working group. Assumptions around population growth and heat pump efficiency in cold weather were modified based on feedback from the City of Ottawa and Enbridge Gas, respectively. A fifth scenario was added to address load sensitivity from customers switching to gas during colder weather conditions (less than -10 degrees Celsius).

Following these adjustments, three scenarios were adopted by the Sub-Working Group for use in regional planning: the Reference Scenario, the Policy-Driven Scenario (high sensitivity), and the Dual Fuel Scenario (low sensitivity). The Sub-Working Group decided to use the Reference Scenario as the primary scenario of investment planning.

Hydro Ottawa has integrated the IRRP forecast Reference Scenario, into its capacity planning process as a crucial sensitivity analysis. This is aimed at proactively informing the utility's investment plans and ensuring that these plans remain aligned with recommendations set out in the IRRP. By incorporating this sensitivity analysis, Hydro Ottawa can better anticipate and respond to potential future scenarios, thus safeguarding the reliability and effectiveness of its capacity investments. For a more detailed and comprehensive understanding of Hydro Ottawa's Planning Forecast and the integration of the IRRP Reference Scenario, refer to Section 9.4 of Schedule 2-5-4 - Asset Management Process.

4.3.2. IRRP Preliminary Results

This section describes the preliminary near- and medium-term asset renewal and capacity constraint needs identified through the IRRP cycle. The asset renewal needs focus on the replacement and capacity upgrades of several transformer stations, including South March TS, Lisgar TS, Russell TS, Albion TS, and Riverdale TS. The capacity constraints section highlights the need for additional transformation capacity in Kanata North, Moulton/Cyrville/Overbrook, Nepean 8kV, and Downtown Ottawa regions.

Asset Renewal Needs:

- **South March TS:** The station's two 230kV/44kV transformers, commissioned in 1971, need to be replaced due to their current asset condition. The IRRP working group is evaluating increasing the transformers' capacity by 50MVA to meet the long-term demand forecast. This Hydro One project has a planned in-service date of 2030-2032. Hydro Ottawa may need to contribute to the cost of increasing the station's capacity under the Connection and Cost Recovery Agreement (CCRA) program. For further details, refer to Section 7 of Schedule 2-5-9 - General Plant Investments.

- **Lisgar TS:** There are two T1/T2 115kV/13.8kV, 45/60/75MVA transformers at the station. Transformer T1 was in-serviced in 1974 and based on its asset condition it needs replacement. Based on the non-coincident forecast, the station loading has reached its capacity. The T1 transformer capacity will be increased at the time of replacement to 100MVA. This Hydro One project has a planned in-service date of 2025. Hydro Ottawa might need to contribute to the cost of increasing the station's capacity under the CCRA program in 2025.
- **Russell TS:** The two 45/60/75 MVA transformers T1 and T2 were installed in 1975 and 1971, respectively, and require replacement. A Hydro One project, coordinated with Hydro Ottawa, is currently underway to replace transformers T1/T2 with 60/80/100MVA units. The planned in-service date for the upgraded transformers is 2027. Upgrading capacity at this station supports the capacity needs in the East 13kV region. Refer to Section 9.1.4.5 of Schedule 2-5-4 - Asset Management Process and Section 7 of Schedule 2-5-9 - General Plant Investments for capacity needs and project details.
- **Albion TS:** The two 75 MVA transformers T1 and T2 were built in the 1970s. They have been identified for replacement with new closest standard size 60/80/100 MVA units. All existing Hydro One owned circuit breakers will be replaced with breakers of similar ratings. The planned in-service date of the project is in 2031. No capital contribution is expected from Hydro Ottawa for increased capacity since transformers are expected to be replaced to the closest standard size.
- **S7M Line refurbishment:** The 115 kV circuit, spread across several S7M line sections totaling 6.5 km, have been identified at or near their end of service life. It was suggested to replace conductors, wood poles, insulators, and other components. Some sections are considered for upgrades, which Hydro Ottawa, Hydro One, and IESO are working together to determine the preferred plan. No capital contribution is expected from Hydro Ottawa.

- **Riverdale TS:** Riverdale TS is a 115/13.8kV station connected to 115kV circuits A3RM, A5RK, and A6R. The 115kV breakers are identified to be replaced based on asset condition assessment. The planned in-service date of the project is in 2038. No capital contribution is expected from Hydro Ottawa.

Capacity Constraints:

- **Kanata North region:** The previous regional planning cycle identified this area as needing additional transformation capacity. Due to the IESO bulk system study being in progress at the time, temporary measures were implemented to mitigate this by load transfer and CDM programs. It was expected that the results from the IESO bulk system study could have impacted the area's supply, and therefore a plan was not developed before the results were available. The need was reviewed again during the current regional planning cycle, and the expected recommendation is a new transformer station and new 230 kV transmission circuit in the Kanata area by 2029. For capacity needs and project details, refer to Section 9.1.4.2.5 of Schedule 2-5-4 - Asset Management Process and Section 2 of Schedule 2-5-8 - System Service Investments. Hydro Ottawa is estimated to contribute to the cost of building the new transmission line to connect the new station under the CCRA program in the 2026-2030 period, refer to Section 7 of Schedule 2-5-9 - General Plant Investments and Schedule 9-2-1 - New Deferral and Variance Accounts.
- **Moulton/Cyrville/Overbrook region:** The 115kV supplied station is expected to have a large load increase in the near term. Given the location of Cyrville station near 230kV supplies, the IRRP working group is proposing to upgrade the station transformation capacity by 50MVA and change its supply to 230kV by 2028, refer to Section 3 of Schedule 2-5-8 - System Service Investments for project details. This will allow the station to meet its load forecast as well provide relief to other stations through distribution transfers. This conversion to 230kV supply will also help preserve capacity on the 115kV system which is nearing its limit. Hydro Ottawa might need to contribute to the cost of extending the transmission line to connect Cyrville under the CCRA program

in the 2026-2030 period, refer to Section 7 of Schedule 2-5-9 - General Plant Investments and Schedule 9-2-1 - New Deferral and Variance Accounts.

- **Downtown Ottawa Transformation Capacity:** Several stations in the downtown core are expected to or have reached their capacity based on the forecast. To address this several recommendations are expected from this cycle of regional planning:
    - **Bronson DS:** Upgrade 4kV station to 13kV and upgrade supply to a transmission connected station with higher rated transformers (150MVA). This will provide additional transformation capacity in the city center. For project details, refer to Section 2 of Schedule 2-5-8 - System Service Investments.
    - **King Edward TS:** Replace aging and limiting circuit breakers and cables at the station to increase the available station capacity by approximately 38 MVA.
    - **Carling TS:** Replace aging and limiting cables at the station to increase the available station capacity by approximately 40MVA.

Hydro Ottawa is estimated to contribute to the cost of removing station breaker and cable limitations at the existing Hydro One stations under the CCRA program in the 2026-2030 period, refer to Section 7 of Schedule 2-5-9 - General Plant Investments and Schedule 9-2-1 - New Deferral and Variance Accounts.

- **Nepean 8kV region:** The area directly west of Merivale TS, supplied by Manordale MTS and Center Point MTS, is predominantly supplied by 8kV distribution system. Hydro Ottawa has received some large scale customer load requests coupled with the transformation capacity being exceeded at nearly all the stations in the area has resulted in a need being identified for a new 230kV-28kV station adding 130MVA of additional capacity in the region. The new Hydro Ottawa owned station, Greenbank MTS, is planned for energization by 2028, refer to Section 2 of Schedule 2-5-8 - System Service Investments for project details.
- **Upgrades to 115kV circuits:** Several circuits have been identified as reaching capacity over the study period. The upcoming Regional Infrastructure Planning cycle is expected

to recommend upgrades to sections of F10MV, C7BM, M4G, and M5G.

- **Non-Wires Solutions:** NWSs are a valuable tool for managing growing electricity demands in Ottawa. Although they cannot replace traditional wire upgrades, they can support existing capacity and shape long-term investments. NWSs can reduce peak demand impacts, allowing for strategic phasing of wire upgrades. Due to significant growth forecasts, a tiered approach was adopted to evaluate NWSs, grouping similar needs together. While NWSs were not feasible for all issues, they showed promise for addressing voltage collapse and were thoroughly analyzed. The impact of planned large-scale battery storage projects was also considered. For further information on Hydro Ottawa NWSs to address capacity needs that align with the IRRP approach to using NWSs to manage growing electricity demands due to decarbonization goals, refer to Section 9.2 of Schedule 2-5-4 - Asset Management Process.

Solutions to address these needs are being finalized in the IRRP, and final recommendations will be available by the end Q1 2025. A Planning Status Letter dated March 14, 2025 has been provided by the transmitter to confirm the alignment of Hydro Ottawa's investment plans with the preliminary findings of the Regional Planning Process, refer to Attachment 2-5-2(A) - Planning Status Letter.

4.4. GREATER OTTAWA REGIONAL INFRASTRUCTURE PLAN

When a wires-only or transmission-based approach is determined to be the optimal solution for a planning need, a RIP is initiated. The transmitter leads this process.

A RIP can be initiated:

1. Following the Scoping Assessment: If it is determined that alternative resources cannot meet the needs.
2. During the IRRP process: If analysis indicates that a wires-only solution is part of the near-term solution.
3. Upon completion of the IRRP process: If it is determined that a wires-only solution is part of

the overall integrated solution for the region or sub-region.

The transmitter will identify the LDCs and other agencies that need to be involved in the planning studies for the RIP.

Preliminary results from the current IRRP suggest that a mix of wires-based and NWSs may be required to address capacity constraints within the region. Once confirmed, the RIP will be initiated.

4.5. RENEWABLE ENERGY GENERATION COORDINATION

Hydro Ottawa's Distribution System Plan (DSP) for 2026-2030 does not include any specific projects focused on Renewable Energy Generation (REG) under Hydro Ottawa's direct responsibility. While the plan considers integrating renewable energy sources into the grid, it does not currently include provisions for Hydro Ottawa to own, operate, or develop renewable energy generation facilities, such as solar farms, biomass, natural gas, landfill gas generators, or wind turbines. Therefore, Hydro Ottawa confirms that there are no REG investments in the region, and as such a letter from the IESO in support of renewable energy generation investments in the region has not been submitted as part of this Application.

Although Hydro Ottawa is not directly involved in REG projects, the utility actively participates in collaborative initiatives to support renewable energy integration. For example, Hydro Ottawa collaborates with the IESO and Hydro One to develop optimal solutions for transmission and bulk system needs within the Ottawa area as part of the IRRP. These solutions encompass conservation, demand management, distributed generation (including renewable generation), large-scale generation, transmission, and distribution. Work on the IRRP began in 2023 and is expected to be completed in the first quarter of 2025.

Additionally, Hydro Ottawa collaborates with the IESO and federal funding agencies (e.g. NRCan) to launch local programming for Hydro Ottawa customers, including programs like the

Ottawa DER Large Solar PV Funding Incentive, which offers financial incentives for the installation of large solar PV systems for facility load displacement. These collaborative efforts are described in detail in Section 2.4 of Schedule 1-4-1 - Customer Engagement Ongoing.

Lastly, Hydro Ottawa collaborates with customers by reviewing renewable generation requests to determine the most suitable connection for their projects. Over the past five years, the Hydro Ottawa service region has experienced substantial growth in connected renewable generation capacity, entirely attributed to grid-connected photovoltaic generators. From 2019 to 2023, almost 300 new renewable DERs were connected under the Net Metering and Load Displacement programs, as detailed in Section 9.3.1 of Schedule 2-5-4 - Asset Management Process.

Hydro Ottawa's active participation in collaborative initiatives and programs with key stakeholders ensures that the electricity grid can meet the demands of a growing population while supporting the transition to renewable energy sources.

5. TELECOMMUNICATION ENTITIES

Hydro Ottawa maintains a strong relationship with the telecommunications (telecom) companies serving Ottawa, as their infrastructure relies on Hydro Ottawa’s poles, ducts and cable chambers. The Building Broadband Faster Act, introduced in 2021, encourages better coordination and quicker permit turnaround times. The legislation’s intention is to provide better internet across Ontario by 2025. Hydro Ottawa consults with telecom companies within its service area on a regular basis through two main channels: the Attachment Process and City of Ottawa engagement, as outlined below in section 5.1 and 5.2, respectively. These consultations ensure timely and efficient coordination during planning and capital project execution. They also ensure telecom companies can rely on Hydro Ottawa's infrastructure to support their services, ultimately providing exceptional service to our customers and their clients. The sections below provide more information and details on those processes.

5.1. ATTACHMENT PROCESS

Hydro Ottawa requires all third parties, including telecom companies and local businesses, to sign an agreement prior to attaching onto its infrastructure. Once an agreement is in place, third parties must go through an attachment permitting process. Third party permits, specifically telecom permits, are submitted daily from various companies and require extensive review prior to approval.

For overhead attachments, the review process allows Hydro Ottawa to assess the structural integrity of the pole in question and plan for the proposed “make-ready work” for Hydro Ottawa to prepare the pole for the attacher. Review of underground attachment permits verifies the existing spacing available in ducts and cable chambers to ensure the telecom has adequate space. At this stage, the permit can be rejected, sent back to the telecom for revision or accepted based on the extent of the permit and make-ready work.

Make-ready work can vary from moving a Hydro Ottawa asset to make room for the telecom’s attachment to replacing a pole for structural reasons. When extensive make-ready work is required, planning is undertaken to optimize work execution through a design project or further discussed with the telecom to incorporate their plans into upcoming projects.

Additionally, Hydro Ottawa provides telecom companies with notice of any upcoming work that may affect attachments to give them an opportunity to relocate or upgrade their infrastructure. As per the existing telecom agreements, telecoms are given a minimum 60 days notice prior to pole replacement, and this occurs for every pole replacement regardless of whether it’s a large project or a single pole replacement. Depending on the nature of the work, for example projects involving poles not owned by Hydro Ottawa as discussed in section 3.3.2 of schedule 2-5-8, a joint-use coordination meeting will be held during the preliminary design process. A second example would be for upcoming OH Distribution Asset Renewal programs relating to Pole Renewal projects, as discussed in Section 3 of Schedule 2-5-7, where Hydro Ottawa will incorporate a third party consultation into the design phase to ensure telecom companies are aware and notified of upcoming changes to infrastructure. This consultation includes reaching out to the local planning contact for any affected telecoms, organizing planning and field meetings, and discussing the nature of the work including reviewing design drawings and proposed timelines. It should be noted that worst-case pole loading for telecom attachments are considered, that being 3 coaxial attachments per pole with maximum overlashing per attachment allowed through the Canada Standards Association (CSA), when sizing new poles. Additionally, adequate telecom spacing on new pole installations is incorporated into construction standards to ensure telecoms have adequate spacing and support, however consultations provide an opportunity for project specific coordination. Additionally, a joint use trench was approved through the City of Ottawa in 2022 to provide adequate underground spacing for all utilities in new residential areas and reduce time delays in coordinating clearances.

The attachment process is curated to ensure that telecom needs are supported by Hydro Ottawa through day-to-day processes, and that they are given an opportunity to incorporate their service planning into upcoming projects. The input received through the attachment process has an effect on DSP planning, as discussed in section 7, and is considered in Hydro Ottawa operations - for example, ensuring that telecom companies have adequate space on the poles and within ducts and maintenance chambers, and infrastructure is sized to properly support telecom infrastructure.

5.2. ENGAGEMENT THROUGH COORDINATION PLATFORMS

Hydro Ottawa partakes in several coordination platforms hosted by the City of Ottawa which provides an opportunity for utilities, including Telecommunication entities, in Ottawa to discuss upcoming projects, planning and initiatives. The main platforms that Hydro Ottawa participates in are the Utility Coordination Committee (UCC), Municipal Consent Circulations and the Central Registry Sub-Committee.[2]

As discussed in section 6.3, Hydro Ottawa meets on a monthly basis with utilities in Ottawa including Bell Canada, Rogers, and Telus through the City of Ottawa's UCC. These meetings address Municipal Consent applications, road cut permitting, locates, planning, capital projects, by-laws and forestry. In 2024, Hydro Ottawa provided an update monthly on outstanding telecom attachments, which led to frequent consultation meetings between Hydro Ottawa and the common attachers - Rogers and Bell Canada. Hydro Ottawa and Rogers met on February 13 2024, April 16 2024, August 22, 2024 and September 11 2024, and have bi-monthly meetings set up beginning in May 2025. Hydro Ottawa and Bell Canada met October 1 and 17 2024, December 6 2024, April 9 2025 and have monthly touch point meetings set beginning in May 2025.

The UCC goes hand in hand with municipal consent Circulations, which is a permitting program run by the City of Ottawa to ensure all utilities agree and coordinate prior to work commencing in the road right-of-way. Municipal consent applications are circulated to all UCC members to review and require approval before construction starts, allowing Hydro Ottawa to consult with telecom companies in Ottawa to ensure their work is incorporated into project execution and ensure conflicts are resolved. In 2024, Hydro Ottawa reviewed approximately 500 circulations - each circulation providing a confirmation of Hydro Ottawa underground infrastructure and pole locations, along with standards, clearances and notices relating to clearances from infrastructure. On rare occasions, the circulation can be rejected due to clearance issues but will be resolved through further discussion. The circulations are reviewed by the design team to notify of any upcoming projects and returned to the utility within 2 weeks. A new requirement in

[2] For more information regarding the City of Ottawa Municipal Consent and Utility Circulations including process and requirements, please refer to: https://ottawa.ca/en/planning-development-and-construction/construction-right-way/municipal-consent-and-utility-circulations#

2024 required utilities to provide any plans for the next 3 years within the municipal road right of way, allowing for further project consultation opportunities with telecoms.

Finally, Hydro Ottawa partakes in a data sharing program through the City of Ottawa Central Registry (CR) UCC Sub-Committee, which includes telecoms such as Bell Canada, Rogers, Telus, Fibrenoire, Zayo, Flex Networks and Videotron. Hydro Ottawa exports existing underground infrastructure locations three times a year, and in return receives an export of other utility infrastructure that is uploaded into Hydro Ottawa's Geographic Information System (GIS). The CR information is incorporated into design processes, MC applications and construction drawings, allowing for further consultation efforts should a conflict occur. The sub-committee meets on a quarterly basis to further discuss data sharing efforts.

Engagement with telecoms has an impact on planning upcoming projects, as discussed in section 7 below, as lack of coordination could cause delays or duplication of efforts to support telecom programs.

Hydro Ottawa relies on the two channels described above to gain extensive and ongoing consultation with telecommunication companies that ultimately feeds into ongoing work as well as the DSP. As noted, Hydro Ottawa considers all feedback received through the abovementioned venues when making capital plans.

6. OTHER UTILITY AND STAKEHOLDER COORDINATION

6.1. CITY OF OTTAWA OVERVIEW

Hydro Ottawa meets annually with the City of Ottawa's Planning Group to review new site plan circulations (see Section 6.2 - City of Ottawa Development Application Circulations) to receive updates on city standards and planning requirements. Hydro Ottawa also uses these meetings to inform the City of its standards and other requirements, and to impart to planning staff a better understanding of the local distribution system.

Hydro Ottawa engages with City of Ottawa right-of-way management personnel on a quarterly basis to discuss current and planned capital programs; municipal consent guidelines and circulation status; as well as road-cut permitting for new local, collector, and arterial roads. This has served to improve communication and information-sharing, while better coordinating required work that impacts for both parties. Hydro Ottawa also participates monthly in meetings of the City of Ottawa's Utility Coordinating Committee (UCC), where participants (including other utilities) can table issues of shared relevance. See Section 6.3 for further details.

Hydro Ottawa meets annually with the City of Ottawa's Building Department to discuss Ontario Building Code changes impacting new residential subdivision servicing, issues with overhead clearances between buildings and power lines, and opportunities to improve collaboration. These interactions have supported the smooth implementation of new requirements, for example, those relating to electric vehicle servicing for new homes.

Further engagement with the City of Ottawa takes place in the context of multi-stakeholder forums such as the IRRP Decarbonization Sub-Working Group, established through the IRRP process. The City of Ottawa was an active stakeholder throughout this process. Refer to Section 4.3.1 for further information.

6.2. CITY OF OTTAWA DEVELOPMENT APPLICATION CIRCULATIONS

The City of Ottawa requires all construction activities within their rights-of-way to be coordinated with stakeholders. This allows utilities to consent to the proposed work or upcoming developments as well as to flag any potential efficiencies or issues.

The municipal consent process requires each utility to submit an application to the City of Ottawa for review. Once the application is approved by the City of Ottawa, the proposed plan is circulated to each utility for 15 days for their review and approval. The types of applications typically seen during this process include:

- **Site Plan Control** - Proponent's development plans for a single site
- **Zoning By-Law Amendment** - Proponent seeking to change individual lot zoning to allow for a development
- **Lifting of Holding By-law** - Municipality removing lot restriction(s) that block development
- **Official Plan** - High-level development plans
- **Demolition Control** - Proponent's demolition plans for a single site
- **Plan of Condominium** - Development plan for condominium
- **Plan of Subdivision** - Development plan for subdivision
- **Community Design Plans** - Neighborhood/community development plan
- **Road/Street/Lane Closure** - Changes in road layout
- **Heritage Applications to be considered by Council** - Proponent seeking heritage status for a premise, so as to circumvent zoning/laws

Typical comments from Hydro Ottawa include: limits of approach notifications, safety notices, permitting required, standards that must be met, and any coordination that should be taken with Hydro Ottawa.

6.3. CITY OF OTTAWA UTILITY COORDINATING COMMITTEE

The City of Ottawa hosts a monthly UCC meeting. This meeting helps ensure safe and efficient construction management within the rights-of-way. It also provides an opportunity to discuss common issues, announcements and helpful information. The committee members are: City of Ottawa, Hydro Ottawa, Hydro One, Heavy Construction Association, Enbridge Gas Distribution, Birch Hill Telecom, Bell Canada, Rogers Cable Communications, Telus Communications, Zayo Group, the Provincial and Federal Government, Flex Networks, South Nation Conservation Authority, Rideau Valley Conservation Authority, Hiboo Networks, Ontario One Call, Canada Post, NAV Canada, and National Capital Commission.

The main topics of discussion are as follows:

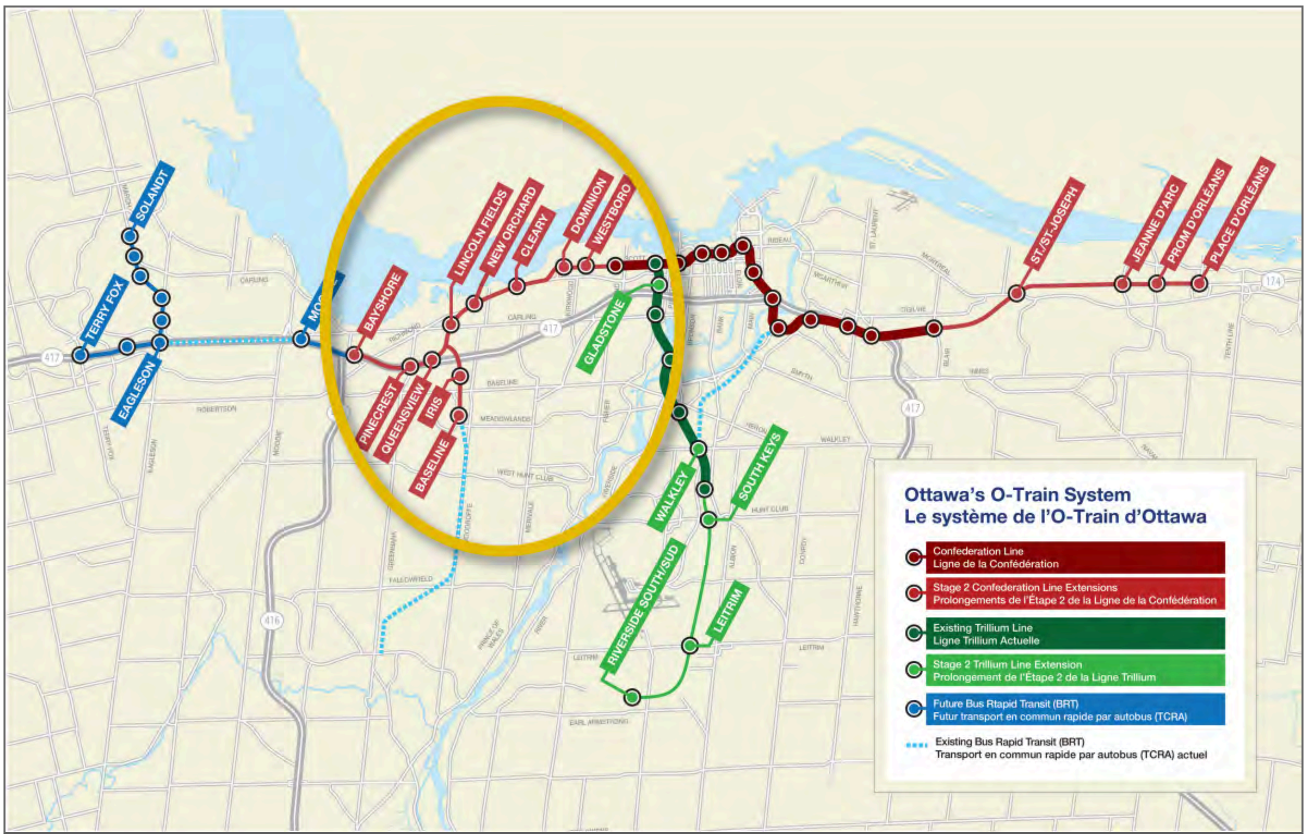
- Joint planning of construction activities
- Setting technical standards
- Steps to protect plant
- Providing a quick communication network
- Maintaining a central registry of underground utilities
- Resolving disputes between the parties
- Assisting the road authority with issues related to utility permit processes

This coordination does not directly impact the DSP, but rather is a part of day-to-day Hydro Ottawa coordination to ensure alignment with other local stakeholders and ensure safety, efficiency, and consistency.

6.4. OTTAWA LIGHT RAIL TRANSIT

The Ottawa LRT system expansion is an ongoing project aimed to improve transit connectivity and capacity in the City of Ottawa. Currently, the project is on Stage 2 which will extend the electrically-powered Confederation Line further to the west and east, and the diesel-powered Trillium Line further south, as shown in Figure 1. Stage 2 is expected to be completed by 2027, with Stage 3 being actively planned while funding options are explored.

Figure 1 - City of Ottawa Confederation Line and Trillium Line Extensions[3]



[3] City of Ottawa, Confederation Line West Light Rail Transit (LRT) Extension, https://ottawa.ca/en/parking-roads-and-travel/transportation-planning/environmental-assessment-completed-projects/confederation-line-west-light-rail-transit-lrt-extension

Hydro Ottawa is actively engaged in the project since the expansion requires upgrading and installing electrical infrastructure to service LRT stations and equipment, as well as relocating existing underground and overhead infrastructure within the planned LRT route to avoid conflict. This requires an electrical servicing strategy that is coordinated with the City of Ottawa and project contractors.

The development of the DSP has accounted for the impacts and planning considerations of LRT construction. For example, the Asset Management Process includes distribution load growth and station cable upgrades as well as the proposed forecasts for the plant relocation and upgrade program under System Access, which aligns with major City of Ottawa transportation projects. Please refer to Schedule 2-5-6 - System Access Investments for further details.

6.5. CITY OF OTTAWA'S RENEWABLE ENERGY STRATEGY – ENERGY EVOLUTION

The City of Ottawa initiated the development of a renewable energy strategy called "Energy Evolution" in 2015. The strategy aims to manage energy consumption, promote renewable energy use, and advance local economic development opportunities in Ottawa.

The City of Ottawa approved the Climate Change Master Plan in January 2020, which led to the full approval of the Energy Evolution strategy in October 2020 as one of the plan's priorities. The Climate Change Master Plan focuses on reducing community greenhouse gas (GHG) emissions by 100% by 2050 and corporate GHG emissions by 100% by 2040. It sets short-term targets of a 43% and 30% reduction, respectively, by 2025, and mid-term targets of a 68% and 50% reduction, respectively, by 2030. These targets align with the Intergovernmental Panel on Climate Change goal of limiting global warming increases to 1.5℃.

Achieving the long-term goals requires five sectors to meet this 100% target: land use and growth management, new and existing buildings, transportation, waste and renewable natural gas, and electricity. The master plan outlines projects and opportunities with two main focuses: GHG mitigation efforts and climate adaptation/resilience efforts.

Under the Energy Evolution strategy, the projected community wide GHG emission reductions required to achieve the long term goal is 6.5% in 2030 and 8.5% in 2050. Also impacting the sector are 2025 goals to increase EVs to 7% of all personal vehicle sales, increase EVs in commercial fleets to 18%, increase OC Transpo's passenger fleet to 48% zero emission, and transition 20% of residential and corporate buildings to heat pumps.

Due to the substantial increase in electrical load and required capacity, Hydro Ottawa has been actively involved in the Energy Evolution initiative since it began in 2017. The targets from the Energy Evolution initiative were considered in the Decarbonization study, which is summarized in Section 9.4.2.1 of Schedule 2-5-4 - Asset Management Process. This study explores the impact on the distribution system as electrification increases to meet 2050 goals.

6.6. CONTRACTORS AND LARGE DEVELOPERS

Hydro Ottawa recognizes contractors and large developers as crucial partners in delivering electricity services and treats them as valued customers. Hydro Ottawa's engagement strategy focuses on fostering strong relationships and ensuring efficient project execution.

For contractors, Hydro Ottawa emphasizes clear communication of technical specifications, predictable cost management through transparent estimates and tracking, and readily available crews (including after-hours support). The aim is to streamline processes like easement registration and change requests, reduce scheduling lag times, and provide easy online access to essential information like standards and documentation. To maintain open communication, Hydro Ottawa actively engages with electrical contractors through industry associations like the Ontario Electrical League (OEL) and the Electrical Contractors Association of Ottawa (ECA Ottawa), using these platforms to disseminate information about regulatory updates, safety developments, and procedural changes.

Similarly, Hydro Ottawa collaborates with builders and developers through the Greater Ottawa Home Builders' Association (GOHBA). Beyond these associations, Hydro Ottawa has established direct engagement mechanisms, including regular coordination meetings with contractors, architects, and developers, which have already led to improvements in project communication, development plans, and intake. Looking ahead, Hydro Ottawa plans to reinstate in-person coordination meetings and developer forums to further enhance communication, address shared concerns, and inform stakeholders about important updates related to personnel, policy, costing, and service level agreements.

This multi-faceted approach demonstrates Hydro Ottawa's commitment to collaboration and continuous improvement in its interactions with these key stakeholders.

6.7. INDUSTRY WORKING GROUPS CEATI

Hydro Ottawa collaborates with organizations like Centre for Energy Advancement through Technological Innovation (CEATI) to share information, advance common goals, and support a sustainable and reliable electricity system.

CEATI provides technology solutions to electrical utility participants. Utility participants can benefit from networking, sharing information, industry benchmarking and cost-sharing on asset technical projects.

Hydro Ottawa participates in several CEATI programs such as Protection & Control, Distribution Line Asset Management, Station Equipment Asset Management, Advanced Distribution Operations, Energy and Integration Strategy, Grounding and Lightning, and Power Quality. Knowledge sharing with other power distribution utilities to solve technical issues allows Hydro Ottawa to enhance its system and provide higher levels of reliability at lower cost.

7. PLANNING COORDINATION EFFECTS ON DSP

Effective planning coordination among customers, regional planning authorities, telecom entities, other utilities and stakeholders is crucial for successful planning of the distribution system. Collaboration and communication enable comprehensive planning, efficient infrastructure development, and the integration of DSP into the overall urban fabric. This coordination ensures that plans align with regional priorities and development, minimizes conflicts with existing infrastructure, and effectively addresses the needs of diverse stakeholders, including Hydro Ottawa customers. Due to the efforts discussed in section 5, telecom consultations have an impact on planning programs including overhead renewal, underground renewal, corrective renewal and distribution enhancements.

The pole renewal program listed in Section 3.1 of Schedule 2-5-7 requires coordination efforts with telecoms attached to all identified poles that will be replaced. Joint use meetings and transfer notifications for existing attachments to new poles will be coordinated as required, as well as cross referencing projects when reviewing permit applications to coordinate timing.

Underground cable and civil renewal work discussed in section 4.1 of Schedule 2-5-7 that identifies telecom attachments within Hydro Ottawa UG infrastructure will require coordination to adjust attachments and relocate as required. It should be noted that UG infrastructure projects by Hydro Ottawa will require an MC application to UCC members, providing another route of consultation with affected telecoms.

Corrective renewal of pole and UG civil and cable replacement mentioned within Section 6 of schedule 2-5-7 will require coordination with telecoms as required. Although emergency renewal projects are not planned, existing telecom needs will be considered while replacing assets to ensure their infrastructure is not affected. Emergency replacements and damage to plants, for example a pole hit by a car, are well coordinated with telecom emergency contacts to ensure effective cooperation and reduce service loss to telecom customers. Critical renewal replacements will be coordinated in advance where possible.

As referenced in Section 3 of Schedule 2-5-8 - System Service Investments, Critical Overhead Lines on Poles not owned by Hydro Ottawa and Strategic Grid Infrastructure enhancements require third party coordination with utilities that own poles in which Hydro Ottawa infrastructure is installed on, specifically with Bell Canada. These meetings typically occur when a pole replacement is in question. These meetings are held to discuss ownership and access to the poles, and potential ownership transfers between parties. These meetings also address ensuring adequate pole loading for new poles during design, and ensuring proper easements for work and access are obtained. Additionally, joint use meetings, applications and planning discussions as permitted through the third party agreement, (such as submitting Authorization for Billing) and Request for Joint Use Work forms, are required to prevent delays and ensure adequate infrastructure integrity. Bell Canada owns approximately 15% of utility poles within the Hydro Ottawa service territory with Hydro Ottawa infrastructure attached, therefore, proper consultation during critical replacement and grid infrastructure enhancements is extremely important.

March 14, 2025

Margaret Flores,
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Via email: margaretflores@hydroottawa.com

Dear Ms. Flores,

Subject: Regional Planning Status – Hydro Ottawa Service Area

This letter is in response to your request for a Planning Status letter. For the purposes of regional planning the province has been divided into 21 regions. A map showing details with respect to the 21 regions[1] and the list of Local Distribution Companies (LDCs) in each region are attached in Appendix A and B respectively. Hydro One Networks Inc. is the lead transmitter in 20 regions and Hydro Ottawa's service area belongs to the Greater Ottawa Region covering Ottawa, Kanata, Nepean, Goulbourn and Gloucester.

Hydro Ottawa load is supplied by Albion TS, Almonte TS, Bilberry Creek TS, Bridlewood MTS, Cambrian MTS, Carling TS, Centrepoint MTS, Cyrville MTS, Ellwood MTS, Nepean Epworth MTS, Fallowfield DS, Hawthorne TS, Hinchey TS, Kanata MTS, King Edward TS, Limebank MTS, Lincoln Heights TS, Lisgar TS, Manordale, MTS, Marchwood MTS, Moulton MTS, Merivale MTS, Nepean TS, Orleans TS, Overbrook TS, Richmond MTS, Riverdale TS, Russell TS, Slater TS, South Gloucester DS, South March TS, St Isidore TS, Terry Fox MTS, Upland MTS and Woodroffe TS in the Greater Ottawa Region.

This letter confirms that the second cycle of the Regional Planning process for the Greater Ottawa region was completed in December 2020. The current third regional planning cycle is currently underway, and the Needs Assessment (NA)[2] report was completed in December 2022 followed by the Scoping Assessment (SA)[3] in March 2023. The Integrated Regional Resource Planning (IRRP) phase is underway and scheduled for completion in March 2025. The final phase of the regional planning process, the Regional Infrastructure Plan (RIP) phase, will follow the completion of the IRRP in Q4 2025.

A summary of the regional planning status, including needs and plans currently identified (up to and including the 3rd cycle Needs Assessment and preliminary results from the ongoing Integrated Regional Resource Plan) in the Greater Ottawa region that affects Hydro Ottawa's service area is provided below. Also please note that, the effect of electrification, decarbonization, and the connection of large scale industrial and commercial customers growth in the region exceeds all historical projections. For example, the winter Gross electricity demand is expected to increase significantly and can double in the next

[1] Hydro One Regional Planning
[2] Greater Ottawa Needs Assessment
[3] Greater Ottawa Scoping Assessment

ten years. This will result in additional needs that will be identified during the next stages of the current and future regional planning cycle.

The previous regional planning cycle and the 3rd cycle Need Assessment identified the following needs:

Supply/transformation capacity need:

- Merivale TS: The need for additional 230/115kV auto-transformation capacity at Merivale TS was assessed. It is recommended to replace autotransformer T22, six (6) 230kV circuit breakers and four (4) 115kV circuit breakers, and the installation of a new autotransformer T23. This project is currently underway with planned in-service date of project is 2029.

- Piperville MTS: A new station was recommended to address the growing demand in the city's southeast and to address overloads at Leitrim MS. The project is ongoing with in service planned in February 2026 and with Hydro Ottawa building the transformer station and Hydro One providing connection to the transmission circuit.

- Mer Bleue MTS: An IESO-led study initiated in 2022 has reviewed different options to address the load growth in the east end of the city. From the findings of the study, the recommendation of the previous planning cycle completed in 2020 has changed and it was determined that, based on the expected demand new transformation capacity supplied from the 230kV network is required. It was also determined that Bilberry Creek TS, a 115kV supplied station, is no longer required and will be retired. The station will be replaced by a new Hydro Ottawa owned station to serve Hydro Ottawa's load. This new station is scheduled to be in-service in 2027. Included also as part of the recommendation is the conversion of Orleans TS to a 230kV DESN and the construction of a new 230kV circuit. The decommission of Bilberry and load transfer to the new Mer Bleue station to 230kV supply will also help preserve capacity on the 115kV system which is nearing its limit.

Asset renewal need:

- Russell TS: The two 45/60/75 MVA transformers T1 and T2 were installed in 1975 and 1971 respectively and they need to be replaced. Project for replacement of transformers T1/T2 is underway and is being led by Hydro One in coordination with Hydro Ottawa. The transformers will be upgraded with 60/80/100MVA units. The planned in-service date of project is 2027.

- Albion TS: The existing transformers T1 and T2 are rated at 75MVA each, were built in the 1970s, and have been identified for replacement with new closest standard size 60/80/100 MVA units. All existing Hydro One owned circuit breakers will be replaced with breakers of similar rating. The planned in-service date of project is in 2031.

- S7M Line refurbishment: The 115 kV circuit, spread across several S7M line sections totaling 6.5 km, have been identified at or near their end of service life. It was suggested to replace conductors, wood poles, insulators, and other components. Some sections are considered for upgrades, which Hydro Ottawa, Hydro One, and IESO are working together to determine the preferred plan. Once selected, the plan is expected to start in the near term over the next five years.

- South March TS: The station has two 230kV/44kV, 50/67/83MVA transformers that were in-serviced in 1971 and based on their asset condition need replacement. Technical Working Group is reviewing if the transformers should be replaced with similar 50/67/83MVA units or if the size should be upgraded to 75/100/125MVA units. Based on the forecast, the station capacity is expected to be reached by 2027 for both summer and winter. Hydro Ottawa, Hydro One Distribution and Hydro One Transmission will work together to determine the appropriate timing for the replacement and upgrade.

- Lisgar TS: There are two T1/T2 115kV/13.8kV, 45/60/75MVA transformers at the station. Transformer T1 was in-serviced in 1974 and based on its asset condition it needs replacement. Based on the non-coincident forecast, the station has reached its capacity under summer forecast and is expected to reach capacity in 2027 under the winter forecast. The TWG has reviewed whether the transformer should be replaced with a 45/60/75MVA unit or upgraded to 60/80/100MVA unit. To increase the station transformation capacity, it was determined to upgrade T1 and the LV circuit breakers and LV cables, and to review the need for T2 upgrade. Hydro Ottawa and Hydro One will work together to coordinate the upgrade at the station and the work is expected to start in the short term.

- Riverdale TS: this is a 115/13.8kV station connected to 115kV circuits A3RM, A5RK, and A6R. The 115kV breakers are identified to be replaced based on asset condition assessment. The planned in-service date of the project is in 2038.

The currently ongoing IESO led Integrated Regional Resource Plan has identified additional needs listed below. As indicated above, the anticipated demand growth is very high compared to the previous cycle. As part of the IRRP study, the working group is assessing non-wire options such as CDM measure and BESS to help meet this demand. The needs listed below are expected to require wire options in addition to non-wire options where feasible.

- Kanata-Stittsville Transformation Capacity. The area was identified as requiring additional transformation capacity in the previous cycle of regional planning which could be mitigated in the short term through load transfer. The recommendation also considered the then ongoing IESO bulk study, which could impact the area supply, before developing a plan for the area. The need was further reviewed during this ongoing cycle of regional planning, and the expected recommendation is a new transformer station and new 230kV transmission circuit in the Kanata area. Based on the forecast, transformation capacity has reached its summer supply limit and is also expected to reach its winter limit by 2026. Plan to upgrade the area is expected to start in the near term with Hydro Ottawa planning to energize the new station in late 2028.

- Downtown Ottawa Transformation Capacity. Several stations in the downtown core are expected to or have reached their capacity based on the forecast. To address this, several recommendations are expected from this cycle of regional planning:
    - Upgrade Bronson MS to a transmission connected station with higher rated transformers. This will provide additional transformation capacity in the city center. The project is expected to be in-service in 2031.
    - Upgrade King Edward TS: Replace aging and limiting circuit breakers and cables at the station to increase the available transformation capacity. Based on forecast, the station capacity is expected to be reached in 2037 in summer, and 2026 in winter.
    - Upgrade Carling TS: Replace limiting cables at the station to increase the available transformation capacity. Based on the forecast, the station capacity is expected to be reached in 2028 in summer, and 2029 in winter.

- West Ottawa transformation: The area directly west of Merivale TS, supplied by Manordale MTS and Center Point MTS, is predominantly supplied by 8kV distribution system. Hydro Ottawa has received some large-scale customer load requests coupled with the transformation capacity being exceeded at nearly all the stations in the area has resulted in a need being identified for new 230kV-28kV station in the short term. Options were reviewed during IRRP, and the expected recommendation is the following
    - Build a new 230kV station in the Greenbank Rd area. Connection of the station would be to circuit E34M and would require a new 230kV circuit from Merivale TS, a distance of approximately 4km. This new transmission line could also be used for further development in the city's west end.

- Cyrville MTS: The 115kV supplied station is expected to have large load increase. Given the station location near 230kV supplies, the TWG as part of the IRRP is proposing to upgrade the station transformation capacity and change its supply to 230kV. This will allow the station to meet its load forecast as well provide relief to other stations through distribution transfers. This conversion to 230kV supply will also help preserve capacity on the 115kV system which is nearing its limit. This plan will start in the near term with targeted energization in 2027.

- Moulton MTS: The existing Cyrville MTS 115kV transformers will be relocated to Moulton MTS to increase the station transformation capacity. This plan will start in the near term with targeted energization in 2027-2029.

- Upgrades to 115kV circuits. Several circuits have been identified as reaching their capacity over the study period. It is expected this cycle of RP will recommend upgrades sections of F10MV, C7BM, M4G, M5G. Upgrade would be required in the mid-term based on the winter forecast.

Capital contribution is expected by Hydro One Networks Inc. from Hydro Ottawa for some of the projects recommended through the regional planning in the Greater Ottawa Region.

Hydro One Networks Inc. would like to acknowledge and thank you for your work and effort in support of the Regional Planning process. We look forward to continuing to work with you in the future. If you have any further questions, please feel free to contact me.

Sincerely,

Ajay Garg,
Senior Manager, System Planning & Regional Planning Coordination

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Appendix A: Map of Ontario's Planning Regions

Northern Ontario

Southern Ontario

Greater Toronto Area (GTA)

Appendix B: List of LDCs for Each Region

[Hydro One as Upstream Transmitter]

Region	LDCs
1. Burlington to Nanticoke	• Burlington Hydro Inc. • GrandBridge Energy Inc. (Formerly Energy+ and Brantford Power) • Alectra Utilities Corporation (Formerly Horizon Utilities Inc.) • Hydro One Networks Inc. (Distribution) • Oakville Hydro Electricity Distribution Inc.
2. Greater Ottawa	• Hydro 2000 Inc. • Hydro Ottawa Limited • Hydro Hawkesbury Inc. • Ottawa River Power Corporation • Hydro One Networks Inc. (Distribution) • Renfrew Hydro Inc
3. GTA North	• Alectra Utilities Co. • Hydro One Networks Inc. (Distribution) • Newmarket-Tay Power Distribution Ltd. • Toronto Hydro Electric System Limited
4. GTA West	• Burlington Hydro Inc. • Hydro One Networks Inc. (Distribution) • Alectra Utilities Co. • Milton Hydro Distribution Inc. • Halton Hills Hydro Inc. • Oakville Hydro Electricity Distribution Inc.
5. Kitchener- Waterloo-Cambridge-Guelph (“KWCG”)	• Alectra Utilities Corporation. • Enova Power Corporation. • Grandbridge Energy Inc. • Centre Wellington Hydro Ltd. • Hydro One Networks Inc. (Distribution) • Halton Hills Hydro Inc. • Wellington North Power Inc.

6. Toronto	• Alectra Utilities • Elexicon Energy Inc. • Hydro One Networks Inc. (Distribution) • Toronto Hydro Electric System Limited
7. Northwest Ontario	• Atikokan Hydro Inc. • Fort Frances Power Corporation • Hydro One Networks Inc. (Distribution) • Synergy North • Sioux Lookout Hydro Inc.
8. Windsor-Essex	• E.L.K. Energy Inc. • Entegrus Powerlines Inc. (Chatham-Kent) • EnWin Utilities Ltd. • Essex Powerlines Corporation • Hydro One Networks Inc. (Distribution)
9. East Lake Superior [Hydro One Sault Ste. Marie L.P. is the Lead Transmitter for the region]	• Algoma Power Inc. • Hydro One Networks Inc. (Distribution) • PUC Distribution
10. GTA East	• Elexicon Energy Inc. • Oshawa PUC Networks Inc. • Hydro One Networks Inc. (Distribution)
11. London Area	• Entegrus Powerlines Inc. • ERTH Power Inc. • Hydro One Networks Inc. (Distribution) • London Hydro Inc. • Tillsonburg Hydro Inc.

12. Peterborough to Kingston	• Eastern Ontario Power Inc. • Elexicon Energy Inc. • Hydro One Networks Inc. (Distribution) • Kingston Hydro Corporation • Lakefront Utilities Inc.
13. South Georgian Bay/Muskoka	• Hydro One Networks Inc. (Distribution) • Alectra Utilities • InnPower • Orangeville Hydro • Elexicon Energy • Lakeland Power • EPCOR Electricity Dist. Ontario Inc. • Newmarket-Tay Power Distribution Ltd. • Wasaga Distribution Inc.
14. Sudbury/Algoma	• Greater Sudbury Hydro Inc. • North Bay Hydro • Hydro One Networks Inc. (Distribution)
15. Chatham-Kent/Lambton/Sarnia	• Bluewater Power Distribution Corporation • Entegrus Power Lines Inc. (Chatham-Kent) • Hydro One Networks Inc. (Distribution)
16. Greater Bruce/Huron	• Entegrus Powerlines Inc. • ERTH Power Corporation • Hydro One Networks Inc. (Distribution) • Festival Hydro Inc. • Wellington North Power Inc. • Westario Power Inc.

17. Niagara	• Canadian Niagara Power Inc. [Port Colborne] • Hydro One Networks Inc. (Distribution) • Grimsby Power Inc. • Niagara Peninsula Energy Inc. • Niagara-On-The-Lake Hydro Inc. • Alectra Utilities Co. • Welland Hydro-Electric System Corporation
18. North of Moosonee [Five Nations Energy Inc (FNEI) is the Lead Transmitter for the region]	• Distribution in this region is provided by FNEI
19. North/East of Sudbury	• Northern Ontario Wires Inc. • Hearst Power Distribution Company Limited • North Bay Hydro Distribution Ltd. • Hydro One Networks Inc. (Distribution) • Greater Sudbury Hydro Inc.
20. Renfrew	• Hydro One Networks Inc. (Distribution) • Ottawa River Power Corporation
21. St. Lawrence	• Cooperative Hydro Embrun Inc. • Hydro One Networks Inc. (Distribution) • Rideau St. Lawrence Distribution Inc.

PERFORMANCE MEASUREMENT FOR CONTINUOUS IMPROVEMENT

1. OVERVIEW

Hydro Ottawa's performance measurement framework, outlined within this document, is designed with a strong focus on customer-centric outcomes, guiding strategic planning, capital investments, and core operations. Aligned with the OEB's four key performance outcomes, detailed below, the framework ensures comprehensive performance tracking. Building on this foundation, the 2026-2030 Distribution System Plan (DSP) introduces an enhanced performance framework, emphasizing data-driven decision-making to ensure the delivery of reliable and sustainable electricity services.

2. INTRODUCTION

Hydro Ottawa has developed a comprehensive performance measurement framework that monitors outcomes and continuous improvement in service delivery. This framework, which prioritizes customer-centric outcomes, guides Hydro Ottawa's strategic planning, capital investments, and core operations, which aligns with the OEB *Renewed Regulatory Framework for Electricity Distributors: A Performance Based Approach,*[1] as well as the OEB's *2016 Handbook for Utility Rate Applications*.[2] Further details regarding Hydro Ottawa's Capital Investment Planning Process can be found in Section 5.3 of Schedule 2-5-4 - Asset Management Process.

Furthermore, Hydro Ottawa's plan incorporates all four key performance outcomes identified by the OEB:

- **Customer Focus:** services are provided in a manner that responds to identified customer preferences

[1] Ontario Energy Board, *Report of the Board - Renewed Regulatory Framework for Electricity Distributors: A Performance Based Approach* (October 18, 2012).
[2] Ontario Energy Board, *Handbook for Utility Rate Applications* (October 13, 2016).

- **Operational Effectiveness:** continuous improvement in productivity and cost performance is achieved; and utilities deliver on system reliability and quality objectives;
- **Public Policy Responsiveness:** utilities deliver on obligations mandated by government (e.g., in legislation and in regulatory requirements imposed further to Ministerial directives to the OEB);
- **Financial Performance:** financial viability is maintained; and savings from operational effectiveness are sustainable.

Hydro Ottawa maintains a steadfast commitment to these performance outcomes and diligently monitors its performance. This monitoring is facilitated through a multi-pronged approach consisting of the following:

- **Service Quality Requirements (SQR):** A comprehensive record of historical performance in respect to Service Quality Requirements, as defined in Chapter 7 of the Distribution System Code, as well Service Reliability Indicators are detailed in Excel Attachment 2-5-3 (A) - OEB Appendix 2-G - Service Quality and Reliability Indicators.
- **Electricity Utility Scorecard**: Submitted annually to the OEB to promote transparency and accountability in Ontario's electricity distribution sector, this scorecard tracks key indicators for all distributors, enables comparisons and highlights areas for improvement. The scorecard empowers customers with information about service quality and value, while also informing regulatory oversight and encouraging continuous improvement across the industry. Refer to Attachment 1-3-3(C) - Electricity Utility Scorecard for more details.
- **Custom Incentive Rate (CIR) Report:** This is an annual report submitted to the OEB under the OEB's Decision and Order on Hydro Ottawa's 2021-2025 Custom IR Application,[3] detailing:
    - Capital expenditure performance, including variance analysis and program progress across the four investment categories: system access, system service, system renewal, and general plant.

[3] Ontario Energy Board, *Decision and Order* EB-2019-0261 (November 19, 2020).

- ○ Continuous improvement tracking via Key Performance Indicators (KPIs) specifically designed to enhance operational effectiveness in safety, system reliability, asset management, and cost control. These KPIs fulfill commitments made during the 2021-2025 CIR setting process (EB-2019-0261) and augment existing OEB reporting metrics.
- ○ Performance Outcomes Accountability Mechanism (POAM) reporting, which tracks progress against targets established in Hydro Ottawa's 2021-2025 Approved Settlement Agreement.[4]

Hydro Ottawa's 2026-2030 DSP introduces a performance framework, detailed in Section 6, that prioritizes data-driven decision-making to ensure the delivery of reliable and sustainable electricity services. This framework represents an evolution from previous iterations, leveraging historical performance data and KPIs to inform decisions, drive continuous improvement, and guide investment priorities. This evolution is driven by Hydro Ottawa's transition to a risk-based asset management approach and advancements in data analytics capabilities, enabling a more accurate approach to performance monitoring at the Material Investment Plan (MIP) level.

3. HISTORIC (2021-2025) DSP PERFORMANCE

Hydro Ottawa's 2021-2025 DSP established KPIs to assess and enhance performance across four critical areas: Customer Oriented Performance, Cost Efficiency & Effectiveness, Asset Performance, and System Operations Performance. The KPIs aligned with Hydro Ottawa's Asset Management Objectives, which directly support the organization's Corporate Strategic Objectives.

Utilizing these metrics, Hydro Ottawa monitored the efficacy of its planning processes, identified operational efficiencies and areas for improvement, and evaluated overall performance. This section presents the historical KPI data and explains the results.

[4] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Settlement Agreement*, EB-2019-0261 (September 18, 2020).

Table 1 below provides a categorized overview of the KPIs, aligning them with the corresponding Asset Management Objective and Sub-Category. Furthermore, the table directs the reader to the relevant sections containing detailed descriptions and historical performance data for each KPI.

Table 1 - 2021-2025 DSP KPIs by Category and Asset Management Objective

Category	Asset Management Objective	Sub-Category	KPIs
3.1. Customer Oriented Performance	Levels of Service	3.1.1. Customer Engagement	○ Customer Satisfaction ○ Staff Knowledge ○ Staff Courtesy ○ First Call Resolution ○ Residential & Small Commercial Satisfaction ○ Commercial Satisfaction ○ Staff Helpfulness ○ Value for Money ○ Customer Loyalty
		3.1.2. System Reliability	○ System Average Interruption Frequency Index (SAIFI) ○ System Average Interruption Duration Index (SAIDI) ○ Customer Average Interruption Duration Index (CAIDI) ○ Feeders Experiencing Multiple Sustained Interruptions (FEMI)
		3.1.3. System Power Quality	○ System Average Root Mean Square Variation Frequency Index (SARFI)
3.2. Cost Efficiency & Effectiveness	Compliance	3.2.1 Distribution System Plan Implementation Progress	○ Cost Efficiency
	Resource Efficiency	3.2.2 Labour Utilization	○ Productive Time ○ Labour Allocation
3.3. Asset Performance	Asset Value	3.3.1 Equipment Failure Contribution to SAIFI	○ System Average Interruption Frequency Index – Defective Equipment ($SAIFI_{DE}$)
	Health, Safety & Environment	3.3.2 Public Safety Concerns	○ Public Safety Concerns (PSC)
		3.3.3 Oil Spilled	○ Litres Annual Oil Spilled ○ Cost of Annual Oil Remediation
3.4. System Operations Performance	Levels of Service	3.4.1 Stations Capacity	○ Stations Exceeding Planning Capacity ○ Stations Approaching Rated Capacity
		3.4.2 Feeder Capacity	○ Feeders Exceeding Planning Capacity ○ Feeders Approaching Rated Capacity
		3.4.3 System Losses	○ Losses

Service Quality Requirements

As per Chapter 7 of the OEB's Distribution System Code and Section 2.1.4 of the OEB's Electricity Reporting and Record Keeping Requirements (RRRs), Hydro Ottawa maintains and reports on Service Quality Requirements (SQRs). The SQRs for the last five historical years are included in Excel Attachment 2-5-3(A) - OEB Appendix 2-G - Service Quality and Reliability Indicators.

Hydro Ottawa met all OEB Targets in its SQRs for the last five years, with the exception of "Rescheduling a Missed Appointment" in 2023. Hydro Ottawa experienced an 84-day labour strike from June through September of 2023. During this period, scheduled appointments were cancelled, and customers were notified via email of the cancellations. Hydro Ottawa rescheduled those appointments when regular business operations resumed after the strike, and thus they were not rescheduled within one business day of the cancellation as per Section 7.5.1 of the Distribution System Code.

Other Appointment-related SQRs were also lower in 2023 than Hydro Ottawa's typical performance due to the strike - namely "Appointments Met" and "Appointment Scheduling". However, these as well as all other SQR targets were met in 2023. Hydro Ottawa expects its SQRs related to Appointments to return to normal levels in 2024.

Hydro Ottawa's service territory is a mix of urban and rural, with more than 50% of Hydro Ottawa's service territory considered rural. The administrative complexity of capturing urban and rural response rates, relative to Hydro Ottawa's emergency response rate performance overall, is not cost effective or insightful for Hydro Ottawa. Rather, Hydro Ottawa strives to adhere to the urban emergency response rate (60 minutes opposed to 120 minutes for rural) for both rural and urban customers. Hydro Ottawa notes that in 2023, its Urban Response time shows a downward trend. This is largely attributed to the Freezing Rain and a subsequent Loss of Supply event that took place in April 2023, as described in Section 4.4 below.

Hydro Ottawa confirms that the SQRs as filed in Appendix 2-G are consistent with those SQRs that appear on the Electricity Utility Scorecard.

The following sections detail Hydro Ottawa's performance as laid out in Table 1 above.

3.1. CUSTOMER ORIENTED PERFORMANCE

Hydro Ottawa's KPIs surrounding Customer Oriented Performance align with the asset management objective for Levels of Service, which in the 2021-2025 DSP was defined as "*to maintain and enhance leading performance of the distribution system through improving electrical service and alignment with customers' expectations.*" Specifically, Hydro Ottawa continuously seeks feedback from customers on their satisfaction with the services provided by the utility. The customer satisfaction levels are greatly impacted by the distribution system's service reliability which is integral to all work undertaken as part of system planning. Hydro Ottawa continually assesses system reliability, and where gaps are found, implements appropriate actions to address the issues.

Hydro Ottawa regularly engages with its customers to inform the utility's planning, strategy and decision making. Full details on Hydro Ottawa's ongoing customer engagement efforts can be found in Schedule 1-4-1 - Customer Engagement Ongoing, while details related to the customer engagement undertaken specific to this Application are available in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

3.1.1. Customer Engagement

Hydro Ottawa conducts customer engagement surveys to inform KPIs and drive service improvements. The feedback collected through these surveys provides valuable insights that are used to identify areas for service improvement and enhancement. Two surveys contribute to this process:

- **Annual Electric Utility Customer Satisfaction Survey:**[5] Details regarding this annual survey are available in Section 2.1.1.1 of Schedule 1-4-1 - Customer Engagement Ongoing.

[5] Previously referred to as the "Customer Satisfaction Survey (SIMUL Survey)" in the 2021-2025 DSP.

- **Contact Centre Satisfaction Survey:**[6] Details regarding this survey are available in Section 2.1.2.1 of Schedule 1-4-1 - Customer Engagement Ongoing.

The KPI results over the past five years are presented in Table 2 and Table 3.

Table 2 - Annual Electric Utility Customer Satisfaction Survey

KPI	Target	2019	2020	2021	2022	2023
Customer Satisfaction: Residential & Small Commercial	≥90%	95%	96%	94%	93%	91%
Customer Satisfaction: Large Commercial	≥90%	96%	N/A	N/A	94%	N/A
Staff Helpfulness	≥80%	78%	59%	69%	74%	78%
Value for Money	Result	77%	80%	74%	73%	73%
	Target[7]	77%	82%	74%	73%	74%
Customer Loyalty	Result	50%	51%	43%	47%	48%
	Target[7]	45%	51%	46%	38%	50%

Descriptions of these measures are as follows:

- Customer Satisfaction: measures overall customer satisfaction at the start of the survey;
- Staff Helpfulness: based on a small sample of customers who said they contacted Hydro Ottawa, describes whether a customers' recent concern was addressed in a manner that was useful, providing a solution to the customers' problem. This metric is based on a limited sample of customer contacts and, as such, may not be representative of overall customer experiences.
- Value for Money: Measures perceptions about service quality and value, and is linked to the utility's overall image;
- Customer Loyalty: Measures the degree to which customers are satisfied, would continue to do business with Hydro Ottawa if given a choice, and would recommend Hydro Ottawa to others

[6] Previously referred to as the "TouchLogic Survey" in the 2021-2025 DSP.
[7] The Hydro Ottawa target is defined to be 2% better than Ontario Average.

Table 3 - Contact Centre Satisfaction

KPI	Target	2019	2020	2021	2022	2023
Call Center Customer Satisfaction	≥85%	87%	87%	86%	84%	85%
Staff Knowledge	≥90%	88%	88%	88%	86%	87%
Staff Courtesy	≥90%	87%	88%	87%	86%	87%
First Call Resolution	≥85%	89%	90%	89%	86%	86%

Descriptions of these measures are as follows:

- Customer Satisfaction – the customer's overall level of satisfaction with the call;
- Staff Knowledge – the customer's assessment of the knowledge of the contact centre staff;
- Staff Courtesy – the customer's assessment of the courtesy of the contact centre staff; and
- First Call Resolution – the ability of the staff to deal with the customer's issue.

Hydro Ottawa notes that the Customer Engagement KPIs are used in combination with other ongoing customer engagement activities as described in Schedule 1-4-1 - Customer Engagement Ongoing to assess customers expectations and experiences.

3.1.2. System Reliability

Hydro Ottawa tracks system reliability performance using four indicators: System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI), Customer Average Interruption Duration Index (CAIDI) and Feeders Experiencing Multiple Sustained Interruptions (FEMI). Historical reliability performance is comprehensively detailed in Section 4 below. Hydro Ottawa confirms that the data presented in Appendix 2-G regarding SAIDI and SAIFI is consistent with the OEB's Electricity Utility Scorecard.[8] This data is included in this Application as Excel Attachment 2-5-3(A) - OEB Appendix 2-G - Service Quality and Reliability Indicators.

[8] Noting that the OEB Scorecard presents SAIDI and SAIFI excluding LOS and MEDs.

3.1.2.1. System Average Interruption Frequency (SAIFI)

This information is comprehensively detailed in Section 4.1.

3.1.2.2. System Average Interruption Duration Index (SAIDI)

This information is comprehensively detailed in Section 4.2.

3.1.2.3. Customer Average Interruption Duration Index (CAIDI)

This index, representing the average time required to restore power per sustained interruption, is defined as follows:

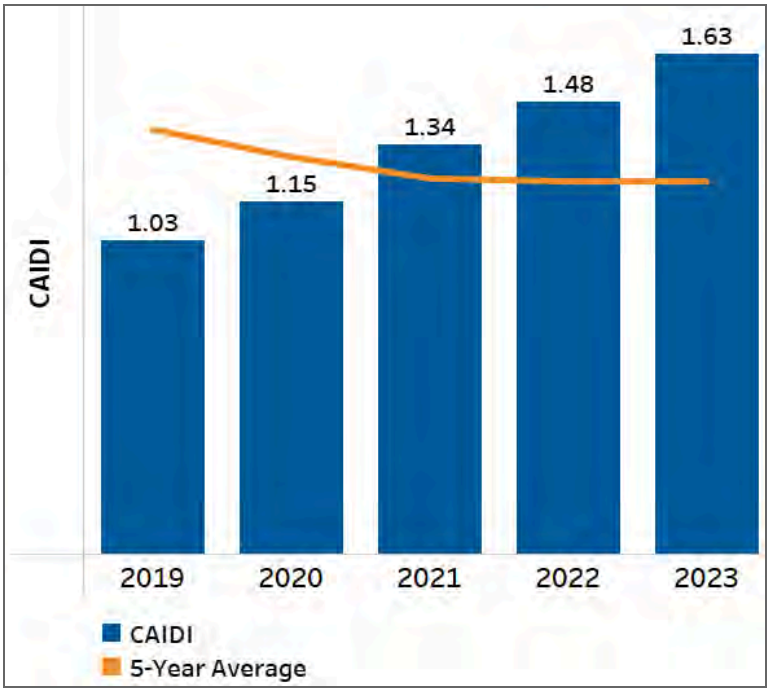
$$CAIDI = \frac{SAIDI}{SAIFI} = \frac{Total\ hours\ of\ customer\ interruptions}{Total\ number\ of\ customer\ interruptions}$$

CAIDI is reported excluding Loss of Supply (LOS) and Major Event Days (MEDs). Please see Table 4 and Figure 1 for the historical results.

Table 4 - CAIDI Reliability Performance

Metric		2019	2020	2021	2022	2023
CAIDI	Excluding LoS & MED	1.03	1.15	1.34	1.48	1.63
	5- Year Historical Average	1.39	1.30	1.23	1.22	1.22

Figure 1 - CAIDI Reliability Performance



Hydro Ottawa monitors the annual trend of CAIDI performance to identify and evaluate potential concerns with restoration efforts. The CAIDI metric exceeded the 5-year historical average for 2022 and 2023 due to the increasing trend of total hours of customer interruptions (SAIDI) and reducing trend of total number of customer interruptions (SAIFI). For analysis of SAIDI and SAIFI refer to Sections 4.1 System Average Interruption Frequency Index (SAIFI) and 4.2 System Average Interruption Duration Index (SAIDI).

3.1.2.4. Feeders Experiencing Multiple Sustained Interruptions (FEMIn)

This index quantifies the number of feeders experiencing sustained interruptions (exceeding one minute in duration) greater than or equal to a value n. Current reporting utilizes n=10, signifying the count of feeders experiencing ten or more sustained interruptions. Hydro Ottawa's performance target is to maintain a $FEMI_{10}$ value less than or equal to 10.

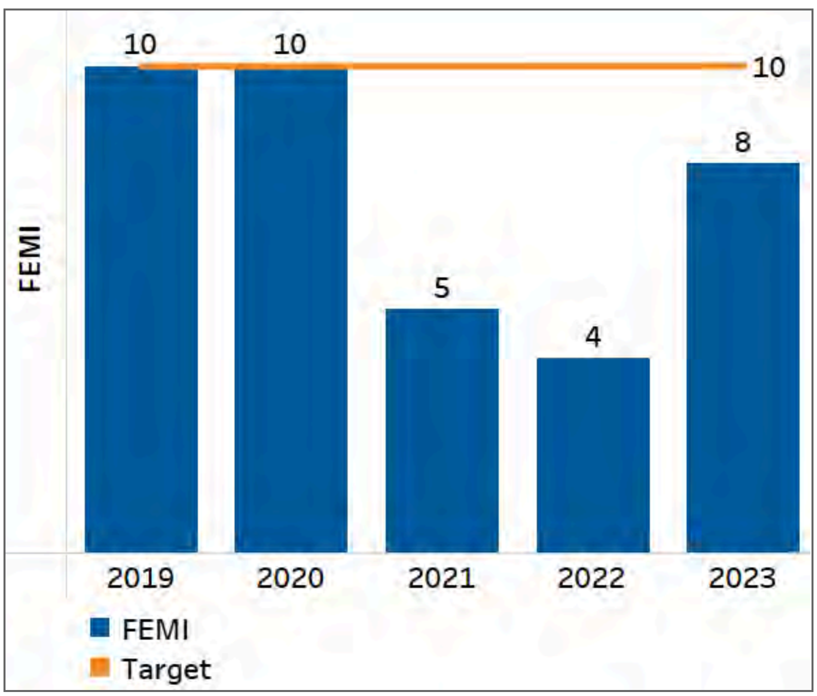
FEMI serves as a customer-centric metric, providing insights into regional variations in service quality. To ensure accuracy and relevance, $FEMI_{10}$ reporting excludes Scheduled Outages, LOS, and MEDs. This exclusion allows for a more focused analysis of system performance and its impact on customers.

Table 5 and Figure 2 show the historical system performance for FEMI.

Table 5 - FEMI Reliability Performance

Metric	Target	2019	2020	2021	2022	2023
$FEMI_{10}$	10	10	10	5	4	8

Figure 2 - FEMI Reliability Performance



Hydro Ottawa achieved its targets for FEMI between the 2019-2023 period. Hydro Ottawa tracks and evaluates feeders that affect the performance of the FEMI metric monthly to identify projects to improve the reliability of these parts of the distribution system. Hydro Ottawa will continue to evaluate the performance of feeders that appear in the FEMI metric to ensure customer reliability is maintained.

3.1.3. System Power Quality

Hydro Ottawa monitors the quality of power supplied to its customers to ensure adherence to service levels outlined in CSA document CAN3-C235-83 for steady-state conditions. With increasing sensitivity of customer equipment to voltage fluctuations, monitoring power quality is a critical aspect of service delivery. To assess power quality, Hydro Ottawa utilizes the System Average Root Mean Square (RMS) Variation Frequency Index (SARFI). This industry-standard metric measures the average number of voltage sags or swells on the system, excluding events originating from the transmission system or third parties.

Hydro Ottawa endeavors to maintain system voltage within ±6% of nominal levels, ensuring compliance with the Information Technology Industry Council (ITIC) curve for acceptable voltage limits. Hydro Ottawa's SARFI performance outcomes for the 2019-2023 period are presented in Table 6, while the 2023 SARFI performance is shown in Figure 3.

Figure 3 - 2023 Power Quality Events ITIC Curve

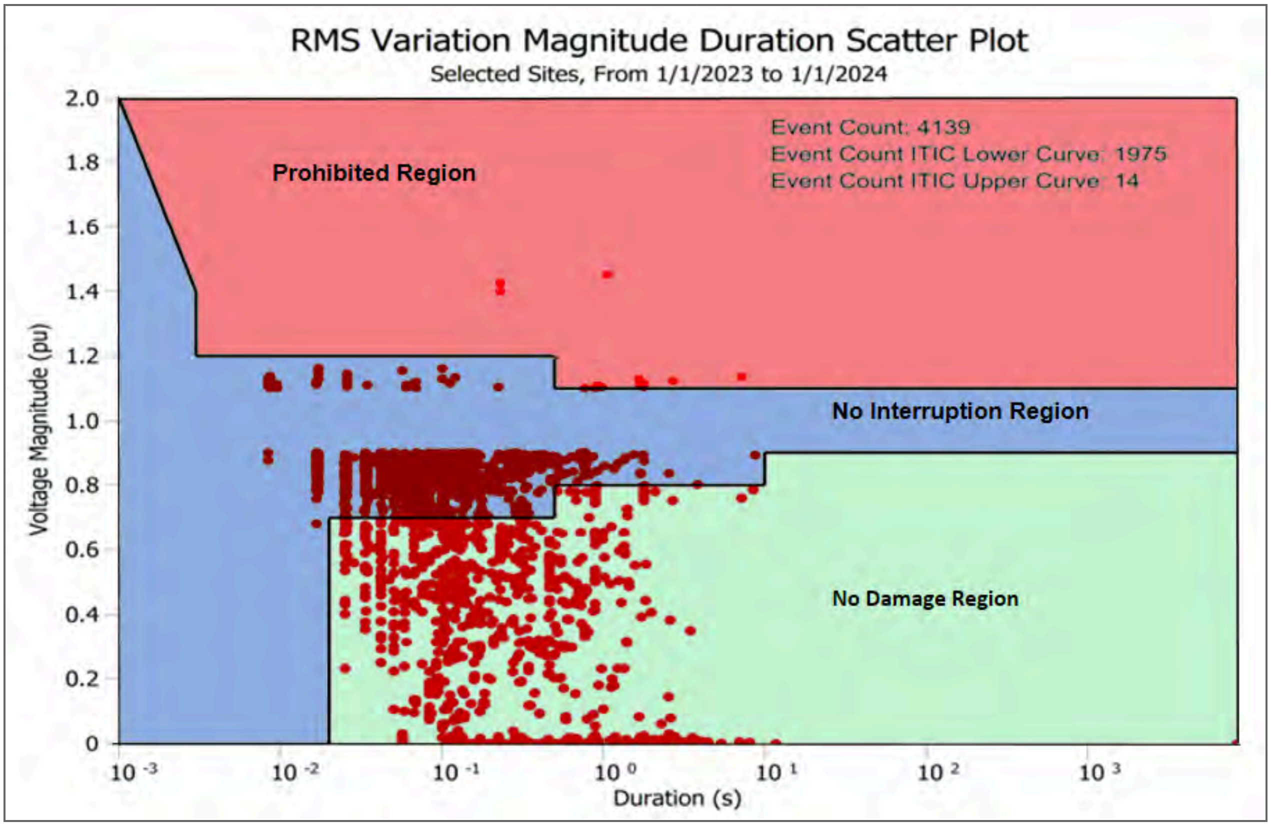


Table 6 - SARFI Performance

Metric	2019	2020	2021	2022	2023
SARFI	10	21	11	20	14

Hydro Ottawa saw SARFI values higher than the 5-year average in 2020 and 2022 due to supply voltage swings upstream (from the transmitter) resulting in a voltage swell event for a short duration until the station transformer tap changer could operate. As illustrated in Figure 4, Hydro Ottawa recorded 4,139 events in 2023, of which 14 fell within the prohibited region of the ITIC curve, with six events caused by Hydro One Networks Inc. (Hydro One) with their tap changer operation/voltage regulation and the remaining attributed to transient fault events on Hydro Ottawa's system. Each year, Hydro Ottawa diligently tracks and monitors SARFI events to identify and address any areas of concern, ensuring that power quality remains within acceptable limits for all customers.

3.2. COST EFFICIENCY & EFFECTIVENESS

Hydro Ottawa conducts annual assessments of its cost efficiency and labour utilization KPIs. This evaluation provides critical insights into the progress, efficiency, and effectiveness of the company's planning processes, as well as the efficiency of plan execution, and supports a continuous improvement framework, data-driven decision-making and operational optimization.

3.2.1. Distribution System Plan Implementation Progress[9]

The Distribution System Plan Implementation Progress (DSP Implementation Progress) KPI measures and reports on the progress of capital projects identified within Hydro Ottawa's DSP. This KPI ensures the company delivers maximum value to its customers by demonstrating the effective execution of essential capital projects necessary for the continued reliable operation of the electricity distribution system. This KPI is publicly reported on the Hydro Ottawa Electric Utility Scorecard under the Asset Management Performance Category and is titled "Distribution System Plan Implementation Progress." Refer to Attachment 1-3-3(C) - Electricity Utility Scorecard Analysis for details.

DSP Implementation Progress tracking focuses on planned capital projects categorized as either system renewal or system service investments. This KPI excludes system access projects, general plant expenditures, and all emergency work. It is calculated as the ratio of the allocated budget for planned capital activities to the actual expenditures incurred annually. The specific formula employed in this calculation is provided below.

$$DSP\ Implementation\ Progress\ (\%) = \frac{Actual\ SS\ \&\ SR\ Expenditures}{Budgeted\ SS\ \&\ SR\ Expenditures} \times 100$$

[9] Previously referred to as “Cost Efficiency" in the 2021-2025 DSP.

The budget and execution of planned capital projects is rigorously managed through Hydro Ottawa's financial system. Any deviations from the projected budget necessitate a formal change request, subject to approval on a case-by-case basis. The target for the DSP Implementation Progress KPI is to achieve 100% completion of the annual planned work within the approved budget. The KPI trend is presented in Table 7.

Table 7 - Distribution System Plan Implementation Progress

KPI	Target	2019	2020	2021	2022	2023
DSP Implementation Progress	100 %	84%	89%	92%	90%	75%

Between 2019 and 2023, inclusive, Hydro Ottawa faced challenges in achieving its target. These challenges were primarily attributed to external factors outside of Hydro Ottawa's direct control, as detailed below.

In 2019, the DSP Implementation Progress was 84%, falling short of the target due to the financial impact of three significant storms in 2018, which necessitated increased spending on emergency repairs and station projects. These reactive investment needs led to a reduction in planned expenditures for 2019 and 2020.

The 2020 DSP Implementation Progress reached 89%. However, the COVID-19 pandemic caused disruptions, requiring deferral of planned work to 2021 in order to accommodate emergency tasks, outage restrictions and constrained labour availability.

In 2021, Hydro Ottawa achieved a 92% DSP Implementation Progress despite the ongoing challenges posed by the COVID-19 pandemic. However, the target of 100% completion remained unmet due to project deferrals necessitated by persistent labor and material shortages, as well as outage restrictions.

In 2022, the DSP Implementation Progress decreased to 90%. This was attributed to project deferrals necessitated by emergency restoration work following severe storms one of which being the Derecho, compounded by ongoing labour and material availability challenges.

The year 2023 saw a significant drop in the DSP Implementation Progress to 75%. This was primarily attributed to an 84-day labour strike, which posed a major obstacle, causing delays across all planned programs. This disruption necessitated re-prioritization efforts and deferral of projects to 2024.

3.2.2. Labour Utilization

Hydro Ottawa conducts annual assessments of its labour utilization KPIs to monitor and report on the progress, efficiency, and effectiveness of plan execution, while also identifying areas for continuous improvement. This practice enables Hydro Ottawa to demonstrate efficient resource allocation and responsible stewardship.

To evaluate labour utilization performance, Hydro Ottawa tracks productive time and labour allocation KPIs. This data-driven approach facilitates ongoing optimization of workforce deployment and operational efficiency.

3.2.2.1. Productive Time

Productive time is defined as the ratio of total regular hours charged to a work order (billable) to the total regular hours available per year. The formula for calculating productive time is as follows:

$$Productive\ Time\ =\ \frac{Percent\ of\ Billable\ Hours}{Total\ Regular\ Hours}$$

It is important to note that this KPI is influenced by hours allocated for training, vacation, and sick time. Additionally, it does not account for work completed using overtime. Table 8 presents the trend in productive time over the past five years. This historical data provides valuable context for evaluating current performance and identifying opportunities for improvement.

Table 8 - Productive Time

KPI	2019	2020	2021	2022	2023
ProductiveTime	72%	69%	73%	69%	73%
Target	≥74%	≥74%	≥72%	≥72%	≥73%

Hydro Ottawa's productivity time performance between 2019 and 2023 has fluctuated relative to its established targets.

In 2019, a 72% productivity time was achieved, slightly below the 74% target but consistent with the previous year's performance. This minor shortfall was partly attributed to over 3,000 hours dedicated to an administrative work order associated with the company's relocation to new offices, Dibblee and Hunt Club.

The year 2020 saw a productivity time of 69%, not meeting the 74% target and the previous year's performance. This was primarily due to COVID-19 related downtime, implemented to facilitate social distancing measures in the second quarter.

In 2021, a 73% productivity time was achieved, meeting the target.

The year 2022 saw a productivity time of 69%, falling short of the 72% target. Analysis indicates that the observed deviation in the 2022 productivity rate is primarily attributable to a significant increase in non-productive time allocation following the relaxation of COVID-19 related restrictions. Specifically, training activities, deemed essential for staff recertifications and other required skill development, consumed 4,700 hours. Additionally, meeting attendance, including the first all-employee forum since 2019, required 700 hours. These increased allocations of time to non-productive activities consequently decreased the available time for productive work, resulting in the reported shortfall in the productivity rate.

Hydro Ottawa achieved its productivity time target in 2023 with a result of 73%. Notably, the result is calculated based on the number of hours worked, thus the labour strike did not impact the productivity rate for the year.

3.2.2.2. Labour Allocation

Labour allocation is defined as the ratio of labour hours dedicated to maintenance and administrative work versus the total productive time available, as defined in Section 3.2.2.1 above. This KPI aims to quantify the proportion of time spent on operations, maintenance, and administration (OM&A) activities, as outlined in annual work plans, compared to time allocated for capital activities. The formula used in this calculation is provided below:

$$Labour\ Allocation = \frac{Percent\ of\ Labour\ Time\ on\ Maintenance\ and\ Administrative\ Activities}{Total\ Productive\ Time}$$

Historically, this metric represented the amount of labour spent on capital activities as a ratio of total regular hours. However, starting in 2020, Hydro Ottawa has modified this metric in order to support broader performance management objectives. Accordingly, the target under the modified metric is to stabilize the amount of labour allocated to maintenance and administrative work. Table 9 presents the trend in this KPI over the previous five years, offering insights into the dynamic relationship between OM&A demands and capital project execution.

Table 9 - Labour Allocation

KPI	2019	2020	2021	2022	2023
Labour Allocation	N/A	37%	29%	35%	35%
Target	N/A	≤ 34%	≤ 33%	≤ 32%	≤ 32%

Hydro Ottawa's performance results for this KPI between 2019 and 2023 are described below.

In 2019, this was the year that this metric was established, resulting in no comparative result for that year.

The year 2020 saw Labour Allocation result of 37%, exceeding the target of 34%. This was attributed to the impact of the COVID-19 pandemic.

In 2021, Hydro Ottawa achieved its target. This success was attributed to a greater allocation of time towards capital projects and improved operational efficiency compared to the previous year, which was significantly impacted by the COVID-19 pandemic.

However, in 2022, the yearly Labour Allocation increased to 35%, exceeding the 32% target. This was primarily due to an increase in non-capital work, both during and after the Derecho storm, which necessitated extensive repair and restoration efforts.

Lastly, in 2023, the yearly Labour Allocation was 35%, again exceeding the 32% target. This was attributed to capital project deferrals caused by the labour disruption which led to an increase in maintenance activities.

3.3. ASSET PERFORMANCE

Hydro Ottawa employs a comprehensive approach to asset performance monitoring, utilizing three key metrics: defective equipment contribution to SAIFI, public safety concern notifications, and oil spill incidents. These metrics collectively enable Hydro Ottawa to effectively achieve its asset management objectives and proactively mitigate risks within the electricity distribution system. This section provides a detailed examination of each metric, explaining their significance in ensuring system reliability, safety, and environmental responsibility.

3.3.1. Equipment Failure[10] Contribution to SAIFI

Hydro Ottawa adopted "Equipment Failure" as the primary cause code, replacing "Defective Equipment", for reliability reporting. This change aligns with the OEB updates to the RRRs. The OEB amended the RRRs in November 2022 to improve interruption reporting detail and usefulness by updating primary and secondary cause codes.[11] Hydro Ottawa implemented the updated primary cause codes on January 1, 2023, and subsequently implemented the updated secondary cause codes on January 1, 2024.

This KPI specifically tracks the contribution of equipment failure outages by asset class to the overall SAIFI (including MEDs) per 100 customers (SAIFI x 100). Hydro Ottawa's target is to achieve year-over-year reductions in customer interruptions caused by equipment failure, employing a rolling average of the previous five years to establish the annual target.

SAIFI, detailed in Section 4.1, serves as a critical metric for Hydro Ottawa in its pursuit of enhancing service levels, optimizing asset value, and improving resource efficiency. By analyzing the contribution of equipment failure outages by asset class to the overall SAIFI, Hydro Ottawa is able to identify assets contributing to multiple outages, allowing for targeted interventions and a more focused approach to addressing issues directly impacting customers.

Each asset class plays a role in the overall SAIFI reliability metric. Table 10 provides a detailed breakdown of each asset class's contribution to the SAIFI x 100 value, facilitating a comprehensive understanding of system performance and areas for potential improvement. The target has been derived from the 2014-2018 average.

[10] Previously referred to as “Defective Equipment " in the 2021-2025 DSP.
[11] Ontario Energy Board, *Notice of Amendments to RRR 2.1.4.2 System Reliability*, EB-2021-0307 (November 21, 2022).

Table 10 - Equipment Failure SAIFI per 100 Customers

Asset – SAIFI x 100	Target	2019	2020	2021	2022	2023
Overhead Assets	10.12	5.20	11.64	9.11	15.73	7.49
Station Assets	1.67	0.35	1.93	0.32	1.25	0.27
Underground Assets	11.16	13.27	11.95	9.26	11.26	4.17

Customer interruptions caused by Overhead and Underground Assets have generally decreased since 2020. The exception was 2022, due to extreme weather events, particularly the Derecho. Through 2019-2023, overhead interruptions were mainly due to the failure of overhead switchgear, transformers and conductors. Underground interruptions were primarily caused by cable and transformer issues, especially leaks. Defective station transformers and switchgear have been the primary contributors to the station equipment trend. The impact of equipment failure to SAIFI underpins the renewal investment needs proposed in Schedule 2-5-7 - System Renewal Investments and the increased maintenance spending outlined in Section 3.1 - Testing, Inspection and Maintenance and Section 3.4 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

3.3.2. Public Safety Concerns

Hydro Ottawa prioritizes public safety through diligent monitoring and response to Public Safety Concerns identified by the Electrical Safety Authority (ESA). These concerns fall into two categories:

- **Hydro Ottawa's Responsibility:** These are issues directly related to distribution equipment, for which Hydro Ottawa takes full responsibility and ensures prompt resolution.
- **Customer-Related Issues:** These concerns stem from customer actions or inactions that impact the safety of the distribution system, such as exposed wiring or construction near power lines. Hydro Ottawa proactively collaborates with customers to address these issues.

Table 11 presents the annual count of public safety concerns recorded by Hydro Ottawa. Hydro Ottawa diligently responds to and undertakes, where required, corrective actions for all reported public safety concerns, ensuring a continuous improvement cycle focused on enhancing public safety.

Table 11 - Public Safety Concerns

KPI	2019	2020	2021	2022	2023
Public Safety Concerns	2	1	7	9	21

In 2023, a total of 21 Public Safety Concerns were identified, of which six were the sole responsibility of Hydro Ottawa. Analysis of historical data indicates no specific trends in the Public Safety Concerns issued to Hydro Ottawa by the ESA.

While this metric is not a fully reliable indicator for achieving health, safety, and environmental objectives on its own, Hydro Ottawa remains committed to monitoring Public Safety Concerns for emerging trends and taking appropriate corrective actions.

3.3.3. Oil Spilled

The annual oil spilled metric is an essential indicator used by Hydro Ottawa to advance its health, safety, and environmental objectives. This metric enables the company to track both the volume of oil spilled into the environment and the associated annual costs of remediation. By monitoring this data, Hydro Ottawa can identify trends and continuously improve its environmental performance.

Table 12 presents the annual volume of oil spilled into the environment, along with the corresponding remediation costs. Hydro Ottawa's objective is to achieve zero oil spills and eliminate associated cleanup costs.

Table 12 - Annual Oil Spilled

KPI	Target	2019	2020	2021	2022	2023
Oil Spilled (L)	0	1,131 L	954 L	804 L	781 L	1,230 L
Oil Remediation ($000)	0	$ 1,234	$ 1,454	$ 1,897	$ 1,565	$ 1,099

Hydro Ottawa monitors oil spills from both an enterprise risk and company-wide performance perspective. While the ultimate goal is zero spills, the inherent challenges of operating tens of thousands of pieces of oil-filled equipment, essential for electricity delivery, necessitate a pragmatic approach. These assets are exposed to extreme environmental conditions, including winter salt, storms, and other weather events, which can lead to leaks despite robust asset management programs. Hydro Ottawa addresses any leaks immediately upon detection.

During 2023, Hydro Ottawa experienced two significant oil spills, each resulting from contractor activity during excavation. In both cases, contractors struck underground infrastructure, leading to a total spill volume of 390 liters. These two incidents represent the primary cause of the 2023 KPI results deviating drastically from recent historical performance. Aside from these incidents, Hydro Ottawa has observed a general trend/issue with leaking transformers related to a specific manufacturer and certain localized regions. The identified transformers are being phased out through the Cable Replacement program and the Emergency Renewal program as outlined in Section 4 and Section 6 of Schedule 2-5-7 - System Renewal Investments.

To further mitigate the environmental impact of oil spills, Hydro Ottawa implements several proactive measures. These include routine inspections of oil-filled equipment, strategic asset replacement initiatives, and periodic communication with local construction associations emphasizing the critical importance of utilizing locate services before commencing any excavation work. This comprehensive and transparent strategy underscores Hydro Ottawa's commitment to environmental responsibility and sustainable operations.

3.4. SYSTEM OPERATIONS PERFORMANCE

Hydro Ottawa's KPIs surrounding System Operations Performance align with the 2021-2025 DSP Asset Management Objectives for Levels of Service and Asset Value. Specifically, Hydro Ottawa monitors the operational performance of the system by tracking annual levels of station capacity, feeder capacity and system losses. This information is used to identify potential equipment upgrades ensuring that adequate capacity is available during normal system conditions and for reliable operation during system contingency in order to meet the levels of service expected by Hydro Ottawa's customers. In addition, these KPIs allowed the identification of stations and feeders operating above or approaching its design ratings in order to implement the appropriate actions required to maximize the value of the distribution system assets throughout its lifecycle.

3.4.1. Stations Capacity

Hydro Ottawa utilizes Station Capacity KPIs to gain insights into large, medium, and long-term capacity needs, as well as to identify smaller capacity deficits that may be addressed through load transfers. These KPIs include:

- **Station Exceeding Planning Capacity**
- **Station Approaching Rated Capacity**

These KPIs quantify capacity risks by comparing demand to a station's planning and equipment ratings and by determining the potential for stranded load during an N-1 contingency. This comprehensive evaluation framework enables proactive capacity planning and risk mitigation.

3.4.1.1. Stations Exceeding Planning Capacity

This KPI is defined as the percentage of stations with a summer peak operating load exceeding 100% of their planned capacity rating. The calculation for this KPI is provided below.

$$Stations\ Exceeding\ Capacity\ (\%) = \frac{\#\ of\ Stations\ Exceeding\ Planning\ Capacity}{\#\ of\ Total\ Stations} \times 100\%$$

Table 13 - Stations Exceeding Planning Capacity

KPI	Target	2019	2020	2021	2022	2023
SEPC %	≤ 5%	8.8%	13.2%	7.7%	4.3%	8.7%
Count		8	12	7	4	8

Since 2019, the number of stations identified as exceeding their planning capacity has remained relatively stable, as per Table 13, fluctuating with variation in the yearly peak' intensity. With respect to this KPI, there are three key capacity constrained regions: South 28kV, West 28kV and Central 4kV. The energization of Cambrian MTS in the south relieved some south-end capacity concerns in 2022, and the proposed Piperville MTS will alleviate the load further. West-end capacity issues represent the largest concern and the proposed "New Kanata" station is aimed at relieving the constrained West 28kV system. Central 4kV stations continue to approach their planned limits due to transit-oriented development and downtown electrification and intensification. The proposed 4kV-to-13kV voltage conversion/station upgrades will resolve the inherent limitations of the 4kV and increase capacity. More information on Hydro Ottawa's capacity upgrade plans can be found in Section 2 of Schedule 2-5-8 - System Service Investments. Overall, Hydro Ottawa's future plans seek to bring the SEPC KPI within or under target over the next rate application term.

3.4.1.2. Stations Approaching Rated Capacity

This KPI is defined as the percentage of stations operating at or above 100% of their rated capacity. The calculation for this KPI is provided below. Rated capacity is defined as the sum of the maximum ratings of all transformers within a given station. Exceeding this operational threshold can result in accelerated transformer degradation and loss of life, impacting system reliability and longevity.

$$Stations\ Approaching\ Capacity\ (\%) = \frac{\#\ of\ Stations\ Approaching\ Rated\ Capacity}{\#\ of\ Total\ Stations}$$

Table 14 - Stations Approaching Rated Capacity

KPI	Target	2019	2020	2021	2022	2023
SARC %	0%	0%	0%	1.1%	0%	0%
Count		0	0	1	0	0

Since 2019, Hydro Ottawa has succeeded in meeting the KPI target of keeping all stations under their rated capacity during the annual system peak, as per Table 14. There is one exception in 2021, where a station was approaching its rated capacity due to capacity constraints in the South 28kV system. It was ensured that the station was operated in a safe manner and the time period when it operated close to rated capacity did not cause any damage to the equipment. The energization of Cambrian MTS in 2022, alleviated this unique situation by bringing additional capacity support to that area.

3.4.2. Feeder Capacity

Hydro Ottawa employs a comprehensive feeder capacity planning approach that considers both coincident peak loading and single (N-1) contingency scenarios. This methodology necessitates the evaluation of two key capacity ratings:

- **Feeders Exceeding Planning Capacity:** This metric identifies feeders where the operational load surpasses the planned capacity, highlighting potential areas of concern.
- **Feeders Approaching Rated Capacity:** This metric identifies feeders nearing their maximum capacity, enabling proactive mitigation to prevent overload conditions.

3.4.2.1. Feeders Exceeding Planning Capacity

This KPI is defined as the percentage of feeders with a summer peak operating load exceeding 100% of their planned capacity rating, calculated using the equation below.

$$Feeders\ Exceeding\ Capacity\ (\%) = \frac{\#\ of\ Feeders\ Exceeding\ Planning\ Capacity}{\#\ of\ Total\ Feeders} \times 100\%$$

Table 15 - Feeders Exceeding Planning Capacity

KPI	Target	2019	2020	2021	2022	2023
FEPC %	≤ 10%	1.6%	1.9%	1.0%	0.9%	2.2%
Count		13	17	8	10	19

As per Table 15, Hydro Ottawa has succeeded in keeping feeders below the 10% target for feeders exceeding their planning capacity. Hydro Ottawa's proactive approach of load balancing and redundancy/backups ensures that adequate capacity is maintained in contingency scenarios, providing secure and reliable power delivery to customers. Feeders that are operating over their planning rating are symptomatic of excess demand at the station, rather than a feeder-level capacity concern, and hence this KPI will continue to improve with the implementation of station capacity plans. Secondly, feeders operating above planning capacity are mostly in the Nepean 8kV system which is currently insufficient to manage the load growth due to electrification in the region. The proposed Greenbank MTS in the South 28kV system will help cater to large loads as well as introduce the 28kV system in the Nepean region. Please see further details in Schedule 2-5-8 - System Service Investments.

3.4.2.2. Feeders Approaching Rated Capacity

This KPI is defined as the percentage of feeders operating at or above 90% of their rated capacity. The calculation for this KPI is provided below. Rated capacity is defined as the 8-hour loading limit of the egress cable. Sustained operation above this threshold for periods exceeding 8 hours can result in overheating and accelerated degradation of the cable, ultimately impacting system reliability and longevity.

$$Feeders\ Approaching\ Capacity\ (\%) = \frac{\#\ of\ Feeders \geq 90\%\ of\ Rated\ Capacity}{\#\ of\ Total\ Feeders} \times 100\%$$

Table 16 - Feeders Approaching Rated Capacity

KPI	Target	2019	2020	2021	2022	2023
FARC %	0%	0.1%	0.4%	0.1%	0%	0%
Count		1	3	1	0	0

As per Table 16, as of 2022, Hydro Ottawa has met the KPI goal for feeders approaching rated capacity. As discussed in Section 3.4.2.1 above, the proactive approach for load balancing and redundancy has ensured based on feeder-level design that feeders do not see excessive amperage. Aforementioned capacity concerns in the South 28kV system led to excessive loading in some feeders, however, the energization of Cambrian MTS and other capacity upgrade work has alleviated that concern since 2022.

3.4.3. System Losses

Hydro Ottawa continuously monitors and records annual system losses to ensure they remain within acceptable levels. An upward trend in losses would trigger the identification of investment needs aimed at reducing losses and maintaining the established levels of service.

Distribution system losses, as defined by the OEB Distribution System Code, are "*energy losses that result from the interaction of intrinsic characteristics of the distribution network such as electrical resistance with network voltages and current flows.*" Table 17 presents the historical performance of system losses as referenced in Table 1 - Losses as a Percentage of Higher Value Purchases for the Previous Five Years in Schedule 8-2-3 - Loss Adjustment Factors.

Table 17 - System Losses

KPI	Target	2019	2020	2021	2022	2023
Losses %	≤ 3.02%	3.02%	3.14%	2.89%	3.05%	3.10%

Hydro Ottawa committed to preparing a plan to reduce distribution system losses as part of Hydro Ottawa's 2021-2025 Approved Settlement Agreement for the Custom Incentive Rate-Setting Application, and maintain the five-year average total system losses below the target of 3.02%.[12]

Please refer to Attachment 8-2-3(B) - Hydro Ottawa System Loss Plan (the Plan), which outlines six mitigating actions to further reduce system losses. These actions included power factor correction, load balancing, reconductoring, voltage conversion, review of unmetered load services, and project optimization. While Hydro Ottawa did not achieve the target of an average system loss below 3.02% over the 5-year period, a low 5-year average total system loss was maintained along with a commitment to continue implementing the Plan. As a part of Hydro Ottawa's regular reliability improvement initiatives and distribution enhancement projects, load balancing and reconductoring is assessed and implemented. There are planned voltage conversions in place and Hydro Ottawa endeavours to continue investing in loss improvement through the execution of the capital programs planned in the 2026-2030 period.

4. HISTORICAL RELIABILITY PERFORMANCE

Hydro Ottawa diligently monitors and reports on its service reliability performance in accordance with OEB reporting requirements for electricity distributors. This section provides a detailed analysis of Hydro Ottawa's reliability performance trends, including an evaluation of SAIDI and SAIFI. A comprehensive assessment of Hydro Ottawa's performance against the OEB's Service Reliability Indicators is presented in Section 4.1 (SAIFI) and Section 4.2 (SAIDI) of this document.

Hydro Ottawa has completed Appendix 2-G, documenting historical performance of Service Quality Requirements, as outlined in Section 7 of the Distribution System Code, and Service Reliability Indicators. Appendix 2-G can be found as Excel Attachment 2-5-3(A) - OEB Appendix 2-G - Service Quality and Reliability Indicators.

[12] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Approved Settlement Agreement*, EB-2019-0261 (September 18, 2020).

The following sections provide a detailed look at historical system reliability, including a close examination of primary cause trends and an in-depth exploration of the factors underlying these trends. The reliability metrics established by Hydro Ottawa in the 2021-2025 DSP are:

- System Average Interruption Frequency Index (SAIFI)
    - SAIFI for all interruptions
    - SAIFI excluding loss of supply interruptions
    - SAIFI excluding Major Events and loss of supply interruptions
- System Average Interruption Duration Index (SAIDI)
    - SAIDI for all interruptions
    - SAIDI excluding loss of supply interruptions
    - SAIDI excluding Major Events and loss of supply interruptions
- Worst Feeder Analysis
- Major Event Days Summary
- Loss of Supply Summary
- Analysis of cause of interruption
    - Number of interruptions that occurred as a result of the cause of interruption
    - Number of customer interruptions that occurred as a result of the cause of interruption
    - Number of customer-hours of interruptions that occurred as a result of the cause of interruption

4.1. SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

SAIFI represents the average frequency of sustained interruptions per customer and is defined as follows:

$$SAIFI = \frac{Total\ number\ of\ customer\ interruptions}{Total\ number\ of\ customers\ served}$$

SAIFI, is reported in three ways:

- **All Interruptions:** This includes all interruptions, regardless of cause.

- **Interruptions Excluding Loss of Supply (LoS):** This excludes interruptions caused by LoS events outside of Hydro Ottawa's distribution system, such as loss of supply from Hydro One.
- **Interruptions Excluding LoS and Major Event Days (MEDs):** This further refines the metric by excluding interruptions caused by LoS and MEDs, such as severe storms, which are outside of Hydro Ottawa's control.

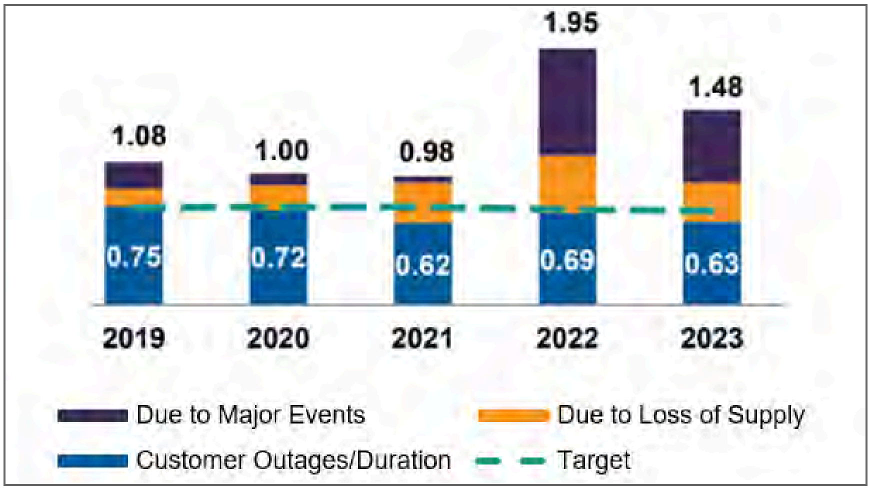
Excluding interruptions caused by MEDs and LoS allows for a more focused evaluation of system performance and isolates factors within Hydro Ottawa's control. Hydro Ottawa's target for SAIFI is to maintain a value at or below the five-year rolling average, excluding MEDs and LoS events. This objective aligns with the OEB distributor-specific target for reliability performance. Table 18 and Figure 4 below show SAIFI performance in tabular form and in graphical form for different methods to depict Hydro Ottawa performance.

Table 18 - SAIFI Reliability Performance

KPI		2019	2020	2021	2022	2023
SAIFI	All Interruptions	1.08	1.00	0.98	1.95	1.48
	Excluding LoS	0.95	0.81	0.67	1.51	1.18
	Excluding LoS & MEDs	0.75	0.72	0.62	0.69	0.63
	SAIFI Target[13]	0.74	0.74	0.74	0.72	0.71

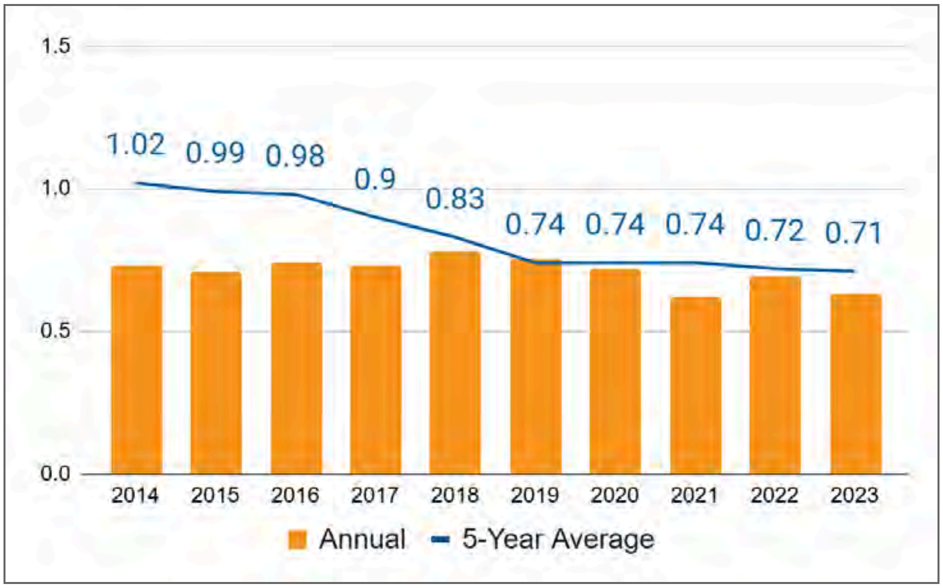
[13] This value represents the rolling five-year historical average excluding LoS and MED.

Figure 4 - SAIFI Reliability Performance



Hydro Ottawa has demonstrated strong reliability performance over the past five years, consistently meeting its goal of keeping the SAIFI excluding LoS and MED, below or equal to the five-year historical average. This trend is particularly evident when excluding major weather events, with 2021 and 2023 showing especially strong performance. The only exception was a slight exceedance of the target by 0.01 in 2019, due to the higher number of outages which were unplanned, mainly due to lightning, foreign interference and unknown, and human element issues. In general, Hydro Ottawa's SAIFI performance has improved due to the renewal of deteriorating key assets, corrective maintenance, feeder reconfigurations to reduce customer impact, and continued improvements to protection coordination. The reduction in annual targets, which are determined based on a rolling 5-year average SAIFI performance excluding Loss of Supply and Major Event Days, demonstrates that targeted efforts mentioned above have supported the overall improvement to system reliability. Figure 5 below shows this downward trend from 2014 through 2023.

Figure 5 - SAIFI excluding Loss of Supply and Major Event Days



However, severe weather events like the 2022 Derecho and the 2023 freezing rain and thunder/hail storms caused significant disruptions, leading to a sharp increase in SAIFI. These events, categorized as MED, highlight the challenge of maintaining reliability in the face of unpredictable weather patterns. Sections 4.4 - Major Event Days and 4.5.3 - Loss of Supply below provide detailed analyses of historical MED and LoS events, respectively.

To maintain the SAIFI trend (excluding LoS and MED), Hydro Ottawa has proposed plans for enhanced investment in degraded assets at risk of failure, feeder ties to enhance redundancy by addressing radial supply configurations, installing sectionalizing devices, feeder reconfigurations and strategic undergrounding of vulnerable overhead sections. For further details on these investments, please refer to Section 3 of Schedule 2-5-8 - System Service Investments.

4.2. SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

SAIDI represents the average interruption duration per customer and is defined as follows:

$$SAIDI = \frac{Total\ hours\ of\ customer\ interruptions}{Total\ number\ of\ customers\ served}$$

SAIDI, is reported in three ways:

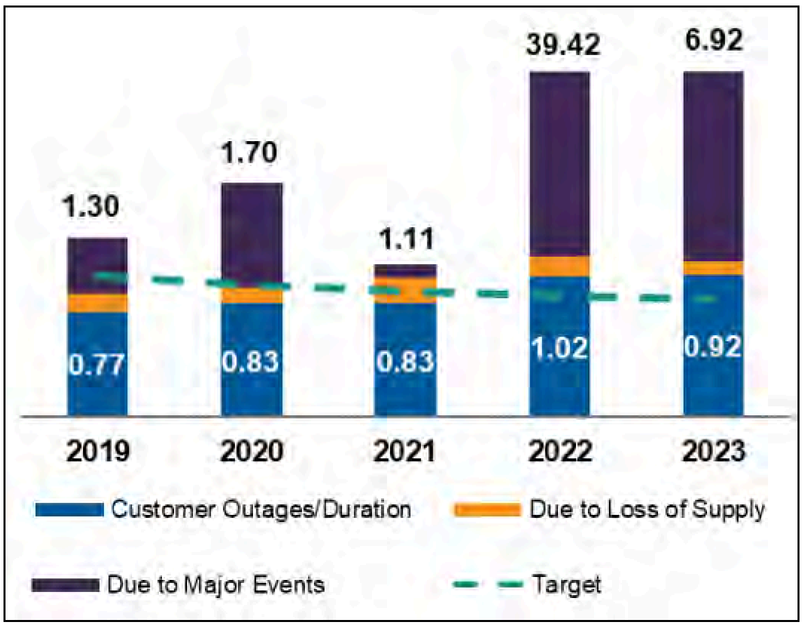
- **All Interruptions:** This includes all hours of customer interruptions, regardless of cause.
- **Interruptions Excluding Loss of Supply (LoS):** This excludes hours of customer interruptions caused by LoS events outside of Hydro Ottawa's distribution system, such as loss of supply from Hydro One.
- **Interruptions Excluding LoS and Major Event Days (MEDs):** This further refines the metric by excluding LoS and hours of customer interruptions caused by MEDs, such as severe storms, which are outside of Hydro Ottawa's control.

Excluding interruptions caused by MEDs and LoS helps to evaluate system and process performance without extenuating circumstances not fully within Hydro Ottawa's control. Hydro Ottawa's target for SAIDI is to maintain a value at or below the five-year rolling average, excluding MEDs and LoS events. This objective aligns with the OEB distributor-specific target for reliability performance. Table 19 and Figure 6 below show SAIDI performance in tabular form and in graphical form for different methods to depict Hydro Ottawa performance.

Table 19 - SAIDI Reliability Performance

KPI		2019	2020	2021	2022	2023
SAIDI	All Interruptions	1.30	1.70	1.11	39.42	6.92
	Excluding LoS	1.17	1.60	0.93	39.28	6.82
	Excluding LoS & MEDs	0.77	0.83	0.83	1.02	1.03
	SAIDI Target[14]	1.02	0.96	0.91	0.88	0.86

Figure 6 - SAIDI Reliability Performance

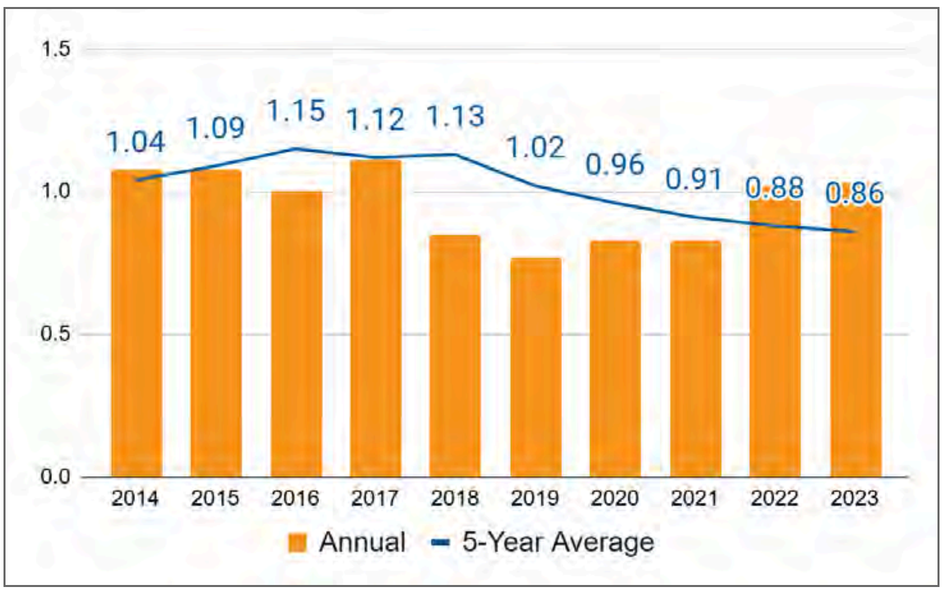


Similar to SAIFI, SAIDI, which measures the average outage duration for each customer, has also been impacted by major weather events. Excluding LoS and MEDs, SAIDI performance remained stable from 2019 to 2021. However, in 2022 and 2023, SAIDI exceeded the five-year average target by 0.14 and 0.17, with a small percentage (3%) of outages being responsible for a relatively large proportion (48%) of SAIDI. This was due to several factors, including delays in making areas safe, increased adverse weather events, need for additional fault locating equipment and resources, tree

[14] This value represents the rolling five-year historical average excluding LoS and MED.

contact, and foreign interference. These findings highlight the importance of mitigating these factors through measures such as investment in resilient infrastructure and enhanced emergency response capabilities to reduce outage duration and severity, and improve grid reliability and resilience. More details are presented below in Section 5 - Continuous Improvement. In general, the targeted infrastructure renewal projects have improved overall system reliability, which is shown by the reduction in annual targets. These targets are determined by using a rolling 5-year average SAIDI performance, excluding Loss of Supply and Major Event Days. Figure 7 shows this downward trend from 2014 to 2023.

Figure 7 - SAIDI excluding Loss of Supply and Major Event Days



Severe weather events like the 2022 Derecho and the 2023 freezing rain and thunder/hail storms caused significant disruptions, leading to a sharp increase in SAIDI. These events, categorized as MED, highlight the challenge of maintaining reliability in the face of unpredictable weather patterns. For a detailed analysis of historical LoS and MED events, please refer to Sections 3.2 - Cost Efficiency & Effectiveness and 3.1 - Customer Oriented Performance, respectively.

To enhance the system's resilience against future storms and support quicker restoration times, Hydro Ottawa is investing in targeted projects through the Distribution System Resiliency, Distribution System Reliability and Distribution System Observability programs, as a key part of its System Service investments, please refer to Schedule 2-5-8 - System Service Investments. These projects aim to mitigate the impact of major weather events on the distribution system, improving grid resilience and advancing grid technology to support faster fault identification and isolation.

To improve the SAIDI trend (excluding LoS and MED), Hydro Ottawa has proposed plans for feeder ties to enhance redundancy by addressing radial supply configurations, installing sectionalizing devices, strategic undergrounding of vulnerable OH sections, relocating lines from areas that are difficult to access, installing remote operable switches and smart fault circuit indicators. For further details on these investments, please refer to Section 3 of Schedule 2-5-8 - System Service Investments.

4.3. WORST FEEDER ANALYSIS

Hydro Ottawa uses a Feeder Performance Index (FPI) to assess the condition of its electricity distribution feeders. This index, detailed in Table 20, considers outage frequency, customer impact, and outage duration over a 12-month period.

Table 20 - Feeder Condition Description

FPI	Performance
85-100	Very Good
70-85	Good
50-70	Fair
30-50	Poor
0-30	Very Poor

Feeders with an FPI score below 30 ("Very Poor" performance) are placed on a worst-performing feeder list. The number of feeders on the worst-performing feeder list has remained relatively stable since tracking began in 2019, with a peak in 2020. Table 21 provides the number of worst-performing feeders over the past five years.

Table 21 - Worst Feeder Analysis

KPI	2019	2020	2021	2022	2023
Worst Feeder Analysis	5	8	6	7	6

Hydro Ottawa continuously monitors feeder performance to guide targeted improvements and minimize customer impact. Hydro Ottawa further addresses the poorly performing feeders through targeted investments in worst feeder betterment projects, please refer to Section 3.6.3.4 of Schedule 2-5-8 - System Service Investments, for details such as:

- Reconfiguring feeders
- Upgrading distribution protection
- Installing sectionalizing devices (reclosers, remotely operable switches)
- Adding animal guards

4.4. MAJOR EVENT DAYS

In accordance with the OEB's RRRs, Hydro Ottawa utilizes the IEEE Standard 1366 approach to identify MEDs.[15] The threshold for classifying an MED is determined annually based on the previous five years' daily SAIDI values.

Over the past five years, Hydro Ottawa has experienced 12 MEDs, as illustrated in Figure 8 below. A notable increase in MED severity was observed in 2022 compared to the preceding three years.

[15] IEEE Std 1366-2022 - IEEE Guide for Electric Power Distribution Reliability Indices.

Figure 8 - Major Event Day Threshold

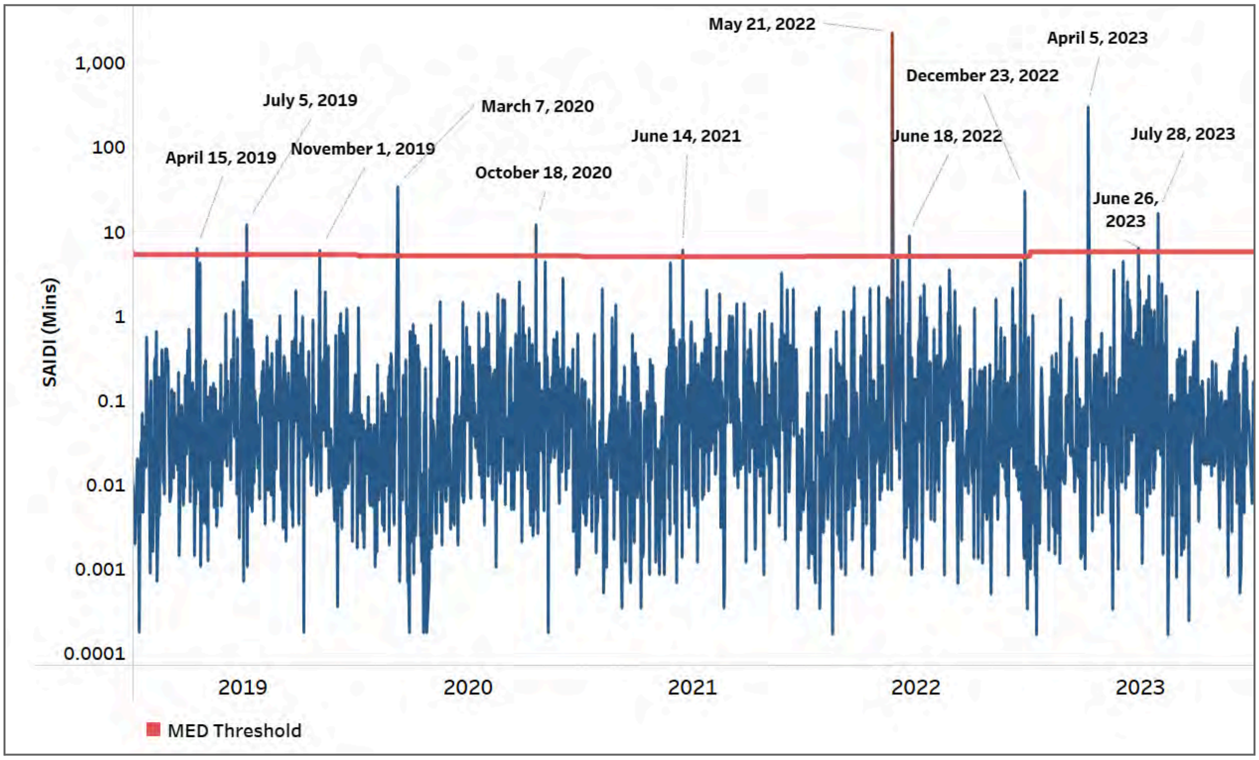


Table 22 below reveals the significant impact of MEDs on reliability over the past five years, with a particular focus on the devastating May 21, 2022 Derecho depicted in the images in Figure 9. This storm stands out as the most impactful event in Hydro Ottawa history, causing a staggering 13,367,385 customer-hours of interrupted service and a SAIDI value of 37.58 hours per customer. This far surpasses the impact of other major events, not only in the past five years but also in the history of the community.

Table 22 – 2019-2023 Major Event Day Overview

Event Date	Interruption Count	Customer		SAIDI (Mins)	Event Description
		Hours	Impacts		
2019-04-15	11	34,425	44,511	6.14	Lightning, Flooding, and Loss of Supply
2019-07-05	13	68,268	70,069	12.14	Hydro One Station derating and an interruption due to planned work
2019-11-01	22	33,805	14,228	5.98	Heavy Wind resulting in Falling Trees and Downed Power Lines
2020-03-07	1	193,888	11,686	34.05	Equipment failure resulting in a fire
2020-10-18	2	69,519	9186	12.14	Loss of Supply and Defective Equipment
2021-06-14	2	35,363	17,441	6.06	Caused by Lightning and Loss of Supply
2022-05-21	City wide	13,367,385	192,474	2,254.65	Derecho storm outages (May 21, 23, 28, 30, and 31), all of which are MEDs
2022-06-18	1	51,196	27,405	8.62	Cable Fault impacting six Hydro Ottawa substations
2022-12-23	35	179,856	67,710	29.98	Loss of Supply and Wet Snow
2023-04-05	112	1,960,834	163,448	324.96	Freezing Rain and a subsequent Loss of Supply
2023-06-26	15	38,691	15,413	6.39	Thunderstorm, Lightning and Loss of Supply
2023-07-28	28	99,360	37,821	16.40	Hailstorms resulting in Falling Trees and Downed Power Lines

Figure 9 - Damage caused by the Derecho Storm in May 2022

Given the numerous and complex drivers influencing the effects of MEDs on the distribution grid, including changing weather patterns, distribution of vulnerable assets, and regional topography, a key indicator of vulnerability is the historical record of MED impacts on regions and infrastructure. Table 23 details the distribution of MED outages between main trunk (main lines designed to handle higher loads and distribute electricity from stations to multiple lateral lines) and lateral sections (lines that branch off the main trunk to serve smaller areas and could extend radially) in the different regions of Hydro Ottawa's service territory since 2019.

Table 23 - Regional Breakdown of MED Outages between Main Trunk and Lateral since 2019

Region	Main Trunk Outage	Lateral Outage
Central	10%	11%
East	21%	15%
South	13%	16%
West	8%	6%
All Regions	**52%**	**48%**

Analysis of MED outages since 2019 indicates that approximately 52% occurred on main trunks, while the remaining 48% occurred on lateral sections. The East region experienced the highest number of main trunk outages (21%), and the South region experienced the highest number of lateral outages (16%). Analyzing the infrastructure and regions most disrupted by these outages helps guide resilience program investment, please refer to Section 3 of Schedule 2-5-8 - System Service Investments. The findings from this analysis, along with inputs from Attachment 2-5-4(E) - Resilience Investment Business Case Report and Section 6.4 of Schedule 2-5-4 - Asset Management Process, inform resilience investments to strategically improve system resilience to severe weather events.

4.5. PERFORMANCE BY CAUSE CODE

Hydro Ottawa assiduously records all power interruptions in accordance with the OEB's definitions for primary causes outlined in the OEB's RRRs. Hydro Ottawa conducts detailed root cause analysis on these interruptions, allowing for risk assessment and investment prioritization. The cause codes defined by the OEB are stated in Table 24 below.

Table 24 - OEB Definition of Cause Codes

Root Cause	Definition
0 - Unknown	Interruptions with no apparent cause
1 - Scheduled Outage	Interruption due to disconnection at a selected time for the purpose of construction or maintenance.
2 - Loss of Supply	Interruption due to problems associated with the distribution system owned and/or operated by another distributor, and/or in the transmission system.
3 - Tree Contacts	Interruption caused by faults resulting from tree contact with energized circuits except for the interruptions under the conditions described under cause code 6.
4 - Lightning	The lightning category includes all interruptions caused by lightning.
5 - Equipment Failure	Interruption resulting from the failure of distributor owned equipment due to deterioration, insufficient maintenance or defective equipment/material.
6 - Adverse Weather	Interruption resulting from severe rain, ice storms, heavy snow, severe windstorm (~90 kilometres an hour or greater), extreme temperatures, freezing rain, frost, hail or other extreme weather conditions (exclusive of cause code 4).
7 - Adverse Environment	Interruption due to distributor equipment being subject to abnormal environments, such as salt spray, industrial contamination, humidity, corrosion, vibration, fire or flooding.
8 - Human Element	Interruption due to the interface of distributor staff with the distribution system. Only interruptions caused by distributor staff should be reported under this cause code, including improper protection settings, improper system operation and improper construction & installation.
9- Foreign interference	Interruption caused by external factors, such as those caused by customer equipment, DERs not owned by distributors, animals, vehicles, dig-ins, vandalism, sabotage, foreign objects and cyber security events.

Table 25 below shows the SAIDI, SAIFI contribution by cause code over the 2019-2023 period with specific contributions broken out for number of interruptions, number of customer interruptions, and the number of customer interruption hours.

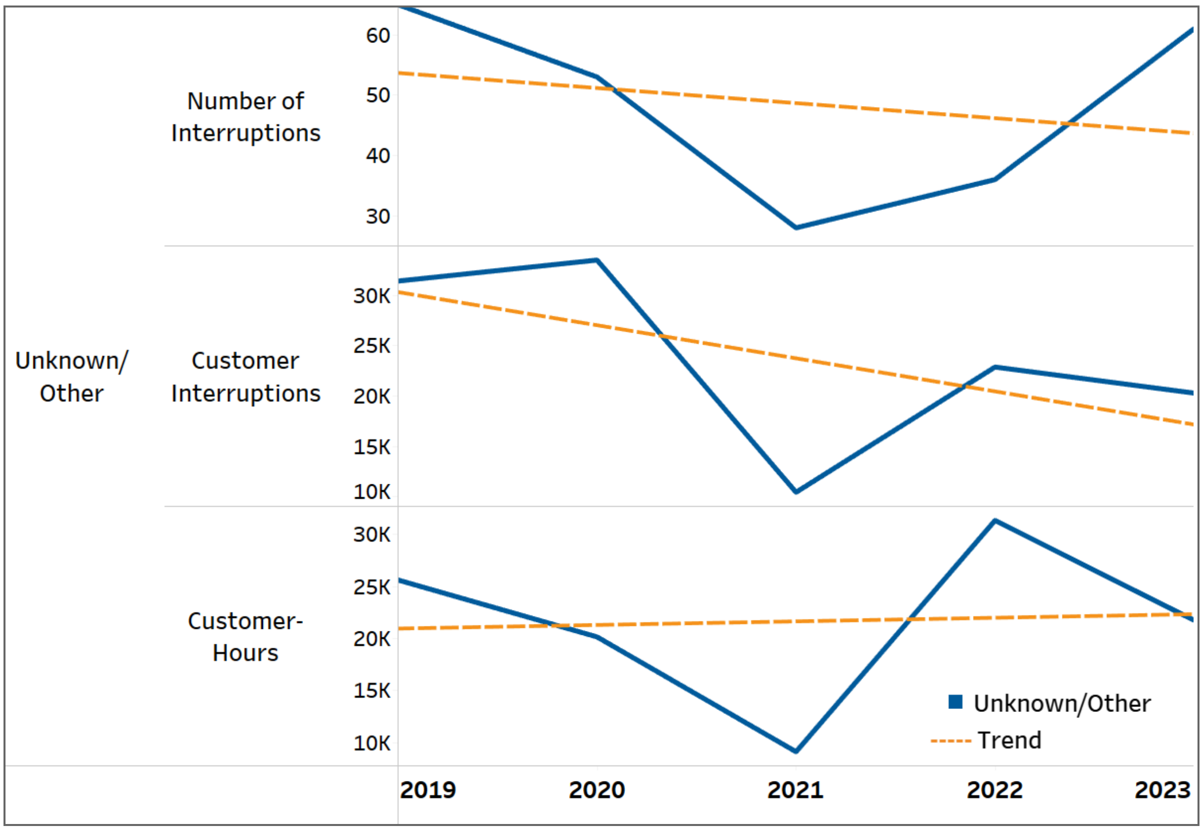
1 **Table 25 - Five-Year SAIFI and SAIDI Contribution by Outage Type (Excluding MED's)**

Code - Cause	SAIFI & SAIDI Contribution	2019	2020	2021	2022	2023
0 - Unknown	Number of Interruptions	65	53	28	36	61
	Customer Interruptions	31,447	33,536	10,420	22,886	20,294
	Customer-Hours	25,623	20,163	9,138	31,339	21,762
1 - Scheduled Outages	Number of Interruptions	645	753	740	614	550
	Customer Interruptions	13,621	22,520	17,044	20,529	29,634
	Customer-Hours	34,807	49,203	59,257	45,350	55,557
2 - Loss of Supply	Number of Interruptions	24	26	34	38	19
	Customer Interruptions	44,089	64,759	107,282	155,674	107,874
	Customer-Hours	42,548	37,565	64,603	52,284	35,794
3 - Tree Contact	Number of Interruptions	60	104	82	101	95
	Customer Interruptions	32,418	18,548	21,460	43,967	32,733
	Customer-Hours	35,526	30,671	30,337	74,967	47,158
4 - Lightning	Number of Interruptions	21	27	16	9	22
	Customer Interruptions	24,659	12,188	11,031	7,008	18,931
	Customer-Hours	8,284	6,797	13,883	3,812	15,713
5 - Equipment Failure	Number of Interruptions	262	265	247	209	158
	Customer Interruptions	64,747	94,236	65,871	100,769	43,302
	Customer-Hours	79,803	104,622	97,052	144,848	84,798
6 - Adverse Weather	Number of Interruptions	13	6	11	10	41
	Customer Interruptions	3,671	1,393	10,706	4,285	13,228
	Customer-Hours	4,237	4,750	7,511	5,852	34,915
7 - Adverse Environment	Number of Interruptions	9	4	9	3	2
	Customer Interruptions	1,327	197	8,740	221	1,243
	Customer-Hours	2,190	475	9,754	530	2,436
8 - Human Element	Number of Interruptions	23	9	17	14	11
	Customer Interruptions	33,391	8,267	19,019	11,109	28,727
	Customer-Hours	16,452	1,508	13,139	3,720	33,600
9 - Foreign Interference	Number of Interruptions	208	177	151	109	169
	Customer Interruptions	47,360	55,962	53,375	36,416	41,057
	Customer-Hours	51,891	65,971	48,916	54,714	77,856

4.5.1. Unknown/Other

Figure 10 provides a visual representation of the trend in outages caused by unknown/other (excluding MEDs) over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year.

Figure 10 - Unknown/Other Historical Trends

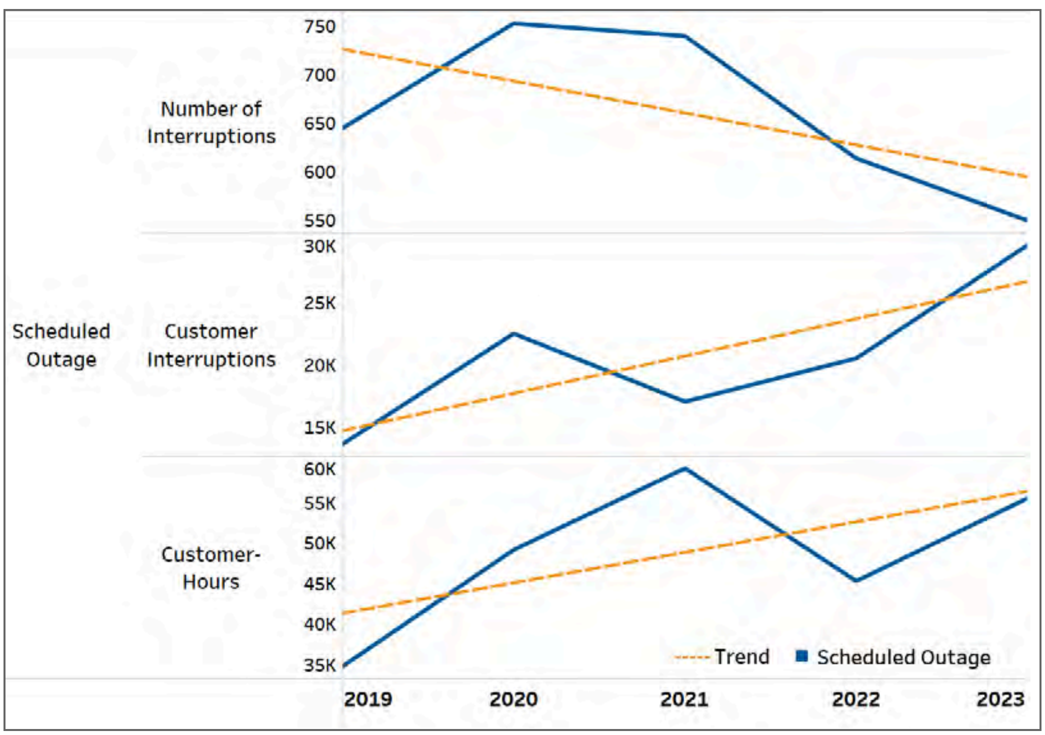


Outages due to Unknown/Other are on a slightly decreasing trend over the last five years with an increase of occurrences in 2023, Hydro Ottawa strives to identify the root causes of unknown outages through line patrols and fault point analysis, however, there are occasions where the cause cannot be identified leading to outages being classified as Unknown/Other. Investment in observability technology under the Distribution System Observability program will lead to a decrease in Unknown/Other outages as more data becomes available for pinpointing and assessing root cause. For more information on observability investments please refer to Section 3.5.4 of Schedule 2-5-8 - System Service Investments.

4.5.2. Scheduled Outages

The OEB defines a Scheduled Outage as a customer interruption due to disconnection at a selected time for the purpose of construction or maintenance. These outages include maintenance and construction work to maintain the assets, as well as, repair work and vegetation management to address the aftermath of MEDs and other events. Figure 11 presents trending for scheduled outages leading to customer interruptions over the past five years. The trends include the number of interruptions, the number of customers interrupted, and the total customer interruption hours.

Figure 11 - Scheduled Outage Historical Trend



While the number of interruptions has decreased, as a result of improved work planning, both the number of customers interrupted and the total customer interruption hours have increased. These increases are primarily attributed to:

- **Major infrastructure upgrades:** Complex riser rebuilds and pole replacements for radial lines, close to highways and in backyards which results in longer outage duration and customer impact.
- **Power restoration activities:** Forced switching and sectionalizing to allow for attending to emergencies such as pole fires and major events.
- **Post-storm recovery:** Extensive vegetation management, with the need to trim outside of the regular trim zone due to vegetation damage from storms.

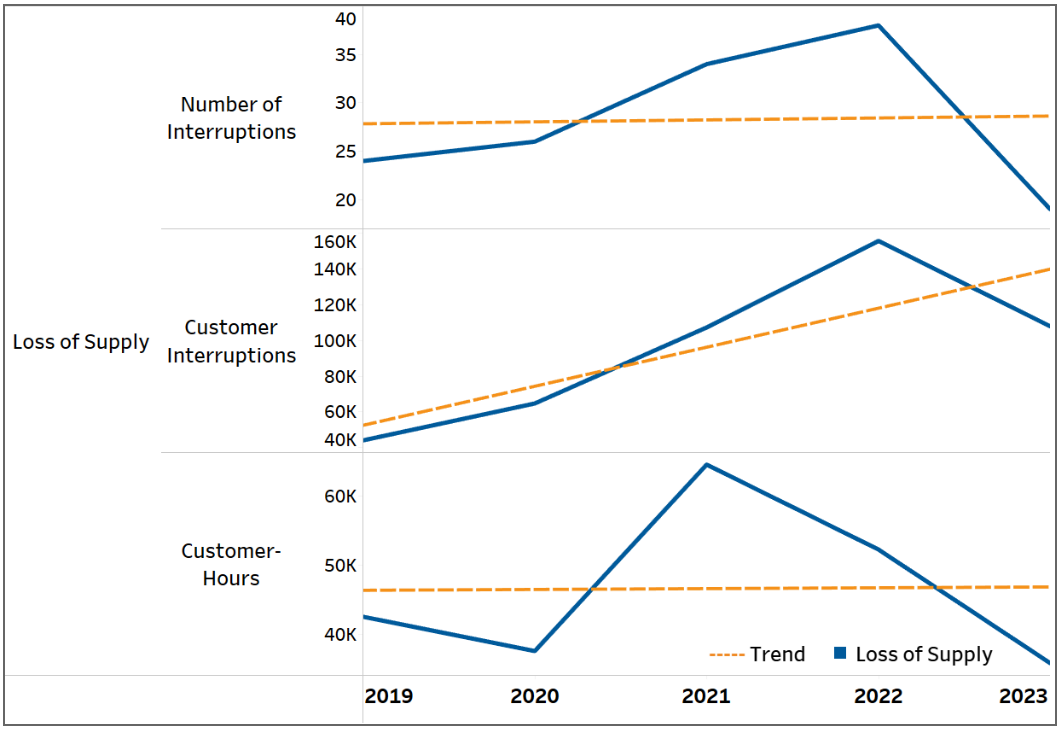
These drivers highlight the lasting impact of major weather events on the distribution system and the ongoing need to maintain and replace deteriorating infrastructure which drives further work.

To mitigate the impact of scheduled outages, Hydro Ottawa endeavours to install temporary switches and employ live-line work methods to reduce the number of affected customers whenever possible. However, due to feeder configuration, some planned work necessitates extended outages. To address this, Hydro Ottawa is taking proactive steps, as part of this application, by planning to reconfigure high-risk radial lines and strategically increase control points to reduce the impact of future planned outages. Refer to Section 3 of Schedule 2-5-8 - System Service Investments for more details.

4.5.3. Loss of Supply

The OEB defines LOS as customer interruptions due to problems associated with the distribution system owned and/or operated by another distributor, and/or in the transmission system. These outages are attributed to issues upstream with Hydro Ottawa's transmission provider, Hydro One. Figure 12 presents trending for LOS (excluding MEDs) leading to customer interruptions over the past five years. The trends include the number of interruptions, the number of customers interrupted, and the total customer interruption hours.

Figure 12 - Historical SAIFI and SAIDI Contribution from LOS Outages



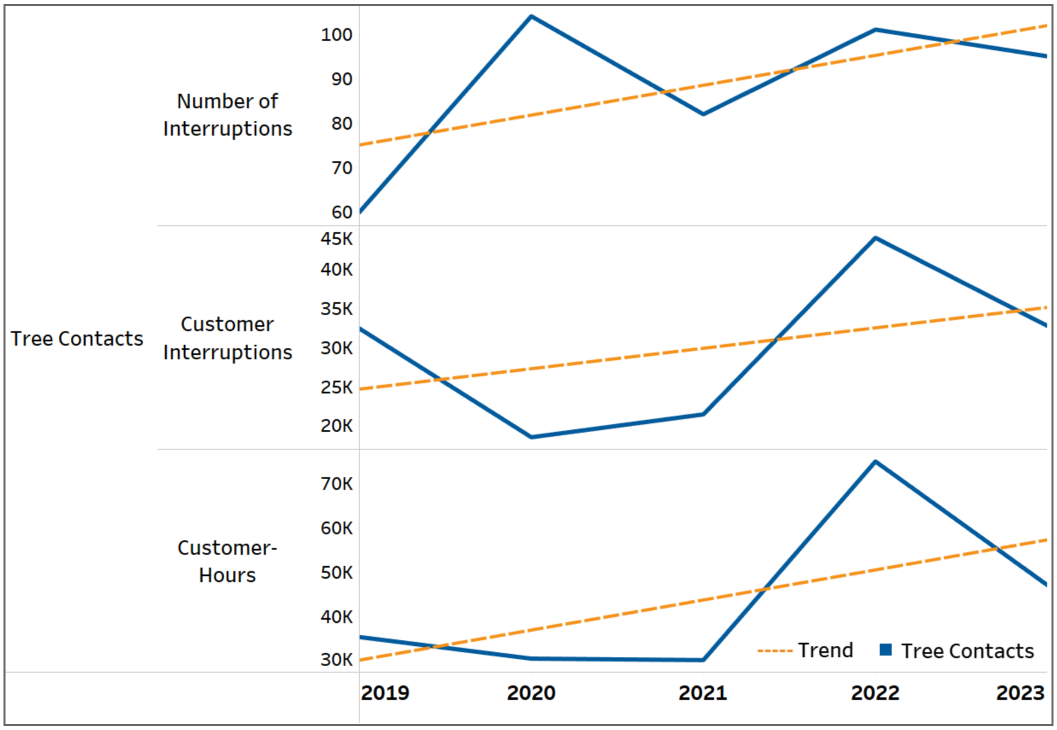
Over the past five years, Hydro Ottawa has maintained relatively stable performance in managing LoS events, particularly with respect to the number of interruptions and customer interruption hours. However, the number of customers affected has trended upward, due to LoS events impacting circuits and stations serving larger customer bases. A notable spike occurred in 2022, with significant increases in both the number of interruptions and customer interruptions, resulting from a surge in LoS events affecting densely populated areas. In 2021, customer interruption hours were significantly impacted by a single LoS event caused by Hydro One crews inadvertently tripping one of Hydro Ottawa's supply stations. Given the projected increase in severe weather events, as discussed below in Section 6.4 - Current and Future Climate, LoS events are expected to continue.

Hydro Ottawa actively monitors and analyzes LoS-related interruptions to proactively identify and address supply reliability issues and minimize customer impact. The primary mitigation strategy involves collaborating with Hydro One through recurring meetings and the Integrated Regional Resource Process (IRPP). This collaboration focuses on Hydro One's investigation and subsequent infrastructure maintenance and upgrades to support Hydro Ottawa's needs. Additionally, Hydro Ottawa explores opportunities to reduce LoS impact through distribution system mitigation like the installation of tie switches between feeders to reduce the impact of LoS events though partial load transfers to unaffected feeders. These improvements are considered opportunistically within other projects under the Distribution Enhancements Program. For further details, please refer to Section 3 of Schedule 2-5-8 - System Service Investments.

4.5.4. Tree Contacts

The OEB defines Tree Contacts as customer interruption caused by faults resulting from tree contact with energized circuits except for the interruptions under the conditions described under Adverse Weather and excluding MEDs. Figure 13 below is a visual representation of the trend in outages caused by tree contacts over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year.

Figure 13 - Tree Contacts Outage Historical Trend



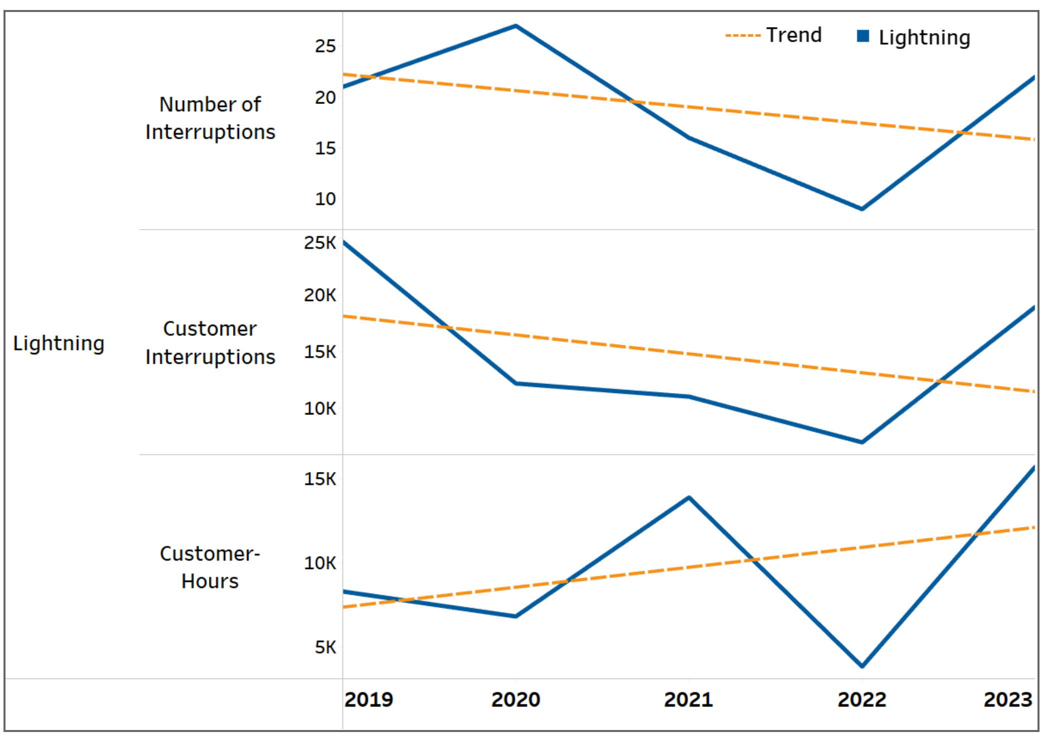
Hydro Ottawa experienced a sharp increase in tree-contact outages in both 2020 and 2022. The 2022 outages were particularly disruptive for customers, impacting both the number of customers affected and the duration of their outages. This disruption stemmed from the lingering effects of the 2022 Derecho Storm on the tree canopy, compounded by other storms (not classified as MEDs) and tree contact with main trunk lines. Contact with main trunk lines (the primary arteries for electricity flow) resulted in widespread customer outages.

To mitigate the impact of tree contacts, Hydro Ottawa has adopted Overstory, a software solution that optimizes vegetation management. Overstory uses Artificial Intelligence (AI) and remote sensing data, such as satellite and aerial imagery, to map vegetation within Hydro Ottawa's service area. Additional information on the application of Overstory is outlined in Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement. Furthermore, increased investment in vegetation management through the OM&A Program, please refer to Section 3.2 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs, is enabling Hydro Ottawa to address the heightened vegetation management needs following severe weather events. This enhanced approach allows Hydro Ottawa to better manage the risk of tree-related outages and improve the reliability of power delivery, even with the rising prevalence of severe weather.

4.5.5. Lightning

The OEB defines all interruptions caused by lightning excluding MEDs as lightning causes. Figure 14 provides a visual representation of the trend in outages caused by lightning over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year, offering insights into how lightning impacts Hydro Ottawa's service reliability.

Figure 14 - Lightning Historical Trend

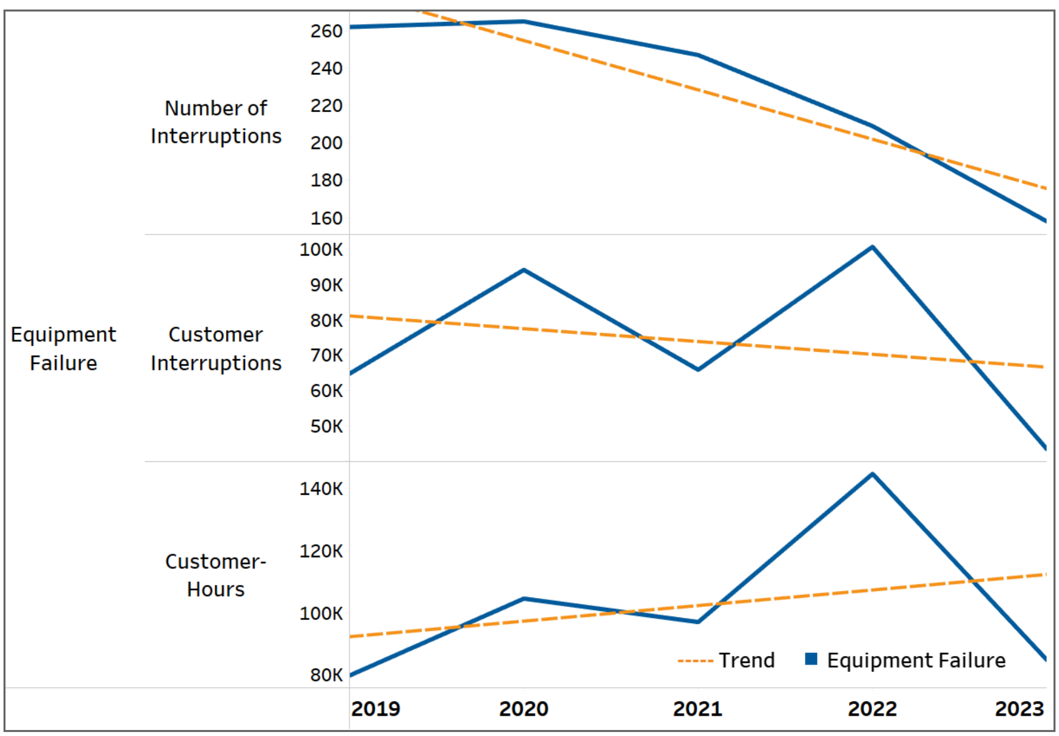


Outages caused by lightning strikes are generally decreasing. Hydro Ottawa proactively mitigates the impact of lightning on its system through robust system design and the application of lightning protection and shielding measures in designs. These measures help to minimize the number and duration of outages caused by lightning, contributing to improved system reliability.

4.5.6. Equipment Failure

The OEB defines Equipment Failure as Customer Interruption resulting from the failure of distributor owned equipment due to deterioration, insufficient maintenance or defective equipment/material. Figure 15 shows equipment failure trends over the last five years with respect to the number of interruptions, number of customers interrupted and customer interruption hours.

Figure 15 - Equipment Failure Historical Trend



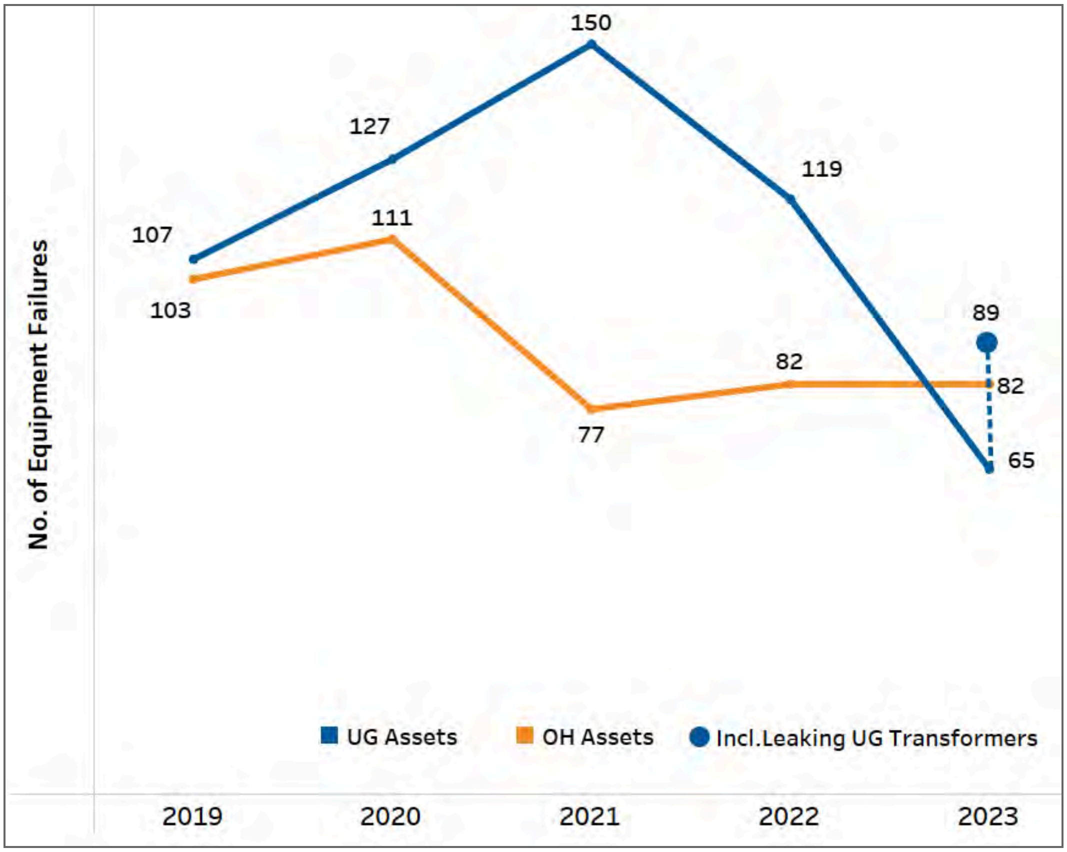
Hydro Ottawa has observed a decline in equipment failure-related outages since 2020, attributed to enhanced maintenance programs and asset condition assessments. To further mitigate equipment failures as asset deterioration progresses, an enhanced asset risk assessment framework has been implemented to determine asset replacement needs over the next five years. This framework utilizes Predictive Analytics, incorporating data from condition assessments and asset failure curves, to assess the risk of failure, for details please refer to Section 5.1.4 of Schedule 2-5-4 - Asset Management Process. The risk-based approach, combined with analysis of observed failures of specific asset types, has informed investment proposals for targeted renewals. For further details, please refer to Schedule 2-5-7 - System Renewal Investments and for enhanced maintenance programs, please refer to Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. Furthermore, the Distribution System Observability Program as outlined in Section 3.5.4 of Schedule 2-5-8 - System Service Investments aims to improve the detection, localization, and restoration of failed equipment through the deployment of additional observation devices.

4.5.6.1. Equipment Failure by Asset Orientation

Building on the strategy of a Predictive Analytics supported risk assessment framework, a detailed analysis of different equipment types and their associated failure modes can provide valuable insights for informing mitigation strategies.

Figure 16 below provides a closer look at equipment failure trends, specifically analyzing failures based on asset orientation (overhead versus underground).

Figure 16 - Equipment Failure by Asset Orientation



Overhead and underground assets face different stressors and thus will have different failure drivers. Analysis of the failure trend for underground and overhead assets reveals a peak in underground (UG) asset failures in 2021, followed by a decrease in 2022. This peak was primarily driven by an investigation into leaking transformers from a specific manufacturer, which led to a significant equipment replacement program.

In 2023, leaking transformers were reclassified as scheduled outages, resulting in a notable drop in UG equipment failures recorded for that year as equipment replacement to address leaking transformers continued to be reported under the Schedule Outage category. The inclusion of leaking transformers under the Equipment Failure category would have resulted in 42 UG transformer-related outages in 2023, resulting in a consistent trend.

4.5.6.2. Equipment Failure by Asset Orientation & Asset Type

A more granular analysis of equipment failures, based on both asset type and orientation, can highlight asset types requiring closer attention. Table 26 presents equipment failure trends from 2019 to 2023, categorized by asset orientation (overhead vs. underground) and specific equipment type. This detailed breakdown provides a deeper understanding of the factors contributing to equipment failures and outages.

Table 26 - Equipment Failure by Primary Apparatus

Primary Apparatus	2019	2020	2021	2022	2023
OH Conductor	17	21	13	9	24
OH Switchgear	34	46	27	26	25
OH Transformers	34	26	19	24	20
Pole	4	6	7	8	2
Pole Attachment	14	12	11	15	11
UG Cable	63	44	48	51	34
UG Cable Attachment	8	12	7	8	8
UG Switchgear	1	2	1	6	3
UG Transformers	34	67	92	49	41 (24 leakers)
Vault Equipment	1	2	2	5	3

Table 26 reveals several key trends in equipment failures. While UG cable failures decreased significantly in 2023, following a steady trend since 2020, overhead (OH) conductor failures saw a slight increase compared to 2022. The increase in OH conductor failures reflect the impact of extreme weather events in 2023, compounded by the ongoing deterioration of overhead infrastructure. The data also indicates that UG transformers, UG cables, and OH switchgear experienced the highest number of failures between 2019 and 2023.

To address these issues, Hydro Ottawa has dedicated renewal programs, which will continue through 2026-2030. Also, based on the information gathered through preventative maintenance, the Emergency Renewal program shall cover the replacement of leaking transformers, to reduce the proportion of known leakers.

The proportion of UG cross linked polyethylene (XLPE) cables in a deteriorated condition is projected to increase from 36.4 km in 2024 to 336 km in 2030, necessitating significant investments, as outlined in Section 2.3.2 of Schedule 2-5-1 - Distribution System Plan Overview. Hydro Ottawa has adopted a forward looking approach to reduce the burden on customers by proposing investments in the UG cable renewal program to maintain system reliability and manage the remaining proportion of deteriorating infrastructure through corrective renewal investments and improvements to preventative maintenance programs as outlined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

The proposed UG distribution asset renewal spend can be found in Section 4 of Schedule 2-5-7 - System Renewal Investments and specifics on the Emergency Renewal program in Section 6 of Schedule 2-5-7 - System Renewal Investments. Additionally, the observed trend in OH switchgear failures has led to increases to the renewal program for this asset type, as detailed in Section 3.5.2 of Schedule 2-5-7 - System Renewal Investments.

4.5.6.3. Unplanned Asset Replacements

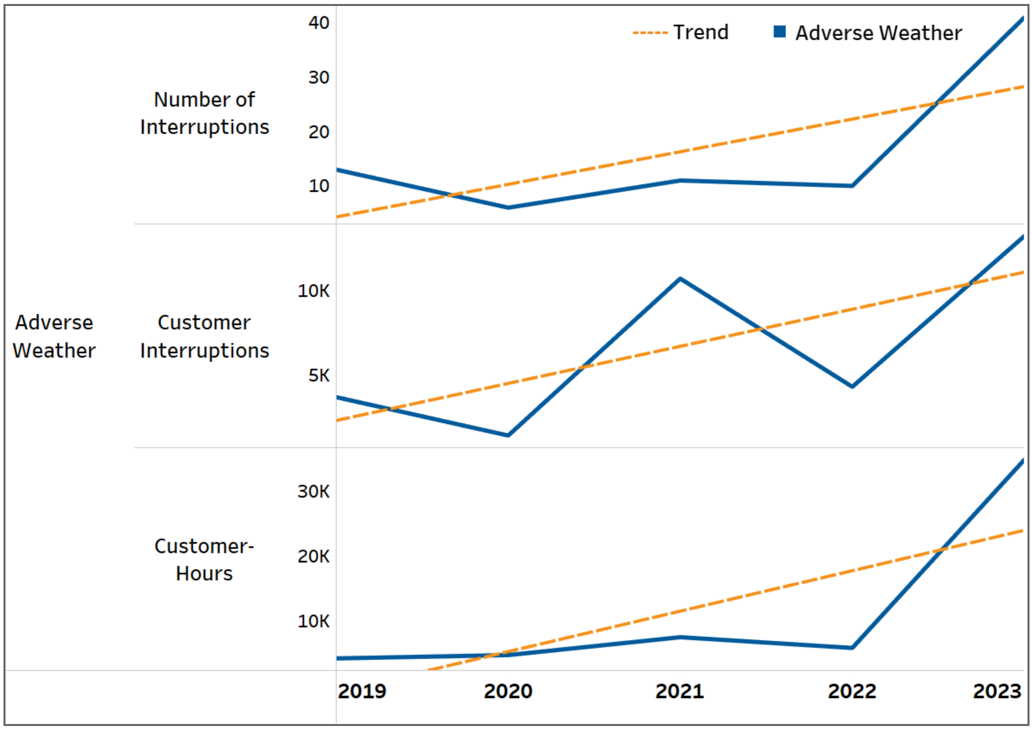
Not all equipment failures cause an outage to customers. Hydro Ottawa's proactive approach to addressing functionally deteriorated assets before they fail has supported the decreasing reliability trend in the number of equipment failures, whereas there is still the impending risk of failure of assets in poor or very poor condition. Corrective renewal, an asset intervention/replacement investment program, is prompted by specific risks that could compromise the asset's performance or system reliability, informed by the routine maintenance programs and subsequent asset condition assessment/health indexing. This means that assets that pose an immediate or imminent risk of failure are replaced or remediated before they cause an unplanned outage. The information gathered through preventative maintenance programs has been instrumental in this regard and Hydro Ottawa will continue to make further improvements in the OM&A programs through 2026-2030, as outlined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. Further information on Hydro Ottawa's asset condition assessment framework is provided in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process. Further details on Hydro Ottawa's Corrective Renewal program can be found in Section 6 of Schedule 2-5-7 - System Renewal Investments.

4.5.7. Adverse Weather

The OEB defines Adverse Weather as a customer interruption resulting from severe rain, ice storms, heavy snow, severe windstorm (~90 kilometres an hour or greater), extreme temperatures, freezing rain, frost, hail or other extreme weather conditions excluding lightning and MEDs.

Figure 17 below provides a visual representation of the trend in outages caused by adverse weather over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year, offering insights into how weather impacts Hydro Ottawa's service reliability.

Figure 17 - Adverse Weather Historical Trend



Outages attributed to adverse weather have been on the rise over the past five years. These outages are primarily caused by extreme winds, wet snow and ice accumulation, and freezing rain, which can damage overhead equipment and disrupt service.

To address this growing concern, Hydro Ottawa analyzes these weather-related outages, along with those occurring during MEDs, to identify vulnerable infrastructure and prioritize projects that enhance system resilience. These projects, which are part of the broader resiliency program, are informed by several key resources:

- **Resilience Investment Business Case Report (Attachment 2-5-4(E)):** This study provides insights into the potential benefits and costs of strategically relocating vulnerable overhead infrastructure underground.

- **Section 6.4: Historic and Future Climate (Schedule 2-5-4 - Asset Management Process):** This section assesses the potential impact of climate change on the distribution system and helps identify areas that may require increased resilience measures.

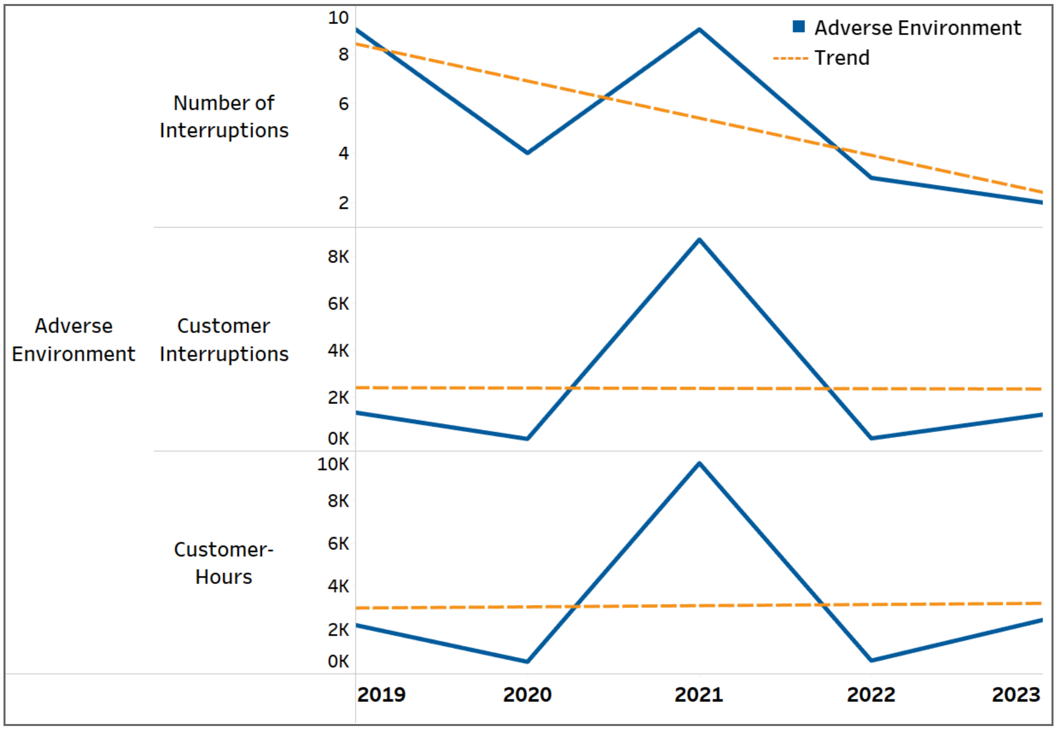
- **Section 3: Distribution Enhancement (Schedule 2-5-8 - System Service Investments):** This section outlines specific projects and initiatives aimed at improving the overall resilience of the distribution system, including targeted upgrades and undergrounding.

By leveraging these resources and analyzing outage data, Hydro Ottawa is proactively working to mitigate the impact of adverse weather on its system and improve service reliability for customers.

4.5.8. Adverse Environment

The OEB defines interruptions from Adverse Environment as customer interruption due to distributor equipment being subject to abnormal environments, such as salt spray, industrial contamination, humidity, corrosion, vibration, fire or flooding (excluding MEDs). Figure 18 below provides a visual representation of the trend in outages caused by adverse environmental factors over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year, offering insights into how environmental factors impact Hydro Ottawa's service reliability.

1 **Figure 18 - Adverse Environment Historical Trend**



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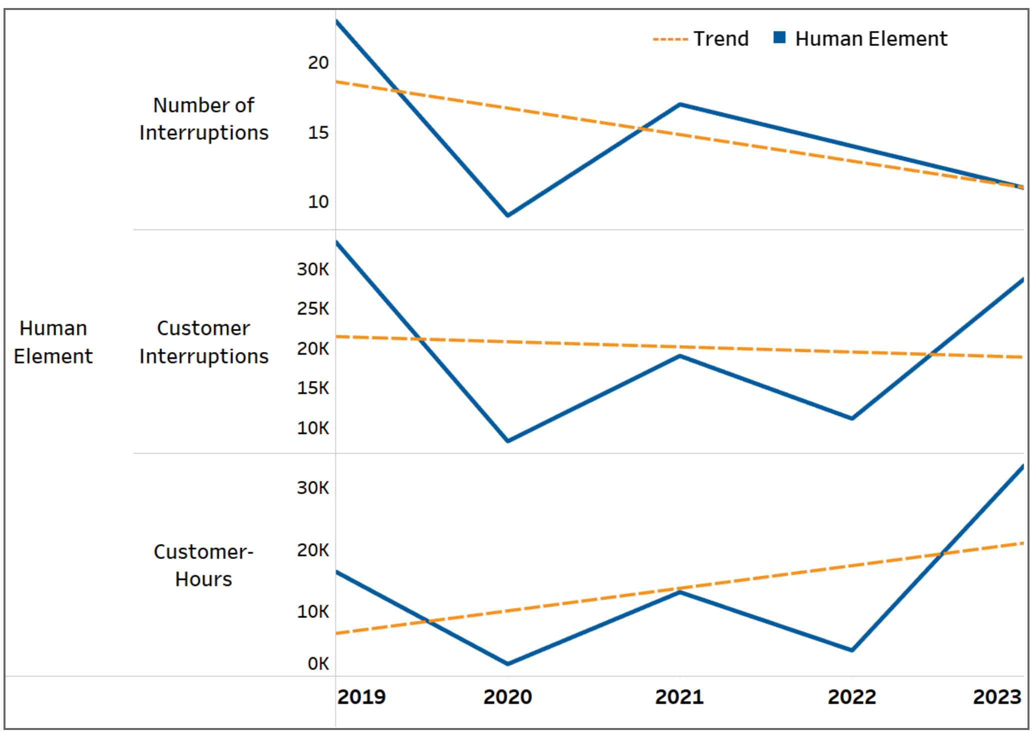
3

4 Outages caused by adverse environmental conditions have shown a declining trend over the past
5 five years. Historically, these outages were largely attributed to pole fires resulting from salt
6 contamination on insulators, a by-product of the City of Ottawa's winter de-icing efforts. The
7 maximum impact/peak in 2021 was due to two outage events (one due to a fire started by
8 grass/vegetation beneath a pole and the other related to a pole fire from salt contamination). To
9 primarily mitigate the risk of pole fires, Hydro Ottawa has implemented a bi-annual insulator wash
10 program to remove salt and other contaminants. Additionally, the ongoing renewal and replacement
11 of older insulators with polymer insulators and prompt clearing of vegetation around poles further
12 reduces this risk.

4.5.9. Human Element

The OEB defines interruptions from Human Elements as customer interruption due to the interface of distributor staff with the distribution system. Only interruptions caused by distributor staff should be reported under this cause code, including improper protection settings, improper system operation and improper construction & installation. Figure 19 shows human element trends over the last five years with respect to the number of interruptions, number of customers interrupted and customer interruption hours.

Figure 19 - Human Element Outage Historical Trend



The high number of interruptions Hydro Ottawa experienced in 2019 were primarily caused by commissioning and switching errors, which have since been addressed and prevented. Despite a general downward trend in human-caused outages since 2019, Hydro Ottawa experienced a peak in customer impact (measured in both hours and number of customers affected) in 2023. This was attributed to two major outages: one stemming from an out-of-phase system condition and another triggered by a Dual Element Supply Network (DESN) station alarm issue. Root cause analysis has been conducted for both these incidents, and system-wide measures have been implemented to prevent similar occurrences.

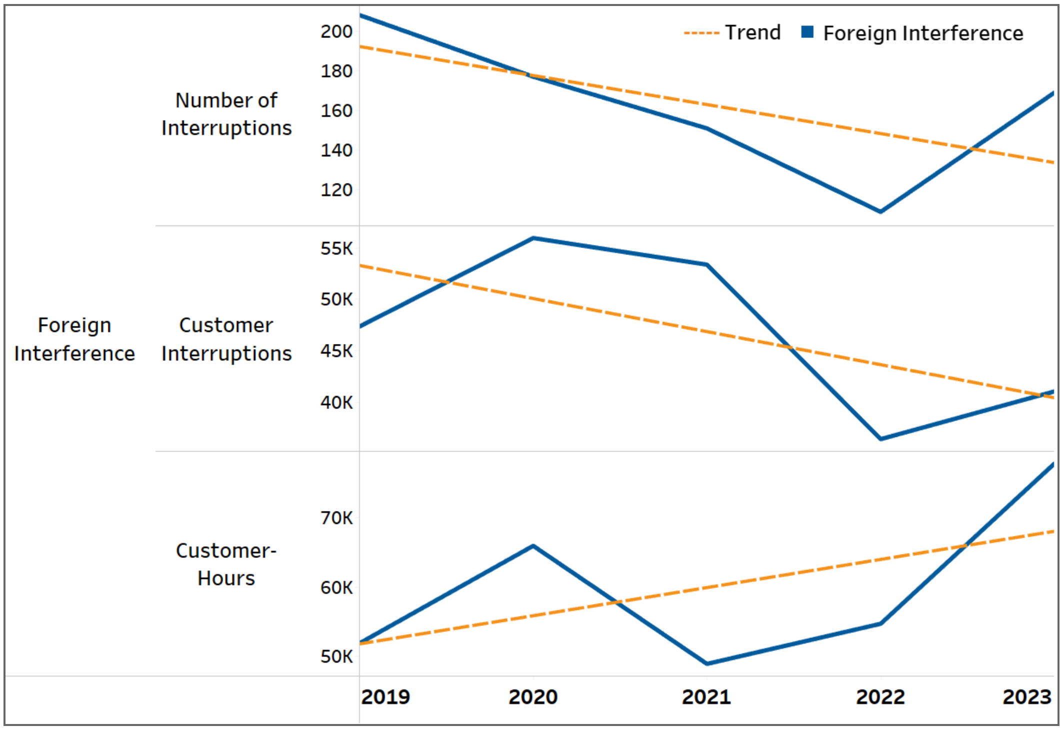
To mitigate further occurrences, Hydro Ottawa is committed to continued collaboration with its contractors to ensure that work methods, training, and internal procedures are all current and aligned with best practices.

4.5.10. Foreign Interference

The OEB defines an outage caused by Foreign Interference as a customer interruption caused by external factors, such as those caused by customer equipment, DERs not owned by distributors, animals, vehicles, dig-ins, vandalism, sabotage, foreign objects and cyber security events excluding MEDs.

Figure 20 provides a visual representation of the trend in outages caused by foreign interference over the past five years. The figure details the number of interruptions, the number of customers interrupted, and the total customer interruption hours for each year, offering insights into how foreign interference impacts Hydro Ottawa's service reliability.

Figure 20 - Foreign Interference Historical Trend



While foreign interference outages show a general downward trend in the number of interruptions and customers affected, there was a notable spike in 2023. Additionally, the overall duration of these outages has been increasing, suggesting that individual incidents cause longer service disruptions.

The majority of foreign interference customer interruptions can be attributed to animal contact. To address this Hydro Ottawa is making targeted investments through its Worst Feeder Betterment program to install animal guards on equipment in areas prone to such incidents. For further details, please refer to Section 3 of Schedule 2-5-8 - System Service Investments. In addition to this, continued efforts by the damage prevention team to avoid dig-ins, along with a sustained focus on cyber security, contribute to preventing other forms of foreign interference. This proactive approach aims to reduce outages caused by foreign interference, ultimately improving system reliability and customer experience.

5. CONTINUOUS IMPROVEMENT

Hydro Ottawa is committed to enhancing system reliability and resilience, particularly in the face of deteriorating infrastructure, increasing climate-related challenges (e.g., the May 2022 Derecho storm) and increasing demand. As highlighted in Schedule 2-5-4 - Asset Management Process, a significant portion of the existing infrastructure is nearing or exceeding Typical Useful Life (TUL), increasing the risk of equipment failures and service disruptions.

Hydro Ottawa's continuous improvement initiatives are guided by the KPIs outlined in Section 3 and Section 4. These initiatives focus on mitigating the risks associated with deteriorating infrastructure and improving system resilience against extreme weather events.

A summary of Continuous Improvement Initiatives is as follows:

- **Post-Derecho Review:** A comprehensive review of the storm response identified key successes, lessons learned, and recommendations to strengthen Business Continuity Management and incident response. This analysis forms the foundation for ongoing process optimization. The report is available in this Application as Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report.
- **Enhancing Resilience:** Recognizing the increasing frequency and intensity of weather events in Ottawa, Hydro Ottawa has made enhancing grid resilience a priority. In 2019, a consultant completed a Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, which was reaffirmed following the 2022 Derecho, providing a foundation for understanding and addressing climate-related risks. In 2023, a consultant conducted a grid resilience assessment and proposed undergrounding investments in the Resilience Investment Business Case Report. However, due to the potential impact on customer rates, Hydro Ottawa developed guidelines with specific criteria to determine when undergrounding is critical. These guidelines also outline alternative measures to enhance

resilience when undergrounding is not the most cost-effective solution, such as line reinforcement, feeder reconfiguration, station egress undergrounding, and line relocation. Please refer to Section 6.4 of Schedule 2-5-4 - Asset Management Process for more details including the Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan and Resilience Investment Business Case Report.

- **Proactive Asset Management:** Hydro Ottawa is implementing proactive measures such as:
  - Prioritizing the replacement of deteriorating assets at risk of failure through a robust Capital Investment Planning Process, as outlined in Section 5 of Schedule 2-5-4 - Asset Management Process.
  - Continued improvements to the UG cable maintenance program and monitoring of performance/condition based on the Very Low Frequency (VLF) Tan-Delta, Partial Discharge and Time Domain Reflectometry test methods to better understand UG cable condition and regional degradation patterns, to manage the condition and risk projections accordingly, as outlined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.
  - Comprehensive testing, inspection, and maintenance programs, as defined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs, which ensure the longevity of distribution assets and identify any necessary corrective actions.
  - More accurate asset condition assessments, with a focus on continuous improvement of data collection and analysis.
  - Increased inspection and replacement of deteriorating underground transformers to reduce environmental risks, incorporating lessons learned from previous incidents.
- **Data-Driven Decision Making:**
  - Hydro Ottawa implemented Predictive Analytics to forecast equipment degradation and optimize system renewal investments based on each individual asset condition and risk (considering reliability, safety, environmental, financial and compliance risk measures) for the 2026-2030 period, contributing to a data-driven continuous improvement cycle. Please refer to Section 5.1.4 of Schedule 2-5-4 - Asset Management Process for further details.

  - To address the potential for data misinterpretation due to fluctuations in asset population, Hydro Ottawa has implemented a more nuanced perspective on asset health. Data-driven asset failure curves (implemented as a part of Predictive Analytics) are utilized for capital investment planning, in forecasting asset degradation patterns. These curves forecast asset degradation over time and provide valuable insights into asset performance trends. A detailed report on this asset failure curve analysis is available in Attachment 2-5-4 (D) - Failure Curves Review.
  - Root cause analysis of equipment failures informs targeted maintenance and replacement strategies, facilitating proactive identification and resolution of recurring issues.
- **Adoption of Station and Feeder Load Index:** Hydro Ottawa has refined its approach to assessing station and feeder capacity. While historically, four KPIs were used — Stations Exceeding Planning Capacity, Stations Approaching Rated Capacity, Feeders Exceeding Planning Capacity and Feeders Approaching Rated Capacity — Hydro Ottawa has adopted the Station Load Index and Feeder Load Index to provide a more comprehensive and simple evaluation. Further details regarding the methodologies for these indices can be found in Section 8.4 of Schedule 2-5-4 - Asset Management Process.
- **Strengthened Internal Governance:** Hydro Ottawa has reinforced its internal financial reporting and controls for capital programs, with a focus on transparency and accountability. Monthly program and portfolio meetings ensure collaborative discussions and data-informed decision-making for project optimization, aligning corporate and OEB objectives. Further details can be found in Schedule 2-5-4 - Asset Management Process and in Schedule 1-3-4 - Facilitating Innovation & Continuous Improvement.
- **Productivity Management:** Recognizing the significance of pole and cable renewal programs, Hydro Ottawa is committed to optimizing program efficiency. This includes tracking unit costs to identify constraints, proactively mitigate risks, and ensure fiscally responsible resource management. New KPIs are being implemented to support monitoring, transparency, and continuous improvement in productivity. Further details can be found in Schedule 1-3-4 - Facilitating Innovation & Continuous Improvement.

- **Improving Outage Restoration:** Based on analyzing the reliability trends between 2019 and 2023, Hydro Ottawa has observed an overall increase in the annual outage duration aspect, despite a decrease in the number of customer interruptions and outage count (with the SAIDI targets not met in 2022 and 2023). Overall, the 5-year averages of both SAIDI and SAIFI have been declining since 2014, indicating a positive trend.

When analyzing the factors impacting SAIDI, Hydro Ottawa has observed:

- Delays in making the outage area safe (coordinating with the City of Ottawa and Emergency Services);
- Increase in adverse weather events (not classified as MEDs) requiring increased patrolling and safety measures prior to restoration;
- Need for more fault locating equipment and SCADA switches;
- Tree contact due to deteriorating vegetation outside of the regular trim zones (requiring additional support and time for clearing); and
- Foreign interference due to motor vehicle accidents and failure of customer owned equipment causing delays in restoration due to the coordination involved.

The number of customer interruptions (measured through SAIFI) have continued to improve due to the prioritization of asset renewals in a deteriorated condition that impact system reliability and factors such as continued improvements to protection coordination, feeder reconfigurations, improving redundancy etc.

As a part of continuing to reduce outage restoration times, Hydro Ottawa is proposing investments in the Distribution Enhancements program, with the following intended benefits:

- **Faster Restoration Times**: Distribution enhancements like automated switches, additional feeder ties, and system reconfiguration provide system operators with more options for isolating outages and restoring load. This leads to faster restoration times and reduces the duration of outages for customers.

- **Backup Supply Options**: Feeder ties and network reconfiguration provide backup supply options during contingency scenarios, such as equipment failures or storm damage. This ensures that customers can be re-energized more quickly, even if part of the system is damaged.
- **Improved System Observability**: Enhancements to system observability allow for real-time monitoring of distribution asset performance. This enables early detection of issues, proactive intervention to prevent failures, and more efficient outage response and troubleshooting.
- **Increased Resilience**: Investments in grid resilience, such as strategic undergrounding and pole line reinforcement, reduce the likelihood of damage from adverse weather events. This minimizes the number of outages and speeds up the restoration process when outages do occur.

Investments in the distribution enhancements program are targeted to improve the speed and efficiency of outage restoration by providing System Operators with more tools and options, thereby enhancing system visibility and increasing the overall resilience of the grid. More information regarding Hydro Ottawa's distribution enhancements program can be found in Section 3 of Schedule 2-5-8 - System Service Investments.

Hydro Ottawa is committed to ensuring grid resilience and providing reliable service to customers by proactively mitigating potential risks. This is achieved through a multifaceted approach that incorporates continuous improvement initiatives, robust governance structures, and effective productivity management. Recognizing that risk is a function of both the probability of an event and its potential impact, Hydro Ottawa proactively manages risk by prioritizing strategies that both minimize the probability of known risks and mitigate the impact of unforeseen events to safeguard its infrastructure, maintain operational efficiency, and provide a consistent and dependable service to its customers.

6. PERFORMANCE MEASUREMENT FRAMEWORK

Hydro Ottawa maintains a strong commitment to transparent monitoring and reporting of its performance in alignment with the rules, regulations and guidance provided by the OEB. This commitment is demonstrated through comprehensive annual reporting, including RRRs, the Electricity Utility Scorecard submission, and annual Custom Incentive Rate (CIR) reports.

For the 2026-2030 DSP, Hydro Ottawa has transitioned to a risk-based asset management framework, augmented by advancements in data analytics capabilities. This evolution has informed the approach to performance measurement.

The adoption of risk-based asset management, coupled with strategic investments in analytics, enables a more comprehensive assessment of Hydro Ottawa's network assets. The 2026-2030 DSP performance outcomes are specifically designed to directly evaluate plan performance at the Material Investment Plan (MIP) level, ensuring greater accuracy and alignment with the company's evolving operational context. Hydro Ottawa has defined MIPs across the four key investment categories:

- System Access - Schedule 2-5-6 - System Access Investments
- System Renewal - Schedule 2-5-7 - System Renewal Investments
- System Services - Schedule 2-5-8 - System Service Investments
- General Plant - Schedule 2-5-9 - General Plant Investments

The performance of each MIP aligns with the performance outcomes established by the OEB. The relationship between OEB performance outcomes, investment categories, and KPIs is detailed in Table 27 below. Further details regarding the expected performance of each MIP are provided in the referenced schedules.

The alignment between Hydro Ottawa's Asset Management Objectives, Corporate Strategy, and the OEB's performance outcomes is visually represented in Figure 5 of Section 4.2 in Schedule 2-5-4 - Asset Management Process.

Table 27 - KPI Names and Categories

Investment Category	OEB Performance Outcome	KPI Name	KPI Target
System Access (Schedule 2-5-6)	Public Policy Responsiveness Customer Focus	New Residential & Small Business Services Connected on Time	≥ 95%
System Renewal (Schedule 2-5-7)	Operational Effectiveness	Reliability Risk Reduction - All Assets	Monitor
		Number of 4kV Feeders Converted	30
		Length of Cable Replaced	≥ 90%
		Number of Poles Replaced	≥ 90%
		Percentage of Metering Assets reaching EOL	≤ 56%
System Service (Schedule 2-5-8)	Operational Effectiveness Customer Focus	Incremental System Capacity	577 MVA
		Station Loading Index	0%
		Controllability & Observability	≥ 30%
		Resilience Risk Mitigated	≥ 15,000
		Worst Performing Feeders	≤ 6
		Percentage of Field Area Network (FAN) assets centrally managed	≥ 60.0%
		Field Area Network (FAN) System Service Level Agreement	99.9%
General Plant (Schedule 2-5-9)	Operational Effectiveness	Percentage of Medium and Heavy Duty Fleet Vehicles at End of Life (EOL)	10-15%
		Network & Service Uptime	≥ 99.9%
		Percentage of Systems that are Supported	≥ 95%
		Percentage of Systems that are Current	≥ 75%

6.1. SYSTEM ACCESS

New Residential & Small Business Services Connected on Time

This KPI, as defined in Section 7.2 of the Distribution System Code and discussed in Attachment 1-3-3(C) - Electric Utility Scorecard Analysis, tracks percentage of new service connection requests for low-voltage customers (less than 750 volts) completed within five business days after all applicable service conditions are satisfied, or at a later date agreed upon by the customer and distributor.

Hydro Ottawa’s target is to meet this timeline for a minimum of 95% of these connection requests.

6.2. SYSTEM RENEWAL

Reliability Risk Reduction - All Assets

This KPI measures the overall reliability risk associated with all major assets. It tracks the reduction in this risk as compared to the 2024 baseline level.

Hydro Ottawa's target is to monitor the overall reliability risk score for assets by 2030 compared to the 2024 baseline.

Number of 4kV Feeders Converted

This KPI tracks the feeder conversions driven by the planned decommissioning of EOL 4kV station assets during the 2026-2030 rate period.

Hydro Ottawa's target is to convert 30 4kV feeders by 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-7 - System Renewal Investments.

Length of Cable Replaced

This KPI measures the percentage of the actual length of cable replaced versus the planned length, in km, through the Cable Replacement program.

Hydro Ottawa's target is to replace at a minimum 90% of the planned length of cable, in km. This is a five-year target based on the initiatives outlined in Schedule 2-5-7 - System Renewal Investments.

Number of Poles Replaced

This KPI measures the percentage of the number of poles replaced versus the planned number of poles through the Pole Renewal program.

Hydro Ottawa's target is to replace at a minimum 90% of the planned number of poles. This is a five-year target based on the initiatives outlined in Schedule 2-5-7 - System Renewal Investments.

Percentage of Metering Assets reaching EOL

This KPI measures the proportion of metering assets that have reached or exceeded their EOL. The goal is to meet or achieve a reduction in the 2030 projected percentage of assets reached or exceeded EOL. This indicates improved asset health and reduced risk of failure.

Hydro Ottawa's target is to achieve a percentage of metering assets reaching EOL at or below 56% by 2030. This is a five-year target based on the initiatives outlined in the MIP.

6.3. SYSTEM SERVICE

Incremental System Capacity

This KPI measures the increase in incremental system capacity achieved through Hydro Ottawa owned stations and Non-Wires Solutions (NWSs) planned upgrades. The target is to increase capacity by 577 MVA through a combination of new station construction or upgrades, and Hydro Ottawa owned Battery Energy Storage System (BESS) unit installations. Note that this target is gross, and does not include the decommissioning of station assets.

Hydro Ottawa's target is to achieve a total capacity increase of 577 MVA by 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Station Load Index

This KPI measures the percentage of stations operating with a load index of 4 or 5, as defined in Section 8.4 of Schedule 2-5-4 - Asset Management Process. A load index of 4 or 5 signifies that a station is operating near or exceeding its capacity rating, posing a risk to reliability and stability.

Hydro Ottawa's target is zero stations with a Load Index of 4 or 5 by 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Controllability & Observability

This KPI tracks the percentage of normally-open overhead and underground distribution switches that are equipped with automation capabilities. This measures the extent to which the distribution grid can be remotely controlled and its status remotely monitored.

Hydro Ottawa's target is to achieve a minimum of 30% of all normally-open overhead and underground switches to be automated by 2030, measured against the 2024 baseline. This is a 5-year year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Resilience Risk Mitigation

This KPI measures the effectiveness of investments in enhancing the resilience of the distribution grid to adverse weather events. Specifically, it quantifies the monetary value of the enhanced resilience achieved through risk mitigation resulting from undergrounding and other storm hardening projects. The unit of measurement is the Copperleaf value point, where one point is equivalent to approximately $1,000, as defined in Section 5.3.2.2 of Schedule 2-5-4 - Asset Management Process.

Hydro Ottawa's target is to achieve or exceed a resilience risk mitigation score of 15,000 by 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Worst Performing Feeders

This KPI measures the number of distribution feeders classified as "worst performing" based on their Feeder Performance Index (FPI) score. A feeder is considered "worst performing" if its FPI score falls below 30, indicating "Very Poor" performance, as defined in Section 4.3 Worst Feeder Analysis.

Hydro Ottawa's target is to not exceed six feeders classified as worst performing. This target is based on the historical average number of worst-performing feeders from 2019-2023.

Percent of Field Area Network (FAN) Assets centrally managed

This KPI measures the percentage of eligible Remote Terminal Units (RTUs) within the Field Area Network that are centrally managed. Hydro Ottawa's target is to achieve at or above 60% of eligible RTUs centrally managed by the end of 2030. This is a five-year target based on the initiatives outlined in Schedule 2-5-8 - System Service Investments.

Field Area Network (FAN) Service Level Agreement for Class A Systems

This KPI measures the system's performance against a predefined maximum allowable downtime (Recovery Time Objective) and a maximum data loss in the event of a failure (Recovery Point Objective).

All IT systems are categorized by the business process they support. Class A systems support Mission Critical business processes which are defined as a business process if stopped, or becomes unavailable for any period of time, directly affecting the delivery of core product and/or time critical operations. Full restoration of normal functionality must be in place otherwise it will:

- Put employee and public health and safety at risk;
- Significantly impact public perception of Hydro Ottawa;
- Result in customer service levels falling below acceptable levels;
- Result in regulatory, legal or contractual infractions that will have significant financial/negative consequences to Hydro Ottawa;
- Result in significant damage/loss to Hydro Ottawa assets;
- Result in finable environmental damage; and/or
- Result in unacceptable backlog or lost work.

The performance target for Hydro Ottawa's Field Area Network (FAN), which supports mission-critical business processes, is 99.9% availability. This target is defined as a maximum allowable downtime of 4 hours and a maximum allowable data loss of 24 hours.

6.4. GENERAL PLANT

Percentage of Medium and Heavy Duty Fleet Vehicles at End of Life

This KPI measures the proportion of medium and heavy-duty fleet vehicles that have reached or exceeded their end of useful life (EOL). The target range is 10% to 15%. This range acknowledges that some vehicles may remain functional and safe beyond their typical lifespan due to condition-based replacement, minimizing maintenance costs and supporting operational efficiency. However, these heavy and medium-duty vehicles are critical workhorses, representing approximately 80% of the capital expenditures in the 2026-2030 fleet program. Therefore, maintaining the EOL percentage below 15% is crucial. Exceeding this threshold poses a significant risk due to the long lead times required for replacing these specialized vehicles. Unlike lighter-duty assets, readily available rentals or replacements for equipment like bucket trucks are not typically an option, making fleet availability paramount for uninterrupted operations. A target range of 10-15% is considered optimal to balance cost-effectiveness with the critical need to maintain a reliable fleet.

Infrastructure & Cyber Security

There are a few key KPIs that can be used to measure the performance of Infrastructure & Cyber Security Programs. These KPIs have been incorporated into KRIs that are defined in Section 8 of Schedule 2-5-9 - General Plant Investments, including:

- **Network & Service Uptime**
  This KPI will measure the overall service uptime of Hydro Ottawa's core network to ensure defined SLAs are met for Class A, B & C networks. This is a quantitative metric.
- **Systems that are Supported**
  The % of network systems that are currently running at a vendor supported level and not EOL. Systems that are EOL result in greater risk to the organization. This is a quantitative metric.

- **Systems that are Current**

  The % of network systems that are running software/firmware/baseline that are at the Vendor's recommended level. Maintaining systems at the Vendor's recommended level ensures the latest features, bug fixes and security updates have all been incorporated. This is a quantitative metric.

7. RELIABILITY TARGETS

In alignment with OEB requirements and the Electricity Utility Scorecard, Hydro Ottawa will continue to utilize SAIDI and SAIFI performance benchmarks, derived from historical averages, to establish reliability targets for the 2026-2030 period.

Attachment 2-5-3(A) - OEB Appendix 2-G - Service Quality and Reliability Indicators

(Refer to the attachment in Excel format)

ASSET MANAGEMENT PROCESS

1. OVERVIEW

Hydro Ottawa's 2026-2030 capital expenditure plan, as developed through the asset management process, demonstrates a comprehensive and forward-thinking approach to asset management. It is guided by the corporate Eight point strategy in Section 3.2 - Corporate Strategy Objectives, the plan aligns with the OEB's performance outcomes and prioritizes customer preferences identified through engagement as in Section 3.3 - Customer Preference and Priorities. Hydro Ottawa advances the corporate objectives and customer priorities through five core business strategies—Asset Management, Grid Modernization, Digital, Facilities, and Fleet—which provide a framework for the development of targeted investment plans. Notably, the Grid Modernization strategy effectively bridges Asset Management and Digital initiatives, ensuring a cohesive approach to technological advancement as described in Section 3.4 - Business Strategies.

This strategic framework is operationalized through Hydro Ottawa's ISO 55001-certified Asset Management System (AMS). The AMS employs a structured four-stage process (prepare, plan, optimize, execute) to ensure methodical asset management, aligning expenditures with the four Investment Priorities: Growth & Electrification, Renewing Deteriorating Infrastructure, Grid Modernization and Enhancing Resilience as described in Section 4.3 - Asset Management Process Overview. Hydro Ottawa's commitment to continuous improvement, as demonstrated by ongoing enhancements to the AMS, includes the implementation of predictive analysis, refined inspection programs, and comprehensive asset health indexing as in Section 4.4 - Asset Management Process Enhancements. This commitment extends beyond the AMS, encompassing a Decarbonization Study projecting future electricity demand, a Climate Study reaffirming the efficacy of existing adaptation measures, and a Resilience Assessment informing a multi-faceted resilience program as described in Section 4.4 - Asset Management Process Enhancements.

These initiatives are critical for managing the complexities of Hydro Ottawa's distribution system, a substantial network encompassing over 364,000 customers and facing diverse challenges, including geographic constraints, the evolving impacts of climate change, and escalating demand as described in Section 6 - Overview of Distribution System. Regional-based planning rigorously considers Ottawa's unique landscape, including its intricate river systems, the protected Greenbelt, and federal lands, while addressing the region's challenging soil conditions and seismic activity detailed in Section 6.3 - Geographic Planning Considerations. Within this context, the utility maintains a vigilant watch on climate change impacts, including temperature extremes and the increasing frequency of high wind events, proactively implementing adaptation measures to bolster grid resilience as in Section 6.4 - Historical and Future Climate. Furthermore, to effectively accommodate escalating demand-driven by residential expansion, the electrification of transportation, and the growing adoption of electric space heating - Hydro Ottawa is strategically augmenting system capacity as described in Section 6.5 - System Demand and Growth Planning Considerations.

Hydro Ottawa is committed to providing a sustainable and dependable electricity service by optimizing asset lifecycles and ensuring reliability and cost-effectiveness through informed asset management practices. A comprehensive analysis of managed assets provides detailed insights into their demographics, condition, failures, and risk profiles, highlighting the critical need for proactive replacement of deteriorating infrastructure, detailed in Section 7 - Overview of Assets Managed. To this end, Hydro Ottawa methodically optimizes asset lifecycles by establishing robust typical useful life (TUL) values, conducting thorough asset replacement and refurbishment analyses, and actively monitoring asset utilization through key performance indicators (KPIs) such as the Station Load Index (SLI) and Feeder Load Index (FLI), as described in Section 8 - Asset Lifecycle Optimization Policies and Practices. Stringent inspection and maintenance programs further ensure the continued safe and reliable operation of the electrical grid as in Section 8.2 - Asset Replacement and Refurbishment Policies.

Hydro Ottawa undertakes a comprehensive System Capacity Assessment, incorporating detailed load forecasting that considers customer growth and electrification, as shown in Section 9 - System Capacity Assessment. Immediate capacity constraints are strategically addressed through the construction of new stations, targeted upgrades, and the implementation of Non-Wires Solutions (NWSs), while medium and long-term needs are met through voltage conversions, strategic distribution transfers, and additional NWSs as described in Section 9.2 - Non-Wires Solutions to Address System Needs. Hydro Ottawa will actively leverage NWSs, including utility owned battery storage solutions and a comprehensive Non-Wires Customer Solutions Program, to proactively manage peak demand, enhance grid reliability, and seamlessly support the integration of distributed energy sources (DERs) as detailed in Section 9.4 - Planning Load Forecasting. Through this holistic and integrated planning process, Hydro Ottawa is strategically investing in its electricity grid to ensure its reliability, resilience, and customer-centricity for the long term.

Hydro Ottawa's asset management practices leverage forward-thinking strategies that anticipate the complexities of a future grid. By incorporating considerations for increased electrification, seamless DER integration, and the evolving impacts of climate change, alongside the asset renewal drivers, this comprehensive strategy enables Hydro Ottawa to not only meet the needs of its customers but also to ensure the long-term sustainability and resilience of its electricity distribution system.

2. INTRODUCTION

This document provides a comprehensive overview of Hydro Ottawa's Asset Management Process. It outlines the strategic framework that guides asset management and integrates decisions with core business strategies and customer preferences.

Hydro Ottawa's systematic approach encompasses lifecycle optimization, risk mitigation, and system capacity assessment. It enables the utility to effectively plan, prioritize, and optimize expenditures.

The planning processes result in a capital expenditure plan that delivers on four Investment Priorities: Growth & Electrification, Renewing Deteriorating Infrastructure, Grid Modernization, and Enhancing Grid Resilience.

The following sections detail Hydro Ottawa's asset management process and how the utility ensures the reliability, resilience, and customer-centricity of its electricity grid.

- **Section 3:** Describes Hydro Ottawa's integrated business planning process
- **Section 4:** Presents Hydro Ottawa's asset management system
- **Section 5:** Explains the detailed asset management process
- **Section 6:** Provides an overview of Hydro Ottawa's distribution system
- **Section 7:** Details the assets managed by Hydro Ottawa
- **Section 8:** Describes the policies and practices for asset lifecycle optimization
- **Section 9:** Presents Hydro Ottawa's system capacity assessment

3. PLANNING PROCESS

This section provides a comprehensive overview of Hydro Ottawa's integrated business planning process, the foundation upon which the utility built its capital expenditure plan for the 2026-2030 period. As detailed in Section 3.1 - Business Planning Process, this plan is not developed in isolation; it is the direct result of a robust and iterative process that aligns strategic objectives, as detailed in Section 3.2 - Corporate Strategic Objectives, incorporates extensive customer engagement in Section 3.3 - Customer Preferences and Priorities, and addresses the specific needs of various asset categories.

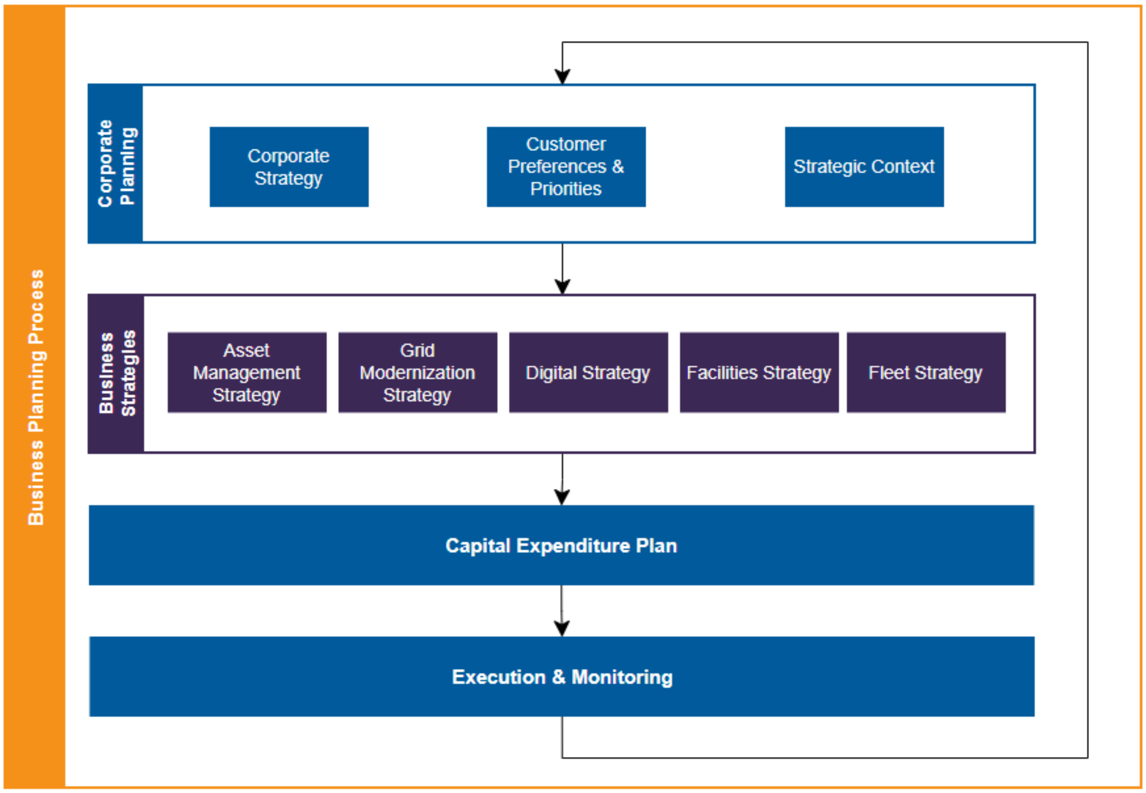
Hydro Ottawa's approach emphasizes a cascading structure, where high-level corporate planning informs specific business strategies, which in turn guide the development of detailed investment plans. This section will explore the key drivers behind Hydro Ottawa's 2021-2025 Strategic Direction, including the "5 Ds" (Decarbonization, Digitization, Decentralization, Diversification, and Demographics) and the utility's overarching Eight point plan (see Figure 2).

It will delve into the customer engagement process, as detailed in Section 3.3 - Customer Preferences and Priorities, highlighting how customer feedback shapes investment priorities and ensures that the plan reflects the needs and expectations of the community it serves. Furthermore, this section details the five core business strategies: Section 3.4.1 - Asset Management Strategy, Section 3.4.2 - Grid Modernization Strategy, Section 3.4.3 - Digital Strategy, Section 3.4.4 - Facilities Strategy, and Section 3.4.5 - Fleet Strategy. Finally, it will examine the capital expenditure planning process itself in Section 3.5 - Capital Expenditure Planning Process, from the development of individual investment plans to their consolidation and prioritization within the broader Capital Expenditure Plan as detailed in Schedule 2-5-5 - Capital Expenditure Plan. This section aims to provide a clear understanding of how Hydro Ottawa strategically plans for its future, ensuring a reliable, sustainable, and customer-centric electricity grid.

3.1. BUSINESS PLANNING PROCESS

Hydro Ottawa's capital expenditure plan is an output of the utility's integrated business planning process. Through this process, Hydro Ottawa advances its overall strategic objectives and provides value to customers by establishing goals and priorities, allocating resources, monitoring performance, identifying areas for improvement, and adapting to developments in the external business environment. Figure 1 outlines the top-level inputs and flows through the business planning process to ultimately deliver a final capital expenditure plan for the four investment categories: System Access, System Renewal, System Service, and General Plant. See Schedule 2-5-5 - Capital Expenditure Plan, for the 2026-2030 Capital Expenditure Plan.

Figure 1 - Business Planning Process



3.1.1. Corporate Planning

Attachment 1-2-3(A) - Corporate Memorandum - 2024-2030 Priorities and Budget Guidelines provides an overview of the business planning process employed by Hydro Ottawa to prepare for this application, including the capital expenditure plan.

The memorandum comprises a set of formal guidelines prepared by the Chief Financial Officer for five-year budgets covering the 2026-2030 rate period. This internal guidance was circulated more than one year in advance of the expected filing date of the rebasing application.

The document serves a number of purposes:

- laying out the timeline for the development of preliminary capital and operational budgets;
- finalizing spending plans based on customer feedback;
- outlining considerations for capital investments and operational expenditures;
- identifying constraints and expectations with respect to such matters as inflation, compensation and headcount;
- stipulating requirements related to productivity, continuous improvement and cost control; and
- directing the alignment of spending with customer interests and outcomes, see Section 3.3 - Customer Preferences and Priorities, the utility's strategic objectives, see Section 3.2 - Corporate Strategic Objectives, and OEB's policy and direction.

The process mapped out in this Corporate Memorandum attests to the rigour, discipline, and customer-oriented focus of Hydro Ottawa's business planning activities.

Affordability was a key consideration when preparing and evaluating preliminary capital and operational budgets. "Affordability" refers to both customer ability and willingness to pay, as well as Hydro Ottawa's financial ratios and capacity to deliver. Throughout the planning process, affordability was essential to optimize the proposed capital expenditure plan and balance rate impacts with the achievement of outcomes valued by customers.

3.1.2. Business Strategies

Hydro Ottawa's five business strategies — Asset Management, Grid Modernization, Digital, Facilities, and Fleet — guide the objectives of its expenditure plan. These strategies share a consistent framework, beginning with corporate planning and then incorporating specific objectives tailored to the scope of each strategy and the assets it oversees. This ensures resulting investment plans contribute to Hydro Ottawa's overall strategic objectives. Because the Grid Modernization Strategy's objectives are achieved through the Asset Management and Digital Strategies, rather than through distinct assets, it does not generate a separate, independent set of investment plans. Instead, it informs and shapes the investment plans developed within the Asset Management and Digital strategies. See Section 3.4 - Business Strategies of this schedule for details on each of the five business strategies.

3.1.3. Capital Expenditure Plan

The investment plans developed for each business strategy (except Grid Modernization, as described above) translate the Strategic Direction, customer insights, and asset-specific objectives into concrete investment needs. These needs are then consolidated through the expenditure planning process, which serves as the mechanism for prioritizing and coordinating the various investment needs identified for each asset category.

3.1.4. Execution & Monitoring

During the 2026-2030 rate period, Hydro Ottawa will continuously monitor and evaluate its execution of the capital expenditure plan, and will consider adjustments to the plan as part of the annual refresh of its business plan and budget. These adjustments may be required during a given calendar year based on a variety of factors (e.g. prior year results; macroeconomic pressures such as interest rates or inflation; and major shifts in the business or operating environment, including severe weather events). Hydro Ottawa is committed to ensuring effective execution of its capital expenditure plan and will continue to implement appropriate controls through annual business planning in support of this priority.

3.2. CORPORATE STRATEGIC OBJECTIVES

Hydro Ottawa's Strategic Direction sets the organization's overarching objectives, which, in turn, drive the planning practices.

Hydro Ottawa's corporate strategy[1] was formulated, and continues to be implemented, against the backdrop of major shifts in the company's operational, business, and policy environments. These key change drivers are collectively referred to as the "5 Ds" and consist of the following:

[1] Hydro Ottawa Holding Inc., 2021-2025 Strategic Direction.

- **Decarbonization** - the removal or reduction of carbon dioxide emissions; the switch to usage of low-carbon energy sources;
- **Digitization** - the conversion of information and processes from analog to digital form;
- **Decentralization** - the transition from large, centralized production and networks to smaller, more distributed production and networks;
- **Diversification** - the process of enlarging a business or varying its range of assets, products, services, business lines, and operational fields; and
- **Demographics** - the 'people' side of the electricity business – customers, community, employees.

The utility's strategy is anchored in an Eight point plan for responding to these external change drivers, while providing value to customers, growing the business, and embedding sustainability into all areas of operations. These eight strategic objectives are outlined in Figure 2.

Figure 2 – Hydro Ottawa's Strategic Objectives

Hydro Ottawa's strategic objectives are aligned with the four core performance outcomes established by the OEB for electricity distributors under the Renewed Regulatory Framework (RRF). This mapping is shown in Table 1.

Table 1 – Alignment between Hydro Ottawa's Strategic Objectives and OEB RRF Performance Outcomes

RRF Performance Outcomes	Corporate Strategic Objectives
Financial Performance	Continue to grow and diversify our revenue sources
	Become the partner of first choice for signature green energy and carbon reduction projects in our community
Customer Focus	Continue to provide best-in-class customer service
	Leverage and promote distributed energy resources
Operational Effectiveness	Accelerate digital transformation to ensure sustainable business practices
	Ensure organizational capacity, culture and leadership to deliver
Public Policy Responsiveness	Achieve net-zero operations by 2030
	Grow our social license to operate

For additional information on Hydro Ottawa's corporate strategy, please see Schedule 1-2-3 - Business Plan.

3.3. CUSTOMER PREFERENCES AND PRIORITIES

As described in Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application, Hydro Ottawa engaged Innovative Research Group (Innovative Research), a national consulting firm with expertise in public opinion research and experience in energy policy. They were hired to collaboratively design, test, and implement a strategy for engaging customers on Hydro Ottawa's 2026-2030 rate application proposals.

An iterative, two-phase customer engagement process was undertaken, with the following key principles adopted in order to maximize the effectiveness of the process:

- Ensure all Hydro Ottawa customers have an opportunity to be heard
- Ensure a representative sample of customers are engaged
- Create an open, voluntary process to allow any customer the opportunity to provide comment
- Focus on the key outcomes and customer preferences
- Inform customers about the distribution system and electricity industry

Phase I

Phase I of the Customer Engagement process surveyed Hydro Ottawa's residential customers, small business customers, Commercial & Industrial (C&I) customers, and key accounts. The purpose of this survey was to gather feedback and insights on priorities, preferences, and needs from these customers. The information collected through this survey helped inform the inputs used to develop the Focus Areas of the Distribution System Plan (DSP) and Business Plan, which were shared in draft with customers in Phase II.

For each customer class, Innovative Research conducted online surveys and focus groups in Phase I. Using these results, Innovative Research established baselines and developed weights that allowed a move to an online methodology for Phase II of the customer engagement program.

Engagement results and key findings from Phase I, in relation to satisfaction and general priorities, include:

- Customer satisfaction has improved relative to 2019 for residential and small business customers.

- Residential and small business customers prioritize very similar general outcomes, with both ranking "maintaining reliable electricity service" as their top priority.
- Commercial and industrial and key account customers have more distinctive prioritizations, with reliable service being important, but outranked by the related and more specific objective of hardening the grid to withstand severe weather. Capacity to meet future demand was also a high-ranked priority of these customer classes.

This feedback helped Hydro Ottawa develop the four themes around which its investment plan is organized for communication with customers:

- Aging Infrastructure
- Grid Resilience
- Growth & Electrification
- Grid Modernization

Phase II

Phase II of the Customer Engagement process focused on gathering customer feedback on Hydro Ottawa's proposed investment plan. This was achieved through an online survey that presented the plan's four key categories: Growth and Electrification, Aging Infrastructure, Grid Modernization, and Grid Resilience. The survey aimed to gauge customer investment preferences across these categories and assess the overall level of support for the proposed plan by outlining priority investment options with varying paces and cost impacts, enabling them to directly influence the final plan by providing feedback on their preferred balance of cost, timing, and system outcomes (reliability, resilience, renewable integration).

Key Findings:

- **Strong Support for the Plan:** The results demonstrated strong overall support for the plan, particularly among commercial customers who recognize the value of a reliable and modern electricity grid. An average of 87% of customers, across all rate classes, gave Hydro Ottawa social permission to proceed with its draft plan. These customers provided social permission by indicating either:

   - 16% think Hydro Ottawa should accelerate spending beyond the level in the draft plan to deliver better system outcomes.
   - 28% support the proposed rate increase that is reflected in the draft plan, or
   - 43% They feel that the proposed rate increase in the draft plan is necessary, even though they don't like the proposed rate increase.

- **Acceptance of Necessary Increases:** While many customers expressed a general dislike for bill increases, a majority within each customer category acknowledged the necessity of these increases to fund critical system investments.
- **Desire for Accelerated Investment:** A significant minority of respondents favoured an even faster pace of investment, indicating a willingness to absorb higher near-term costs to expedite system upgrades and realize their associated benefits sooner.

Phase II of the Customer Engagement process successfully gathered valuable customer feedback on Hydro Ottawa's proposed investment plan. The results demonstrated strong overall support for the plan, particularly among commercial customers, and provided insights into customer perspectives on affordability and the need for continued investment in a reliable and sustainable electricity system.

This feedback provided valuable insight into customer perspectives on the balance between affordability and the need for continued investment in a reliable and sustainable electricity system, which is outlined in Table 2.

Table 2 - Support for Proposed Investment Plan per Rate Class[2]

Support for Proposed Investment Plan	Residential	Small Business	C&I and Key Account (GS>50 kW)
I think Hydro Ottawa should accelerate spending beyond its proposed draft plan to deliver better system outcomes	19%	20%	8%
I support the proposed bill increase when it comes to preparing Hydro Ottawa's grid for the future	28%	25%	32%
I don't like the proposed bill increase, but I think it's necessary to maintain the grid to a reasonable standard and prepare for the future	37%	39%	54%
Total Social Permission for Investment Plan	**84%**	**83%**	**94%**
I oppose the bill increase and think Hydro Ottawa needs to scale back its plan	11%	13%	2%
I don't know	5%	4%	4%

3.4. BUSINESS STRATEGIES

This section outlines business strategies that oversee the key asset categories: Asset Management, Grid Modernization, Digital, Facilities, and Fleet. These strategies are grounded in a consistent framework that aligns corporate Strategic Direction and customer feedback with individual asset needs. The following sections detail the specific strategies for each category.

3.4.1. Asset Management Strategy

Hydro Ottawa's Asset Management Strategy, which covers distribution assets, creates the crucial link between the company's overarching strategic objectives and customer preferences and priorities down through to the Asset Management Objectives, as illustrated in Figure 5. These objectives then guide the development of individualized asset management plans

[2] Totals may not sum due to rounding.

(AMPs) that support the foundation of the capital investment planning process. See Section 4.2 - Asset Management Scope, Strategy and Objectives for further details on the strategy.

3.4.2. Grid Modernization Strategy

Hydro Ottawa's Grid Modernization Strategy is a comprehensive plan to address evolving challenges in the utility sector. Developed in response to deteriorating infrastructure, decarbonization, and changing customer expectations, the strategy aims to enhance grid reliability, flexibility, resilience, and customer engagement while promoting sustainability. The strategy promotes five grid modernization objectives, and aligns with the company's Eight point strategy, see Section 3.2 - Corporate Strategic Objectives, emphasizing data-driven and technologically-advanced grid management.

A reliable and modernized grid is at the core of Hydro Ottawa's Strategic Direction. To enable the company's Eight point strategy, the grid modernization plan outlines five grid modernization objectives:

1. **Enhanced Reliability**
   Improve grid reliability through advanced monitoring, proactive failure detection, fast fault detection, automated power control, automated system restoration, and reduced outage times.
2. **Adaptive Grid Flexibility**
   Enable the grid to adapt to the changing energy demand and incorporate diverse energy sources.
3. **Fortified Resilience & Robust Security**
   Improve the grid's ability to withstand disruptions caused by system faults or extreme weather and protect its assets from cyber threats.
4. **Strengthened Customer Engagement & Empowerment**
   Engage and empower customers by providing them with real-time data, efficient billing, and tools to manage their energy use.

5. Sustainable Decarbonization & Renewable Integration

Reduce carbon emissions and promote sustainability by optimizing grid planning and operations to support the integration of renewable energy sources.

Table 3 illustrates how each of the five objectives contribute to the Eight point strategy.

The Grid Modernization Strategy translates the corporate priorities into actionable objectives, which are then achieved through the Asset Management and Digital Strategies. This strategy informs the objectives of both the Asset Management and Digital Strategies, ensuring coordinated investment and avoiding duplicated effort or inefficiencies that could arise from shared asset accountabilities. Specifically, it allows for sole oversight and coordination of distribution assets under the Asset Management framework and information technology (IT) assets under the Digital framework.

The Grid Modernization Roadmap operationalizes the Grid Modernization Objectives in conjunction with the Capital Expenditure plan. The Strategy defines the needs, which are then translated through the Asset Management and Digital strategy processes into concrete investment plans. These plans are consolidated within the capital expenditure planning process and monitored through the Grid Modernization Roadmap to ensure the Grid Modernization Objectives are achieved.

Table 3 - Comparative Analysis of Grid Modernization Objectives and Eight Point Strategy

		Eight Point Strategy							
		Achieve net-zero operations by 2030	Become the partner of first choice for signature green energy and carbon reduction projects in our community	Accelerate digital transformation to enable sustainable business practices	Leverage and promote distributed energy resources	Continue to grow and diversify our revenue sources	Grow our social license to operate	Ensure organizational capacity, culture, and leadership to deliver in a post-pandemic environment	Continue to provide best-in-class customer service
Grid Modernization Objectives	1. Enhance Reliability			✓	✓		✓	✓	✓
	2. Adaptive Grid Flexibility	✓	✓	✓	✓			✓	✓
	3. Fortified Resilience & Robust Security			✓	✓		✓	✓	✓
	4. Strengthened Customer Engagement & Empowerment		✓	✓	✓	✓	✓	✓	✓
	5. Sustainable Decarbonization & Renewable Integration	✓	✓	✓	✓	✓	✓	✓	✓

3.4.3. Digital Strategy

The 2026-2030 Digital Strategy is built on the overarching Strategic Direction of Hydro Ottawa. There are five key themes of the digital strategy:

Customer Experience

Providing customers with the tools to understand their consumption patterns and costs, giving them more control over their usage. Generative AI will be able to assist customers 24/7, creating a faster and more convenient way for customers to get answers.

Employee Experience

Employees expect to be able to access the tools they need where they are, when they need them, in a secure manner. Touch-screen devices and modern applications, on web or mobile, augment workflow efficiency for employees in the field. HR and safety platforms will continue to be improved as a core aspect of the employee experience.

Productivity & Operational Effectiveness

The new Enterprise Asset Management (EAM) System referred to in Attachment 4-1-1(A) - Transition to Cloud Computing will improve lifecycle management and optimize resource planning. Planned enhancements to the ERP system will streamline workflows.

Grid Automation

Increasing demand for electricity, combined with the increasing threat of severe weather events, require a reliable and responsive grid. Automation and the integration of technology like DERs, have the potential to meet these needs.

Cyber Security & Business Continuity

The risks from cyber threats are growing as the world becomes more interconnected. Hydro Ottawa, as a critical infrastructure company, must invest not only protection from these threats, but proactive detection and response.

For more details on the Digital Strategy, please see Attachment 1-3-4(B) - Digital Strategy.

3.4.4. Facilities Strategy

The facilities strategy is a key pillar of Hydro Ottawa's Eight point plan by supporting the organization's capacity to deliver its programs and moving toward its goal of achieving Net-Zero Operations. The overall facilities strategy is to maintain facilities in a suitable condition for their intended purpose and to achieve the lowest overall lifetime cost of ownership. The Facilities Program manages a portfolio of administration, operations, and substation building components needed to provide the environment necessary for employees to work safely, effectively and efficiently as well as to protect and store inventory and operating equipment. For clarity, the substation building components refer to the building shell and supporting systems such as fencing, ground surfaces - asphalt / concrete, roofing, and HVAC Systems. Facilities are strategically located throughout Hydro Ottawa's service territory to provide operational coverage and allow for a central location for administration and for training functions.

Hydro Ottawa invests in building improvements that are critical to the operation of the utility's electricity distribution system. Capital expenditures in the Facilities Program relate to structures, systems, and site work necessary for a facility to reach its operational service life or capital expenditures that extend service life enhance capacity or functionality of the facility. For example, expenditures on window and roof replacement help to ensure an ongoing safe and effective work environment and also avoid the potential cost of building structural damage or deterioration and future costly repairs.

Operations and maintenance costs for these facilities are included in the Facilities Program and discussed in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

Hydro Ottawa's Facilities strategy is focused on two main types of facilities, as outlined below.

Administration Facilities

Hydro Ottawa's two main Administration centres are located at 2711 Hunt Club Road and 4565 Bank Street. The primary function of investments in these facilities is to help ensure productivity by replacing poor-condition and end-of-life assets that may otherwise cause hazards or business interruptions. Expenditures also include investments that support the utility's strategic objectives and outcomes, such as providing suitable space for new staff additions.

Stations and Operations Facilities

Stations and Operations facility capital investments are to sustain and improve buildings that house Hydro Ottawa's distribution stations and operations and manage risks that may arise from any facility's assets deteriorating to the point of poor condition or end of life. The integrity and operating condition of stations buildings may significantly affect safety and the reliability of distribution equipment housed within these assets, which are critical to grid safety and performance.

The Facilities Strategy considers both the condition of all facility assets in the process to develop the capital work program and the imperative to comply with legislative and regulatory requirements, as described below:

Asset Condition Assessment

Hydro Ottawa undertakes an Asset Condition Assessment (ACA) process to determine both (a) the risks that may be present in respect of facilities assets, and (b) plans to mitigate these risks. The results of this assessment and risk management prioritization process were used to inform the planned scope of the Facilities Program capital work for the 2026-2030 rate period. Without sufficient funding to make these investments, Hydro Ottawa's facilities would be exposed to the risk of structural failures, significant hazards, and/or damage, e.g. due to flooding or leaking. If these risks were to materialize, they could endanger Hydro Ottawa's employees and public safety and cause severe disruption to the utility's business activities and potentially prolonged outages.

Legislative and Regulatory Requirements

It is essential that Hydro Ottawa be compliant with applicable legislative and regulatory requirements, such as the *Occupational Health and Safety Act*, the Ontario Building Code and the Fire Code. The Facilities Program supports this by:

- Providing safe and functioning facilities by addressing deficiencies that may cause hazards;
- Addressing stations-related deficiencies such as the absence of secondary exits, non-compliant stairs, and inaccessible doors along pathways;
- Improving internal lighting conditions and external damaged lighting in work areas;
- Installing enhanced safety systems to deter theft, vandalism and reduce the risk of unauthorized access into work centres and stations; and
- Installing and improving security systems and technology.

Hydro Ottawa identified required work over the 2026-2030 rate period based on inspections and management judgement with respect to sound asset management practices. Capital expenditure decisions were also informed by Hydro Ottawa's Net-Zero Strategy. This includes replacements and upgrades of equipment that is reaching end of life with electrically powered equipment that meet certain standards and reduce environmental impacts, where it is feasible and cost effective to do so. These expenditures include electrical service upgrades that are necessary to support green initiatives and equipment such as electric heat pumps and water heaters. Further details on Hydro Ottawa's Net-Zero Strategy can be found in Attachment 4-1-3(E) - Health, Safety and Environmental Compliance, Sustainability and Business Continuity Management, Section 5.2. All identified work was prioritized and only critical projects are included in this plan. Projects that were identified but not funded in this plan will be brought forward in the next rate application.

3.4.5. Fleet Strategy

The fleet strategy is a vital component of Hydro Ottawa's Eight point plan by providing the vehicles and equipment that support the organization's capacity to deliver its programs and contribute toward its goal of achieving Net-Zero from operations. Hydro Ottawa's fleet management practices are governed by established corporate policies and procedures related to fleet operations and asset lifecycle management. Vehicle purchases are made in accordance with standard Hydro Ottawa procurement policies and procedures.[3] Hydro Ottawa's fleet is categorized as Light-duty (pick-up trucks, vans) for staff transport and inspections; medium-duty (dump trucks, step vans) for materials and mobile workshops; heavy-duty (bucket trucks) for line work; and specialized equipment (trailers, forklifts) for support.

The utility has a multi-year capital plan to effectively manage, replace and add to its fleet assets. The objectives of the fleet replacement/addition plan are as follows:

- **Safety:** Provision of safe, reliable, and efficient vehicles and equipment to meet operational requirements.
- **Regulatory:** Compliance with all applicable legislation and regulations, as well as accepted industry norms and practices. For example, Fleet must perform annual vehicle inspections to make sure vehicles are compliant with its Commercial Vehicle Operators Registration.
- **Financial:** Management of assets to the lowest overall lifecycle cost, while ensuring asset reliability and employee and public safety.
- **Environmental:** Environmental considerations from the point of procurement through the life of the vehicle. This includes consideration of fuel economy, exhaust emissions, route optimization, reducing idle time (through education of vehicle operators), and reviewing environmentally friendly options where feasible.
- **Operational:** Provision of readily available and reliable vehicles and equipment to meet the requirements of an expanding workforce.

A key objective is that capital investments be made at a level and pace that allows overall costs to be minimized. An optimally-timed vehicle replacement and growth strategy helps to ensure that the appropriate number of vehicles are available to support system maintenance and capital investment

[3] Please see Attachment 4-2-2(A) - Procurement Policy.

plans. The planned pooling program as described in Schedule 2-5-9 - General Plant Investments will further minimize costs and optimize vehicle utilization.

Hydro Ottawa's fleet replacement plan reviews all current vehicles and proposes future replacement dates and cost. The replacement plan is based on a vehicle-by-vehicle assessment weighing the following criteria:

- Vehicle age
- Mileage
- Engine hours
- Power take off (PTO) hours
- Operating and maintenance costs
- Repair history
- Availability of repair parts
- Overall internal mechanic assessment of vehicle condition
- Utilization

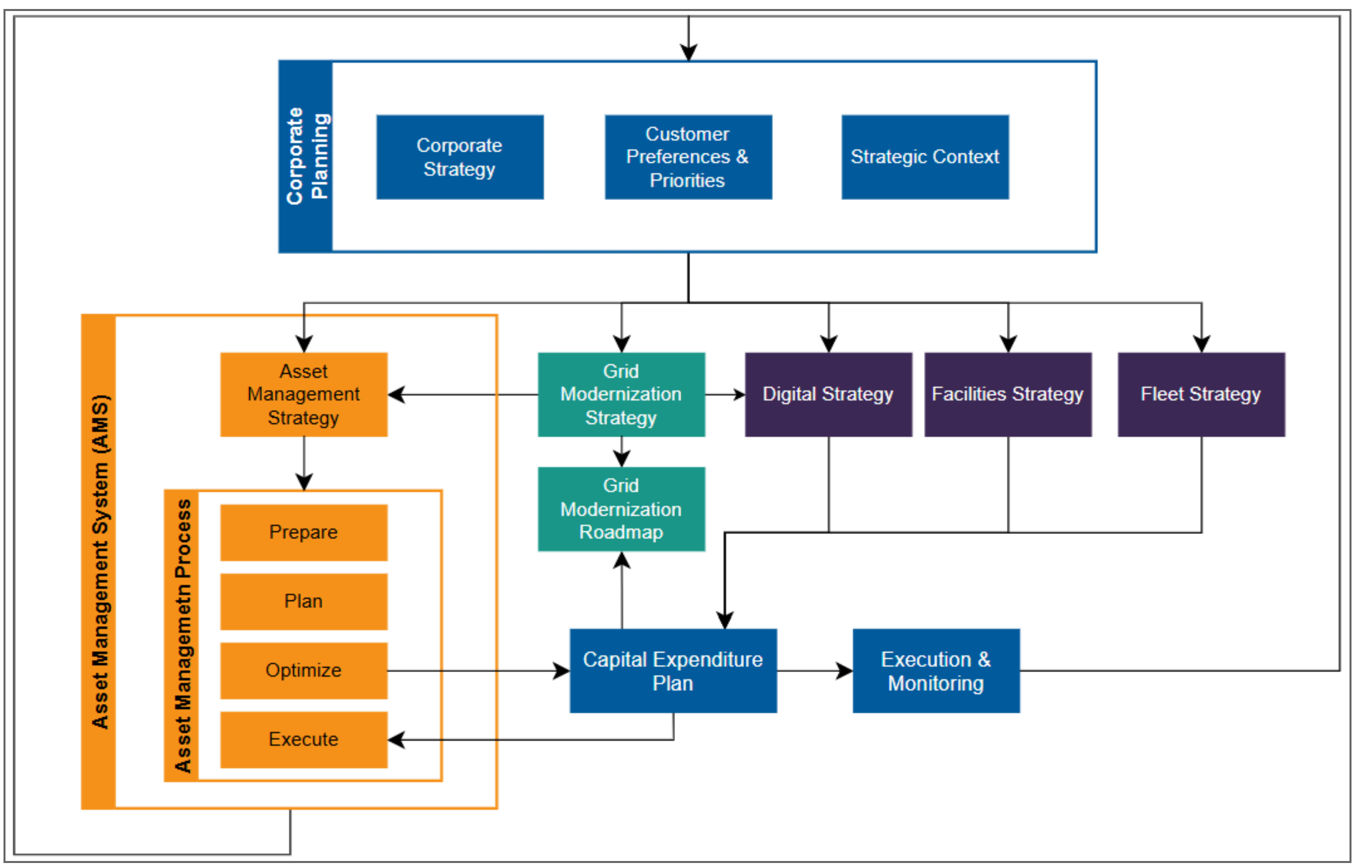
As a result of these assessments, vehicles may be retained longer due to being in better than average condition, while others may be replaced earlier due to being in poorer condition. Of note, Ottawa is subject to extremely hot and humid summers and harsh and cold winters. This has a direct effect on the life expectancy of engines and hydraulic equipment as well as on road conditions. Reactive repairs increase during the harsh months and vehicle condition can sometimes deteriorate ahead of projected schedules. Hydro Ottawa factors in conditions such as these, along with specific vehicle condition assessments, in order to determine which vehicles should be replaced and the appropriate year of replacement.

Hydro Ottawa continues to invest in green fleet vehicles and technology, where it is available for commercial fleets and cost effective. This includes replacing vehicles, as per the established fleet replacement schedule, with hybrid or more energy efficient vehicles, where available; hybrid technology to operate hydraulics for aerial devices, where it is effective; battery technology to eliminate idling for heating and lighting, while servicing underground cabling; and electric vehicles (EVs), where appropriate.

3.5. CAPITAL EXPENDITURE PLANNING PROCESS

Hydro Ottawa's business planning process uses a cascading structure: corporate objectives inform business strategies, which then guide investment plan development. These plans are then optimized and prioritized within the expenditure planning process, culminating in the Capital Expenditure Plan, as illustrated in Figure 3.

Figure 3 - Detailed Business Planning Process



Distribution asset management investment plans originate within the AMS and are also shaped by the Grid Modernization Strategy. These plans feed into the expenditure planning process, and approved plans are executed and monitored within the AMS through the core asset management process. Sections 4 through 9 of this Schedule details the AMS.

IT investment plans, governed by the Digital Strategy and aligned with the Grid Modernization Strategy, are combined with the Fleet, Facilities and Asset Management investment plans within the expenditure planning process. Selected plans are executed and monitored under their respective governance processes.

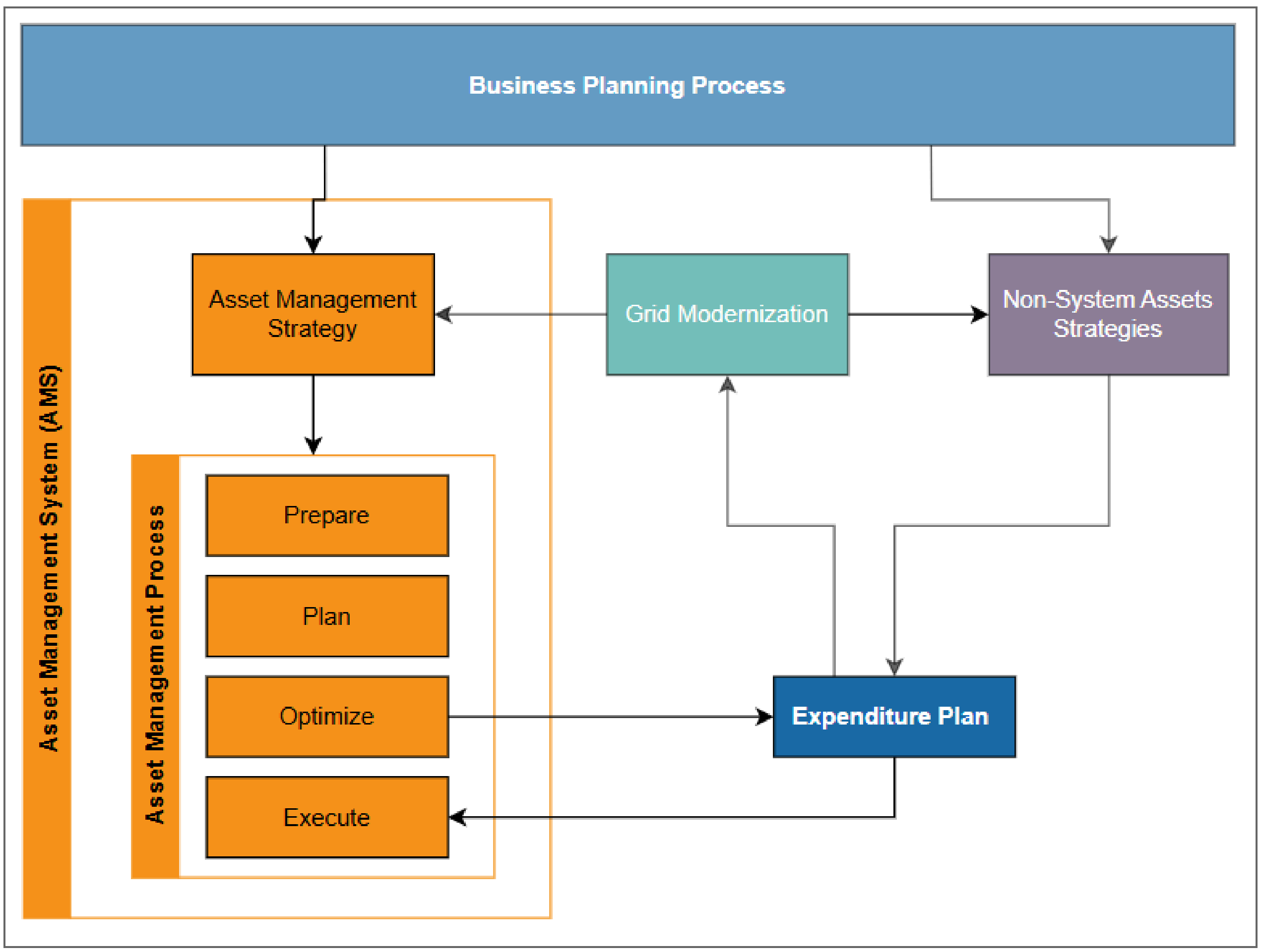
The Capital Expenditure Planning Process evaluates proposed investment plans and alternatives, balancing overall corporate risk to determine investment priorities for the Capital Expenditure Plan. This plan is handed back to the various areas of the business to implement through their asset management frameworks.

The remainder of this Schedule details the AMS, from the guiding Asset Management Strategy to the identification, execution, and monitoring of the capital expenditure plans for the distribution assets.

4. ASSET MANAGEMENT OVERVIEW

This section provides a comprehensive overview of Hydro Ottawa's AMS, outlining the strategic framework guiding the management of its distribution assets, which are critical to the utility's core operation. By effectively managing its assets, Hydro Ottawa ensures it can provide safe, reliable, and affordable electricity. Components of Hydro Ottawa's AMS are shown in Figure 4.

Figure 4 - Hydro Ottawa's Asset Management System



Hydro Ottawa's AMS, certified against ISO 55001, manages assets through a four-stage process: prepare, plan, optimize, and execute. The program-level output from the optimization stage is integrated with results from other non-system assets for optimization of the entire asset portfolio. This process, which is described in Section 3.5 - Capital Expenditure Planning Process, ensures that assets are used effectively and efficiently to provide value to customers and stakeholders and that non-system assets are planned to support the utility's core operations. Once the expenditure plan has been submitted and approved, it is used as a directive to develop a project-level list for annual execution.

Hydro Ottawa is committed to continuously improving its AMS to meet future challenges by leveraging data-driven insights and advanced technologies to optimize asset performance, enhance service reliability, and deliver long-term value.

The asset management processes culminate in a Capital Expenditure Plan that effectively delivers on the four Investment Priorities: Growth & Electrification, Renewing Deteriorating Infrastructure, Grid Modernization and Enhancing Grid Resilience. This is achieved through strategic mapping that aligns program-level decisions with the DSP Investment Priorities, see Section 2.3 of Schedule 2-5-1 - Distribution System Plan Overview, ensuring that all expenditures and activities contribute to achieving Hydro Ottawa's long-term goals for a reliable, resilient, and modern electricity grid.

This section provides a comprehensive overview of Hydro Ottawa's AMS, specifically tailored for the management of distribution assets. It is divided into the following key areas to provide a structured and detailed exploration of the AMS:

- **Section 4.1: Asset Management System Certification** delves into the processes and achievements related to the certification of Hydro Ottawa's AMS. It outlines the requirements and standards that the AMS has been certified against, as well as the benefits that certification brings to the organization and its asset management practices.
- **Section 4.2: Asset Management Scope, Strategy, and Objectives** defines the scope of Hydro Ottawa's AMS, outlining which asset classes and types are included within its purview. It articulates the overarching strategy that guides the AMS, including the goals and

objectives that the organization aims to achieve through effective asset management.

- **Section 4.3: Asset Management Overview** provides a holistic overview of the AMS, explaining its core components, processes, and how it integrates with other organizational systems and functions.
- **Section 4.4: Asset Management Process Enhancements** explores the ongoing efforts to improve and enhance Hydro Ottawa's AMS. It discusses new technologies, methodologies, or strategies that are being implemented to optimize asset performance, reduce costs, and improve overall asset management outcomes. It also includes information about lessons learned from past experiences and how they are being applied to future asset management initiatives.

4.1. ASSET MANAGEMENT SYSTEM CERTIFICATION - ISO55001

Hydro Ottawa's asset management process is certified against the ISO 55001 standard, as outlined in Section 4.2 - Asset Management Scope, Strategy, and Objectives. This international standard provides a framework for asset management systems, offering a structured approach for utilities to optimize the value and minimize the risks of their physical assets throughout their lifecycle.

This framework helps an organization manage the lifecycle of their assets, from acquisition to disposal. Hydro Ottawa’s certification against ISO 55001 demonstrates that its AMS:

- Ensures that assets are managed systematically and consistently.
- Improves the efficiency and effectiveness of asset management.
- Reduces risks associated with asset ownership.
- Improves decision-making about asset investments.
- Ensures that asset management objectives are achieved.
- Demonstrates a commitment to asset management best practices.

In 2023 Hydro Ottawa's AMS was re-certified against the ISO 55001 standard, demonstrating that it has been independently audited and meets all requirements. For details, see Attachment 2-5-4(A) -

ISO 55001 Hydro Ottawa Certificate of Conformance 2023. This achievement showcases Hydro Ottawa's ongoing commitment to excellence in asset management.

The ISO 55001 certification process includes a rigorous evaluation of the utility's asset management practices, including planning, implementation, monitoring, and improving asset performance. The standard requires utilities to establish clear asset management objectives, develop strategies to meet these objectives, and implement processes to ensure continuous improvement and risk management. To maintain this certification, Hydro Ottawa undergoes scheduled internal and external audits to ensure that the standard is met on an ongoing basis. These audits help to identify areas for improvement and ensure assets are effectively managed to deliver value to customers and stakeholders.

By attaining ISO 55001 certification, Hydro Ottawa has demonstrated strength in managing its assets responsibly and effectively. The certification demonstrates that Hydro Ottawa has a robust AMS that optimizes the performance and value of its assets, minimizes risks, and ensures long-term sustainability.

4.2. ASSET MANAGEMENT SCOPE, STRATEGY, AND OBJECTIVES

As outlined in Section 3.2 - Corporate Strategic Objectives, Hydro Ottawa's Eight point strategic objectives outline the company's business strategy, and provides all stakeholders with visibility into trends shaping the business environment and how the company plans to respond.

The Eight point plan establishes a balanced program for robust performance in existing operations as well as sustainable and profitable growth, with a focus on customer centricity, financial responsibility, and responsiveness to a changing environment. This alignment underscores Hydro Ottawa's commitment to adapting to evolving market conditions and customer needs, ensuring continued success and relevance in a dynamic industry.

The company's Eight point plan serves as the foundation for developing the Asset Management objectives and the outcomes used to evaluate the risk and performance of the AMS.

4.2.1. Asset Management Scope

Hydro Ottawa's AMS covers distribution assets, metering, and specified telecommunications assets. Distribution assets are further categorized into several asset classes:

- Station Assets
  - Station Transformers
  - Station Switchgear & Breakers
  - Station Batteries, Protection & Control Equipment
- Overhead Assets
  - Poles, Fixtures & Primary Overhead Conductors
  - Overhead Switches
  - Overhead Transformers
- Civil Structures
- Underground Assets
  - Underground Primary Cables
  - Distribution Underground Transformers
  - Distribution Underground Primary Switchgear
  - Vault Transformers
- Telecommunications
- Metering

This categorization allows for targeted management and maintenance practices, which help to ensure the reliability and efficiency of the electrical infrastructure and a focused and effective approach to asset management in aligning with its Eight point strategic objectives.

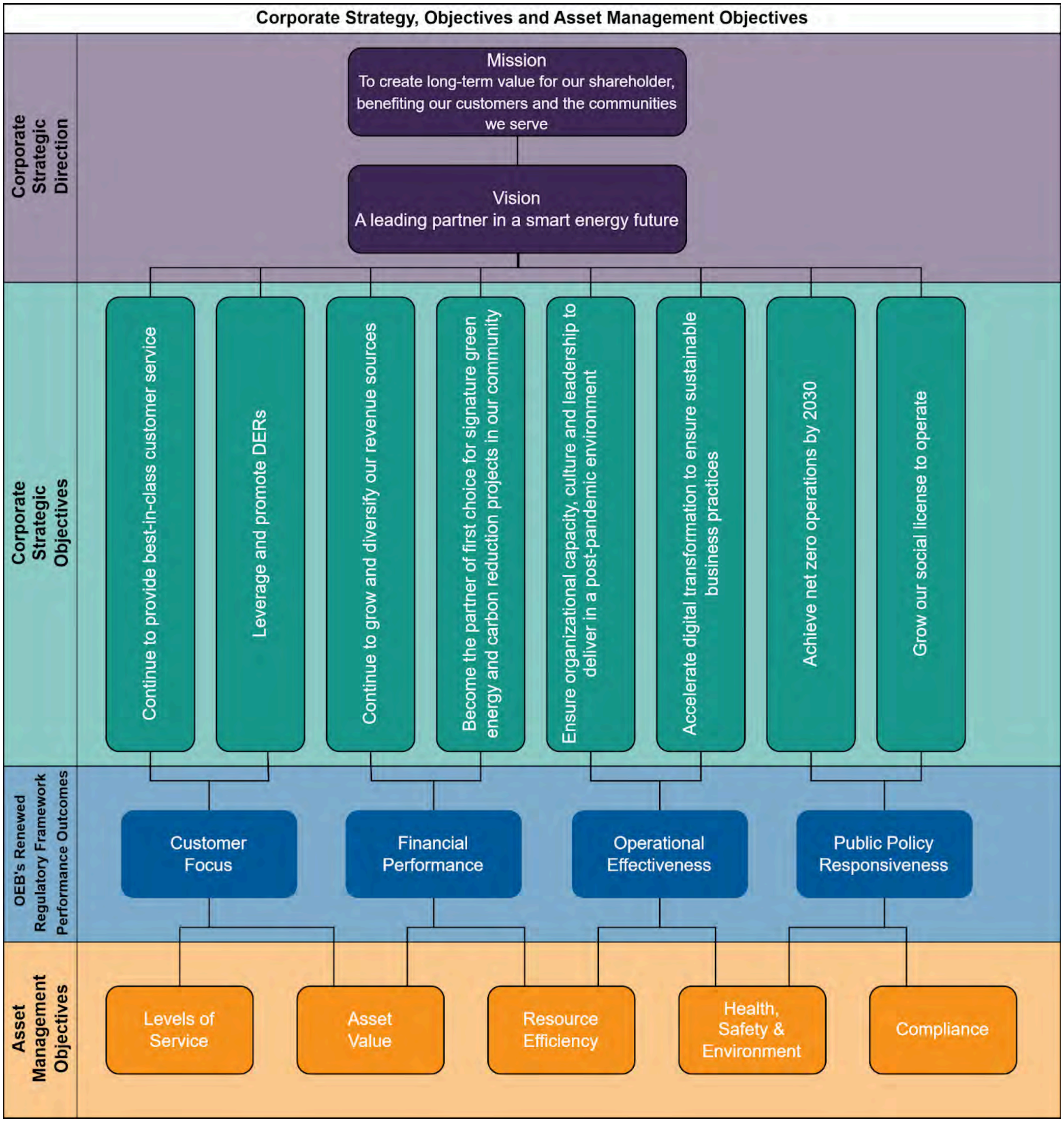
4.2.2. Asset Management Strategy

Hydro Ottawa's Asset Management Strategy provides a crucial link between the company's overarching strategic objectives and the focused goals of asset management. This strategy not only outlines the development of individualized AMPs but also emphasizes the critical role these plans play in achieving those objectives. A visual representation of this cascading hierarchy, from corporate Strategic Direction through to the asset management objectives, is illustrated in Figure 5. By establishing this framework, Hydro Ottawa ensures a cohesive and strategic approach, aligning all asset management endeavors with the company's broader vision and goals.

Hydro Ottawa's asset management strategy is based on data and a portfolio approach that balances risk reduction with level investments. The strategy gives priority to the following:

- **System Risk Mitigation:** Addressing assets that pose the greatest risk to reliability, environment and safety, in a proactive manner.
- **Maintaining Asset Performance:** Extending the life and value of assets through targeted renewals and upgrades, timely repairs, and proactive maintenance. Proactive maintenance includes making investments to improve data collection, quality, and condition assessments for critical assets, which prevents minor issues from becoming major problems.
- **Portfolio Investment Optimization:** Balancing program investments across the portfolio to achieve a level investment strategy for effective asset replacement and renewal targets.

1 **Figure 5 - Corporate Strategic Direction & Asset Management Objectives**



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4.2.3. Asset Management Objectives

Hydro Ottawa's AMS is built upon a foundation of five Asset Management Objectives, ensuring that investments and activities directly support both the company's Eight point plan and the four OEB Performance Outcomes. These five Asset Management Objectives, as detailed in Table 4, act as guiding principles for all asset-related decisions. They ensure a focus on maintaining high **Levels of Service**, maximizing **Asset Value**, driving **Resource Efficiency**, prioritizing **Health, Safety & Environment**, and maintaining **Compliance**. These objectives are not just abstract goals; they are actively pursued through Hydro Ottawa's established asset management processes and translated into tangible capital, operational, and maintenance programs.

Table 4 - Asset Management Objectives

Asset Management Objective	Description
Levels of Service	To maintain and enhance the leading performance of the distribution system through improving electrical service and alignment with customers' expectations.
Asset Value	To maximize the realization of value from distribution assets over their entire lifecycle through managing risks and opportunities.
Resource Efficiency	To maximize economic efficiency by minimizing costs associated with maintaining and operating the distribution system.
Health, Safety & Environment	To minimize employee and public health and safety risks and environmental risks from distribution system activities.
Compliance	To maintain compliance with all internal and external requirements while managing the distribution system.

The connection between overarching objectives and practical execution becomes even clearer when examining Hydro Ottawa's four strategic Investment Priorities for the 2026-2030 DSP. These priorities—Growth & Electrification, Renewing Deteriorating Infrastructure, Grid Modernization, and Enhancing Grid Resilience—are the direct result of a comprehensive analysis that considered customer feedback, system needs, historical performance, and future trends.

The four Investment Priorities serve as the practical application of the five Asset Management Objectives.

1. **Growth & Electrification - Powering a Growing Community:** This priority, focused on expanding grid capacity, relies on all five Asset Management Objectives. Levels of Service ensures the expanded grid meets growing demand reliably. Asset Value guides strategic investments in new infrastructure with long-term value. Resource Efficiency ensures cost-effective expansion. Health, Safety & Environment prioritizes safety and environmental responsibility during expansion. Compliance ensures all expansion activities meet regulatory requirements.

2. **Renewing Deteriorating Infrastructure:** This priority, focused on upgrading deteriorating infrastructure, is heavily driven by Asset Value, as the core goal is to maximize the remaining value of existing assets through strategic replacements and upgrades. Levels of Service is also crucial, as these upgrades aim to improve reliability and prevent service disruptions. Resource Efficiency plays a role in selecting replacements that are more efficient. Health, Safety & Environment is paramount, as older infrastructure may pose safety or environmental risks. Compliance ensures all upgrades meet current standards.

3. **Grid Modernization - Enabling the Energy Transition:** This priority, focused on technology adoption and infrastructure upgrades for the energy transition, relies heavily on Levels of Service, as modernization aims to improve grid capabilities and customer experience. Asset Value guides the selection of modern technologies with long-term value. Resource Efficiency is often a key driver, as modern grids can optimize energy flow and reduce losses. Health, Safety & Environment is essential, as new technologies must be implemented safely and with environmental considerations. Compliance ensures all modernization efforts adhere to regulations.

4. **Enhancing Resilience** This priority, focused on protecting against severe weather and cyber threats, is strongly linked to Levels of Service, as resilience measures aim to maintain service during disruptions. Asset Value informs investments in resilient infrastructure. Resource Efficiency guides cost-effective resilience measures. Health, Safety & Environment is crucial, as resilience efforts must consider safety and environmental impacts. Compliance ensures all resilience measures follow regulations and best practices.

In essence, the four Investment Priorities are the "how" – the concrete actions – that will enable Hydro Ottawa to achieve its "what" – the five overarching Asset Management Objectives. This strategic alignment ensures that every investment contributes to a more reliable, resilient, and future-ready electricity system for the community.

The Asset Management Objectives consider stakeholder expectations, business drivers, and compliance with relevant legislation, codes, licenses, and technical standards. Hydro Ottawa's commitment to delivering safe, reliable, and sustainable electricity to support community growth and prosperity is reflected in its approach to asset management. The AMS is revisited annually to ensure that it incorporates evolving industry best practices and maintains alignment with Hydro Ottawa’s Strategic Direction, regulatory changes, and emerging technologies. This process ensures that Hydro Ottawa's asset management practices effectively support the company's objectives, driving strong performance, sustainable growth, and value creation for stakeholders.

4.3. ASSET MANAGEMENT PROCESS OVERVIEW

Hydro Ottawa's asset management process for distribution assets, certified against the ISO 55001 standard, utilizes a risk-based approach to optimize the value and resource efficiency of its assets while ensuring compliance and effective risk management. This process is guided by asset management objectives outlined in Section 4.2 - Asset Management Overview, which covers the Scope, Strategy, and Objectives of Asset Management.

The asset management process at Hydro Ottawa consists of four main stages: prepare, plan, optimize, and execute, as illustrated in Figure 6.

Figure 6 - Hydro Ottawa's Asset Management Process

The **prepare** stage involves establishing the context of asset management by identifying assets and associated risks, reviewing results from testing and maintenance, analyzing assets condition, identifying regional growth, and analyzing performance metrics.

The **plan** stage encompasses the development of comprehensive AMPs that directly address the identified risks and objectives. This involves a strategic alignment of asset plans with the overarching system needs, ensuring that capacity constraints, reliability, resilience, and grid modernization requirements are all taken into account. A key component of this stage is the identification of both capital and operations, maintenance, and administration (OM&A) investments required to support the asset management strategy and achieve the desired outcomes.

The **optimize** stage consists of two parts: program-level assessment and project-level assessment. During program-level assessment, plans to address asset and system needs are allocated under specific investment categories and programs based on primary drivers. In addition, plan alternatives are evaluated in material investment plans (MIP) for evaluation and selection of the preferred alternative. Project-level assessment involves evaluating and scoring identified projects. This stage utilizes a portfolio optimization tool to further refine and optimize project selection.

The **execute** stage includes implementing the plan, tracking performance for ongoing improvement, and making necessary adjustments to ensure that the AMPs achieve their objectives. Additionally, any insights gained during this phase are integrated into the development of the subsequent plan.

Hydro Ottawa's asset management process is designed to align asset management practices with both organizational objectives and customer expectations, ultimately ensuring the safe, reliable, and cost-effective delivery of electricity. This risk-based approach enables the utility to maximize asset value, enhance operational efficiency, and bolster service reliability. Furthermore, it supports compliance with regulatory requirements and facilitates sound financial risk management. A more detailed exploration of the Asset Management process can be found in Section 5.

4.4. ASSET MANAGEMENT PROCESS ENHANCEMENTS

Hydro Ottawa continuously reviews its asset management process to identify opportunities for enhancements that would help to navigate the changing electrical distribution network landscape. In this regard, some of the asset management process enhancements introduced by Hydro Ottawa since the 2021-2025 DSP include:

4.4.1. Implementation of Predictive Analysis

In 2024, Hydro Ottawa enhanced its asset management framework by incorporating Predictive Analytics (PA) into its System Renewal investment planning. This involved creating a comprehensive distribution asset model within the Copperleaf Asset PA module. Copperleaf is an Asset Investment Planning and Management software solution that provides evidence-based support for strategic asset planning and budgeting decisions. This integrated, enterprise-wide solution connects and streamlines asset analytics, risk, financial and performance modeling, investment portfolio optimization, budgeting, and variance analysis, ultimately supporting a risk-informed approach to asset management.

In order to manage assets effectively, PA was required as a tool to predict the effects of asset degradation over time and the required spending on the remediation of the deteriorated assets. The PA module within Copperleaf forecasts system renewal investment needs for Hydro Ottawa’s asset population and generates the risk and cost profiles of various sustainment levels. The output of Copperleaf PA can then be input into Copperleaf Portfolio, Hydro Ottawa's investment optimization software (refer to section 5.3.2 for more details) as investments. The information generated by Copperleaf PA will grow and be refined over time as there are improvements to asset risk information.

Copperleaf PA leverages age/Health Index information or condition assessments to determine the probability of failure and the risks associated with each asset. Based on the risk information at the individual asset level, Copperleaf PA can create an optimal strategic plan for the entire asset population.

Copperleaf PA utilizes various information such as asset nomenclature, condition data, probability of failure curves, risk consequences, and intervention data, to compute risk at an individual asset level. Key risk measures, such as those related to reliability, safety, environmental impact, financial implications, and compliance, are calculated by the model.

Deployed across Hydro Ottawa's major asset classes, this model forecasts the impact of asset degradation over time. This enables risk assessment and optimized replacement scheduling by evaluating the overall value of various intervention strategies, ultimately leading to more informed investment decisions. The PA module helps to determine the optimal timing for asset interventions like replacements or upgrades. It considers factors such as risk mitigation, cost-effectiveness, and resource constraints to guide investment decisions. By considering a comprehensive range of risk factors and optimizing intervention strategies, PA has enabled Hydro Ottawa to make more informed system renewal investment decisions for this application. Further details are available in Section 5.1.4 - Asset Risk Assessment of this Schedule.

4.4.2. Inspection Enhancements

Through 2024, Hydro Ottawa further improved its testing, inspection, and maintenance programs to capture additional inspection parameters down to the asset component level such as insulators, elbows, barriers, etc. As a result, Hydro Ottawa is gathering more granular visual inspection and infrared scanning data on its distribution equipment. Specifically, the overhead asset inspection program now captures information on pole-mounted transformers, switches, and related hardware at every pole inspected rather than only when an issue was found, though currently only from the ground level, as noted in Schedule 4-1-2 Operations, Maintenance and Administration Program Costs, a drone pilot program is planned for 2025.

For underground infrastructure, Hydro Ottawa enhanced its cable testing methodology by including advanced testing methods such as Very Low Frequency Tan-Delta, Partial Discharge, and Time Domain Reflectometry. These advanced techniques provide a deeper understanding of the condition of cable components, facilitating targeted remediation efforts, compared to the initial cable testing technique employed by Hydro Ottawa, which was solely based on the detection of water trees in the cable insulation. Furthermore, Hydro Ottawa has expanded its vault inspection program to include visual and infrared assessments of vault equipment, in addition to the civil inspection.

These improvements in data collection and analysis empower Hydro Ottawa to conduct more accurate condition assessments. This enhanced accuracy is essential for effective risk-based investment planning through PA and the proactive maintenance of Hydro Ottawa's critical asset infrastructure. Further details regarding Hydro Ottawa's 2026-2030 preventative maintenance programs are available in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

4.4.3. Comprehensive Asset Health Indexing

In 2023, Hydro Ottawa started to enhance its ACA framework by incorporating parameters captured through existing testing, inspection and maintenance programs into the calculation of asset health index scores. This change was driven by a need for more precise condition assessments to inform risk-based investment planning to effectively maintain assets, based on information already captured through inspections, but not utilized in health indexing.

Previously, Hydro Ottawa's condition assessments relied on less granular data, focusing on reporting on exceptions or major issues identified during inspections. The new framework includes asset-specific parameters for calculating the health index score, based on data already being gathered through inspections. These parameters are tailored to reflect the specific degradation mechanisms and failure modes relevant to each asset class. These enhancements ensure that the relevant data required for calculating the updated health index is collected for each individual asset. This shift from exception-based reporting to individual asset assessment provides a much richer dataset.

Some other key improvements implemented to the asset health indexing process include:

- Reducing the heavy reliance on age as a major contributor to health index through two ways:
    - Decreasing the weighting assigned to age as a part of the health indexing process.
    - Translating age to condition based on the linear piecewise relationship established between age and condition through the failure curve development exercise outlined in Section 4.4.4 - Failure Curves and Typical Useful Life Update. This approach was used to determine the equivalent condition value for assets that had a known age, but lacked a valid health index.
- Implementing validity to the health index process to ensure that at least 70% of the condition information is available to define a health index value.

With improved condition data, Hydro Ottawa will make more informed, risk-based investment decisions through the use of PA. This means prioritizing System Renewal investments by the assets that pose the greatest risk to system reliability, safety, and performance. A third-party assessment of Hydro Ottawa's ACA implementation, completed in 2024, confirmed the robustness of its framework. The assessment, conducted by Hatch, found that Hydro Ottawa's ACA framework used best-practice formulations and was well-integrated with its broader asset management processes, procedures, and outcomes. For further information, please refer to Attachment 2-5-4(C) - Asset Condition Assessment Third Party Review. While Hatch identified minor calculation gaps with minimal portfolio impact, Hydro Ottawa has already implemented updates to address them. Hatch also provided recommendations for ACA methodological enhancements, and Hydro Ottawa is currently gathering additional data and exploring solutions to support advanced analytics and meet evolving data needs, through improvements to OM&A programs as outlined in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

4.4.4. Failure Curves and Typical Useful Life Update

In 2024, concurrent with the PA implementation, Hydro Ottawa engaged Hatch to enhance asset failure curve knowledge and insights, aiming to refine the utility's risk-based and value-based asset management framework. This initiative involved:

- A thorough review of existing failure curves.
- The development of new, data-driven failure curves.
- Augmentation of existing age-condition curves using asset registry data to improve accuracy.
- Establishing the TUL values of the various asset types.

As the first step of the data-driven failure curve development process, Hydro Ottawa provided Hatch with the asset registry information for all major asset classes, including:

- All asset-related information such as the voltage class, current rating, insulation type, installation date, health index, etc.
- Existing asset failure curves and TUL information
- Number of assets replaced each year (since 2016) within each asset class under the different OEB investment programs (System Renewal - Planned and Corrective, System Service, and System Access)

Hatch employed statistical techniques to analyze and interpret the data provided by Hydro Ottawa to create a simulated asset population to align with Hydro Ottawa's actual asset registry. This analysis focused on deriving the best representative Weibull curve parameters (a matrix of shape and scale values), a common industry practice for failure curve development. The simulation results, including the TUL values obtained during this first phase, closely matched Hydro Ottawa's asset registry, and were identified as Data Driven Results.

Hatch identified that it is common in the utility sector that converging at an absolute steady state or the exact asset registry is a challenge, primarily due to variations in asset information maturity and quality. Hatch's model encountered this challenge with certain asset classes, which showed deviations from typical industry TULs. To refine the results, Hatch produced TUL Adjusted Results. This involved selecting the top 10% of matches that most closely aligned with Hydro Ottawa's asset registry, while still utilizing Hydro Ottawa data. These selected results were then used to generate adjusted failure curves and TUL values. Following this, Hatch conducted a workshop with Hydro Ottawa to review both the initial Data Driven Results and the TUL Adjusted Results.

Hydro Ottawa updated existing TUL values for asset classes exhibiting substantial variations (exceeding five years) between the Data Driven Results, TUL Adjusted Results, and the current TUL values. This resulted in changes to the TUL values for underground transformers, electronic relays, maintenance holes (manholes/cable chambers), and station VLA batteries.

For the remaining asset classes, the Data Driven or the TUL Adjusted Values were found to be either identical or very similar (within a few years) to Hydro Ottawa’s current TUL values. During the workshop, Hydro Ottawa and Hatch subject matter experts agreed to retain the existing TUL values for these asset classes. This decision stemmed from Hydro Ottawa’s high maturity asset survival records and less developed failure records. To confidently adjust the TUL values by a few years, it is necessary for Hydro Ottawa's asset failure records to mature further.

To enable future TUL value refinements, a workshop recommendation was for Hydro Ottawa to strengthen its asset tracking by consistently recording annual failures and renewals, including age, health index at failure, and replacement details. Hydro Ottawa has already begun this process, tracking age and condition at failure since 2023. The accumulation of this data over the next few years will support further TUL adjustments (even by a few years) for the relevant asset classes.

Section 8.1 - Asset Typical Useful Life outlines the TUL values finalized for the different asset classes. A segmented linear piecewise relationship was also developed to establish the relationship between Health Index and age across all asset types. A detailed report on this asset failure curve analysis is available in Attachment 2-5-4(D) - Failure Curves Review. The Copperleaf PA module uses the failure curves developed in this study to forecast asset degradation and determine future asset risk levels.

4.4.5. ISO 55001 - Asset Management System Recertification

Hydro Ottawa's mature AMS is a robust framework that effectively directs, coordinates, and controls asset management activities. It incorporates interrelated and interacting elements to establish an asset management policy, asset management objectives, and the overarching processes necessary to achieve those directives. This framework strengthens the strategic asset decision-making processes by effectively balancing the weighting of cost, risk, and asset performance. It is designed to meet or exceed the service level expectations of customers; comply with applicable acts, licenses, and codes; improve asset value and resource efficiency; and minimize health, safety, and environmental impacts.

Hydro Ottawa's dedication to advancing asset management practices culminated in the adoption of the ISO 55001 Asset Management Standard in preparation for this application. Achieving initial certification in 2020, the organization further solidified its commitment through successful recertification in 2023. This achievement serves as a testament to the ongoing advancements and maturity of Hydro Ottawa's AMS, a fundamental element in the recertification process.

During the recertification process, Hydro Ottawa demonstrated enhancements to its AMS. These enhancements include:

- Utilization of a comprehensive risk register to proactively identify and mitigate potential issues.
- Implementation of a defective equipment tracker to facilitate efficient monitoring and resolution of equipment deficiencies.
- Development and execution of targeted mitigation plans for specific asset-related risks, exemplified by the comprehensive strategy for managing SF_6 switchgear leaks.

Furthermore, Hydro Ottawa maintains a commitment to continuous improvement through structured ongoing operational practices focused on assessing risks and mitigations, adherence to standards, consideration of emerging technologies and evolving industry standards, and other opportunities for enhancement.

4.4.6. Decarbonization Study

To gain an understanding of the evolving energy landscape and strategically navigate its associated complexities, Hydro Ottawa commissioned Black & Veatch in 2023 to conduct a Decarbonization Study. This study evaluated the potential impacts of societal electrification trends on the Hydro Ottawa distribution system, projecting outcomes in five-year increments through 2050 with a scenario based approach. Five scenarios with varying assumptions of decarbonization initiatives on the distribution system were assessed.

Completed in 2024, the study provides:

- Projections of electricity demand driven by the decarbonization-related electrification of buildings and transportation for 5 different scenarios.
- Rough-order-of-magnitude capital cost estimations.
- Strategic insights to inform future infrastructure investments.

Hydro Ottawa's capacity investment planning and forecasting initiatives leverage the insights from this study for the medium to long-term outlook (beyond 2030). Decarbonization and the subsequent electrification of key sectors necessitate a shift from traditional to scenario-based electricity demand forecasting. Hydro Ottawa is utilizing the Decarbonization Study's Reference Scenario, see details in Section 9.4.2.1 - Decarbonization Study, to inform its Integrated Regional Resource Plan (IRRP) forecast (details in 9.4.2. IRRP Forecast). This alignment is crucial for long-term regional transmission planning, given the extended lead times of transmission grid investments. This approach ensures that immediate capacity investments, guided by Hydro Ottawa's planning forecast, see details in Section 9.4.1 - Hydro Ottawa Planning Forecast, are strategically aligned with long-term regional transmission needs, thereby optimizing capital allocation and asset utilization.

Recognizing the uncertainties of government policies and technological advancements, Hydro Ottawa leveraged the IRRP forecast derived from the Decarbonization Study's reference scenario to augment investment decisions for the mid- to long-term. Hydro Ottawa prioritized investments in areas with existing capacity constraints and immediate, confirmed, and committed load requirements (as per the planning forecast) necessary to meet customer service obligations. These investments include upsizing new stations to align to a consistent 100 Mega Volt Ampere (MVA) design, converting voltage levels to 13kV when replacing deteriorated 4kV station assets to support intensification and other known large projects, utilizing NWSs, and implementing grid modernization initiatives. Hydro Ottawa will continuously monitor the impact of electrification to minimize disruptions and ensure the ability to connect new customers. This strategic approach also emphasizes driving efficiencies across investment programs by leveraging technological advancements and enhancing grid reliability, resilience, and adaptability. By strategically phasing investments, Hydro Ottawa ensures that immediate customer needs are met without compromising its ability to support future growth.

Further details are available in:

- Schedule 2-5-4 - Asset Management Process, Section 9 - System Capacity Assessment
- Schedule 2-5-4 - Asset Management Process, Attachment 2-5-4(F) - Decarbonization Study

4.4.7. Climate Study Reaffirmation

In 2023, Hydro Ottawa commissioned Stantec Consulting Ltd. (Stantec) to conduct a study to update the 2019 climate risk assessment,[4] incorporating the latest climate projection data and factoring in recent extreme weather events, including the 2022 Derecho.

[4] See Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020); and in this Applicaton, Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan.

This comprehensive assessment utilized updated climate models and regional projections to refine the probability estimations of extreme weather events. Notably, two new wind speed thresholds, exceeding 130 km/h and 180 km/h, were introduced based on updated criteria and empirical observations from the 2022 Derecho storm. This led to a reassessment of potential high-wind impacts on infrastructure, resulting in elevated consequence ratings.

Despite the increased risk scores associated with severe wind events, the overall risk level for the majority of Hydro Ottawa's infrastructure remained unchanged. This finding indicates that the adaptation and mitigation measures outlined in the 2019 plan retain their efficacy. Consequently, the primary areas of vulnerability within Hydro Ottawa's system, namely overhead assets, remain consistent with previous assessments.

As a result, Hydro Ottawa commissioned a further study, conducted by 1898 & Co., to explore strategic opportunities for undergrounding vulnerable sections of overhead lines to enhance the overall resilience of the electricity distribution system. Further details on the study's findings can be found below in Section 4.4.8 - Resilience Assessment.

4.4.8. Resilience Assessment

Following a series of severe weather events and recognizing that grid resilience is a priority for its customers, Hydro Ottawa engaged 1898 & Co. to conduct a comprehensive assessment and develop a Resilience Investment Business Case. This initiative aimed to enhance grid resilience by strategically burying vulnerable sections of the overhead distribution system. The resulting report underscored the escalating importance of grid resilience in the face of increasingly frequent major weather events and society's growing reliance on a stable power supply. Employing a data-driven model, the study identified and prioritized resilience investments, focusing on the strategic conversion of overhead lines to underground systems.

Hydro Ottawa integrated the study's findings with empirical evidence from recent storm events to proactively incorporate resilience investments into the capital plan. The resulting Distribution System Resilience program encompasses a multi-faceted approach, including:

- Strategic undergrounding of vulnerable overhead lines
- Reinforcement of existing overhead infrastructure
- Feeder reconfiguration
- Undergrounding of station egress points
- Relocation of lines

These investments are designed to mitigate system disruptions caused by severe weather events, ultimately minimizing restoration costs, customer outage durations, and overall system recovery time.

Hydro Ottawa's Distribution System Resilience program closely aligns with the OEB's ongoing consultation of a Vulnerability Assessment and System Hardening (VASH) framework[5] by using climate projections, conducting asset-based vulnerability assessments, employing quantitative analysis to prioritize investments, and focusing on maximizing customer value. This data-driven approach allows Hydro Ottawa to align with the VASH framework in order to strategically improve the grid's ability to withstand extreme weather while minimizing customer impacts.

A detailed description of the Distribution System Resilience program is provided in Section 3 of Schedule 2-5-8 - System Service Investments.

4.4.9. Capture Implementation

Hydro Ottawa utilizes Copperleaf Portfolio, Hydro Ottawa's investment optimization software, to optimize its decision-making processes and ensure the long-term sustainability of its infrastructure

[5] OEB, *Decision and Order*, EB-2024-0199 - Vulnerability Assessment and System Hardening Project (December 17, 2024).

assets. Further details can be found in Section 5.3.2 - Project Level Investment Planning. In 2022, Copperleaf significantly enhanced its software suite by introducing the Capture module. This module streamlines and optimizes the input of investment ideas and potential system risks from various stakeholders. By empowering stakeholders to directly submit these ideas or risks into the Copperleaf Investment Planning software through an intuitive and user-friendly form, the Capture module effectively simplifies and accelerates the initial stages of both project and risk management.

The form's intelligent design automates the creation of a draft project or risk, which can then be subjected to a thorough review and refinement process. This automation not only yields substantial time savings but also ensures that all submissions adhere to a standardized format, thereby making the subsequent review and approval processes significantly more efficient. Moreover, the Capture module fosters a culture of transparency and accountability by enabling the meticulous tracking of project and risk lifecycles throughout their various stages, from inception to completion. This comprehensive tracking functionality plays a pivotal role in ensuring that all projects and risks receive the requisite approvals and are managed in a manner that is both consistent and compliant with prevailing regulations and internal policies.

The Capture module's capacity to facilitate the seamless integration of stakeholder input directly into the Copperleaf Planning software holds the potential to catalyze a more collaborative and inclusive approach to decision-making. By breaking down traditional barriers to participation and affording stakeholders a direct and accessible channel for contributing their insights and perspectives, the module can foster a sense of shared ownership and commitment to the success of projects and the mitigation of risks. This, in turn, can lead to more informed and robust decision-making, as well as enhanced organizational agility and responsiveness to emerging opportunities and challenges.

4.4.10. Portfolio Management Enhancement

To enhance financial reporting and control over distribution sustainment projects, Hydro Ottawa implemented process improvements during 2021-2025. Benefits included enhanced reporting and oversight, improved project tracking, strategic alignment, contingency planning, and increased rigor in project and program delivery.

Budget Programs, as identified in Schedule 2-5-5 - Capital Expenditure Plan, were categorized into four Programs: Corrective Renewal, Distribution Construction & Maintenance, Stations, and Maintenance, and further grouped into a Portfolio. Hydro Ottawa uses a multi-stakeholder model composed of Distribution Design, Program Management, Asset Planning, Contractor Management, Maintenance & Reliability, Supply Chain, and Operations to oversee the execution of the programs/portfolios on a monthly basis. This group considers key issues and risks impacting execution, such as inflation, supply chain, impactful weather events, labour disruptions, safety, third-party coordination, and third party service availability. The core focus of this team is to proactively monitor and adjust the execution of the plan as needed to achieve project and program objectives in light of evolving conditions and circumstances on the ground.

Key topics impacting expenditures in the historical 2021-2025 period include inflation, unprecedented supply chain disruptions, customer connections (volume, complexity and cost), unforeseen externally-driven projects, increased emergency renewal work due to major storms such as the 2022 Derecho, equipment failure and new stations investments to address growing electricity demand. To mitigate these pressures, Hydro Ottawa implemented proactive financial management strategies, notably deferring planned projects such as Major Station Rebuilds, Voltage Conversions, ERP Upgrades, and Underground Switchgear Renewals. Please refer to variances in Section 4 of Schedule 2-5-5 - Capital Expenditure Plan.

Hydro Ottawa will leverage this framework and model through 2026-2030, continuing to refine financial reporting and control across investment categories.

4.4.11. Asset Management Technology

In addition to the aforementioned enhancements, Hydro Ottawa has recognized that many of its asset management processes are restricted by existing technology and disparate systems, with limited interoperability, unable to scale effectively to meet asset growth and customer demands. As a result, Hydro Ottawa is seeking an EAM platform as outlined in Section 3 of Attachment 4-1-1(A) - Transition to Cloud Computing, to address these challenges and further transform asset management processes over the 2026-2030 rate period.

5. ASSET MANAGEMENT PROCESS

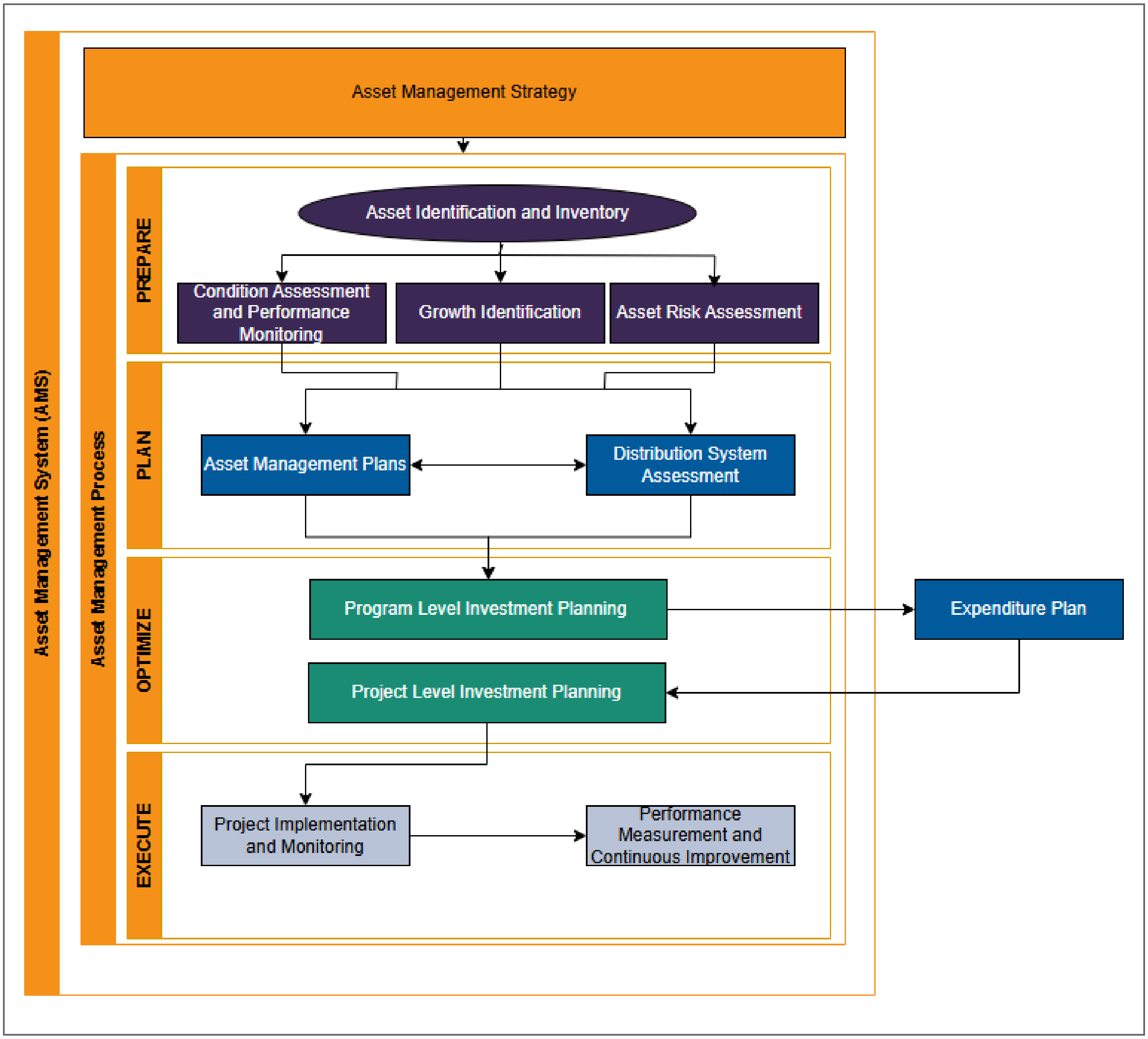
Section 5 describes the process used to plan, prioritize, and optimize expenditures related to distribution assets. This section speaks to the components of Hydro Ottawa's asset management process used to satisfy asset and system needs, in alignment with the asset management objectives described in Section 4.2 - Asset Management Scope, Strategy and Objectives. For each process, details are provided on the tools and methods used, inputs and outputs of information, and how opportunities are identified to coordinate for cost effectiveness.

The process involves several crucial stages that collectively contribute to the development of the investment plan for both Capital and OM&A activities. Each of these stages is described in the following sections:

- **Section 5.1: Prepare**
- **Section 5.2: Plan**
- **Section 5.3: Optimize**
- **Section 5.4: Execute**

Hydro Ottawa's asset management process is shown in Figure 7.

1 **Figure 7 - Asset Management Process Details**



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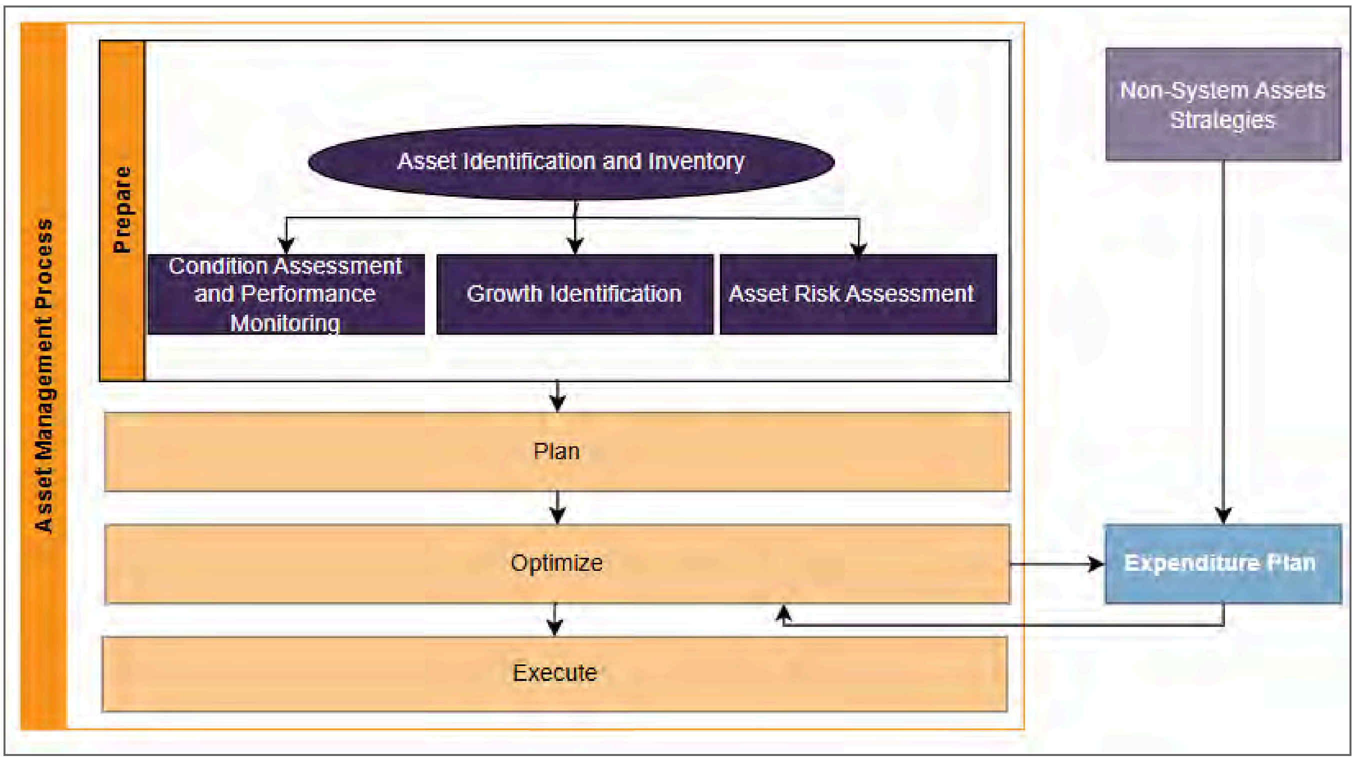
5.1. PREPARE

The preparation stage of asset management is a multifaceted process that lays the groundwork for effective and strategic decision-making. Figure 8 shows the components of this stage of the asset management process. It commences with a comprehensive identification of distribution assets, followed by a meticulous assessment of the risks associated with each asset, considering factors such as operational, financial, and environmental risks.

Figure 8 - Asset Management Process: Prepare Stage



Furthermore, the preparation stage entails a thorough review of the results gleaned from testing and maintenance activities. This involves scrutinizing maintenance records, analyzing test data, and identifying trends or patterns that may indicate potential asset degradation or failure. Additionally, the condition of each asset is evaluated, taking into account factors such as age, usage, and wear and tear.

Another crucial aspect of the preparation stage is the identification of regional growth patterns. This involves analyzing demographic trends, economic indicators, and infrastructure development plans to anticipate future demands and ensure that asset management strategies are aligned with regional growth objectives.

Finally, the preparation stage encompasses a rigorous analysis of performance metrics. This involves tracking KPIs such as reliability, asset condition, asset utilization and efficiency to assess the effectiveness of asset management practices and identify areas for improvement. By diligently executing these tasks, the preparation stage ensures that asset management is rooted in a comprehensive understanding of the organization's asset landscape, risks, and performance, enabling informed and proactive decision-making.

5.1.1. Asset Identification and Inventory

In this phase, Hydro Ottawa focuses on establishing and maintaining an inventory of all distribution assets under its ownership or management. The inventory process involves meticulously gathering detailed information about each asset, including its type, precise location, current condition, and criticality. This comprehensive inventory serves as the cornerstone for subsequent asset management activities.

Asset Register

The asset register is the system of tools used to capture, organize, and disseminate data pertaining to Hydro Ottawa's distribution assets. Hydro Ottawa maintains electronic repositories to store its technical, testing, inspection, and maintenance information, and geographic data for most of its distribution assets (buildings and other non-power delivery assets are excluded). These repositories allow the data to be collected, reported, and queried in a manner that enables efficient dissemination and reporting of information.

The system of record for Hydro Ottawa’s power delivery assets is the Geographical Information System (GIS), based on Intergraph’s G/Technology platform. With minor exceptions (i.e. secondary conductors in the downtown core), it forms a complete repository of Hydro Ottawa's assets used within its stations and distribution system. These minor exceptions do not reduce the effectiveness or usability of GIS as they are few in number and typically do not bring additional clarity during analysis. The missing data can be readily retrieved elsewhere if the need arises.

Hydro Ottawa's GIS is used to store, query, and provide reports to enable the analysis and development of investment plans. The data kept in the system is continuously improved through feedback from field staff and data collected through inspection programs. Using a graphical interface, it enables users to view distribution assets on a geo-referenced map showing location, technical nameplate data, and assess their relationship to other nearby assets, including electrical connectivity and relation to civil structures. Further, this system is used by resources in the field while collecting asset condition data, exclusive of station assets, before storing it within the same repository.

For Hydro Ottawa's Station assets, the PowerDB system is used for the collection of testing, inspection, and maintenance data as it allows for more complex collection forms. Technical data is stored through customized forms for each asset class and maintenance activity. This technical data can then be exported for further analysis, and is used as input into the health index formulation for specific assets described in Section 5.1.2 - Condition Assessment and Performance Monitoring. Each station's geographic information is stored in GIS.

To satisfy the increased inspection data demands for well-informed investment choices and the shift towards condition-based maintenance, a more effective tool for gathering asset data is necessary. The adoption of an EAM solution over the 2026-2030 rate period will facilitate this, among other key benefits. The resulting robust network model and automated field data collection will allow for sophisticated analytics, anomaly identification, and enhanced health assessments. For further information on the EAM project, please refer to Attachment 4-1-1(A) - Transition to Cloud Computing.

5.1.2. Condition Assessment and Performance Monitoring

Regular condition assessments are conducted to evaluate the current state of assets. These assessments involve inspections, testing, and data analysis to determine the physical condition, remaining useful life, and potential risks associated with each asset. Performance monitoring systems track asset performance indicators, enabling early identification of issues and proactive maintenance or replacement.

5.1.2.1. Asset Condition Assessment

Hydro Ottawa uses health index scores for its assets to rate their condition and understand the requirements for intervention. Hydro Ottawa engaged a third-party expert (METSCO) to develop its asset health indexing and condition assessment framework in 2015, which is a weighted addition of a number of degradation factors to determine an overall health index score. This framework has since been reviewed twice, once for the 2021-2025 DSP and again for the 2026-2030 DSP. The most recent review by Hatch, which is filed in Attachment 2-5-4(C) - Asset Condition Assessment Third Party Review, concluded that (i) Hydro Ottawa's ACA framework is comprehensive and that (ii) the calculations are aligned with methodologies that generally reflect industry best practices.

The health index is an indicator of an asset's condition and remaining life and is assigned a score from 100% to 0%. A new asset will have a health index of 100%, while an asset in very poor condition would have a health index below 30%. Table 5 presents the health index ranges, corresponding asset condition, and the required action generally associated with each health index band.

Table 5 – Asset Condition Based on Health Index

Health Index (%)	Condition	Description	Requirements
85-100	Very Good	Some aging or minor deterioration of a limited number of components	Normal maintenance
70-85	Good	Significant deterioration of some components	Normal maintenance
50-70	Fair	Widespread significant deterioration or serious deterioration of specific components	Increase diagnostic testing; possible remedial work or replacement needed depending on criticality and degradation pattern
30-50	Poor	Widespread serious deterioration	Replace or rehabilitate considering risk and consequences of failure
0-30	Very Poor	Extensive serious deterioration	Asset has reached its end-of-life; immediately assess risk; replace or refurbish based on assessment

To determine the health index for a given asset, an assessment specific to the asset under consideration is used to convert various condition parameters (such as visual inspection, electrical test results, infrared scan information, etc.) that describe the asset's condition down to a single value. These values are then used to prioritize asset replacement, when warranted, and are used to determine the probability of failure associated with each individual asset, alongside the related baseline risk as established by the PA process, see Section 5.1.4 - Asset Risk Assessment for more details.

As a part of the failure curve calibration exercise for the various asset classes, Hydro Ottawa engaged a consultant, Hatch, to review its existing asset failure curves and develop data-driven failure curves where applicable. Please refer to Attachment 2-5-4(D) - Failures Curves Review and Section 4.4.4 Failure Curves and Typical Useful Life Update of this Schedule. Statistical analysis leveraging Hydro Ottawa's asset registry and replacement information was instrumental in arriving at the best synthetic registry (aligned with Hydro Ottawa's asset population) and the corresponding Weibull curves. For the asset classes where the simulation model did not converge, recommended failure curves were developed based on ensuring an alignment with industry consensus and Hydro Ottawa's data maturity/asset registry demographics. Hatch categorized Hydro Ottawa as a utility with slightly low maturity specific to historical failure records but having robust asset survival information. Even prior to this exercise (from 2023), Hydro Ottawa started compiling detailed asset failure information, relating any asset failure to the nomenclature, age, and condition at the time of failure (apart from establishing the probable root cause). Also, the historical asset failure curves used by Hydro Ottawa were largely found to be in alignment with best industry estimates. As an output of the failure curve calibration initiative, Hatch recommended Hydro Ottawa to continue to improve the tracking of asset failure information and ensure continued health indexing across its asset fleet.

The failure curve results obtained through this exercise greatly aided in improving Hydro Ottawa's risk assessment process for system renewal investment planning by utilizing them in the Copperleaf PA module for forecasting asset degradation patterns and establishing the optimal time of intervention for each individual asset in the system. Also, the typical useful lives of all asset classes were established to highlight the expected duration an asset can reliably operate before it requires replacement or refurbishment.

Hydro Ottawa has made several key improvements to its condition assessment process since 2014. The health indexing framework now includes additional condition parameters captured from existing inspection and maintenance programs, and age is no longer as heavily weighted. Age is now translated to condition using the linear piecewise/linear relationship established between age and condition through the failure curve development exercise with Hatch. This approach was used to determine the equivalent condition value for assets that had a known age, but lacked a valid health index to be used in Copperleaf PA. Additionally, a validity measure was implemented to ensure that at least 70% of the condition information is available to define a health index value.

Hydro Ottawa has also assessed the maturity of its ACA implementation by a third party. The summary of this assessment can be found in Attachment 2-5-4(C) - Asset Condition Assessment Third Party Review. Overall, the third party, Hatch, found that Hydro Ottawa's ACA framework utilized robust formulations that are in alignment with best practices, and that it was tightly integrated with Hydro Ottawa's broader Asset Management related processes, procedures, and outcomes. Hatch identified minor calculation gaps with minimal impact to the overall asset portfolio and Hydro Ottawa found mitigation solutions, ultimately resulting in addressing all the calculation gaps as a result of the project. Hatch also provided suggestions for enhancing the methodologies, with Hydro Ottawa being in the process of gathering additional data and exploring solutions to support advanced analytics and meet evolving data requirements. The potential opportunities for improvement highlighted by Hatch as a part of this exercise include:

- Enhanced coding/modeling practice for asset health indexing, see Section 4.4.11 - Asset Management Technology
- Integrated analytics and/or EAM and/or Asset Performance Management solution, see Section 4.4.11 - Asset Management Technology
- Non-linear modeling to better reflect asset management philosophy
- Considering additional criteria for certain asset classes, if feasible (e.g. including short circuit/fault level information)

Hydro Ottawa has targeted plans to further advance its ACA process as a part of the 2026-2030 rate period, inclusive of enhancements in data collection and analysis (based on OM&A programs), exploring an EAM solution and investments in ADMS to have better visibility into system level information.

5.1.2.2. Testing, Inspection, & Maintenance Programs

Hydro Ottawa's planned testing, inspection, and maintenance programs are the utility's primary means of collecting condition data used to calculate the health index of assets and to identify corrective actions to ensure continued reliable operation.

Hydro Ottawa's planned programs can be divided into three groups:

1. Predictive: Assessing the condition of the asset
2. Preventative: Maintaining the condition of the asset
3. Corrective: Improving the condition of the asset

Predictive programs: Collect technical details, testing, and inspection data used to identify assets in need of corrective actions while determining the asset's overall condition. These programs use a combination of inspection techniques depending on the asset type being considered and the failure mode(s) that pose an increased risk to safety, reliability, or the environment. The deployment of communication and sensors on certain new or upgraded assets provides the ability to monitor the condition of assets and collect operational data in real-time. This can reduce or eliminate the need for predictive programs to physically collect asset data. Furthermore, the ongoing monitoring can support the eventual transition from time-based to condition-based maintenance.

Preventative programs: Maintain the existing condition of the asset. Some asset types require regular maintenance activities that are time-based, while other assets are maintained after a certain number of operations to ensure that they will continue to operate as designed. These include visual inspection/mechanical activities such as cleaning, tensioning, tightening, calibrating, and realigning various components, aside from electrical testing.

Corrective programs: Improve the condition of the assets by repairing, replacing, or refurbishing various defective or degraded components. This activity aims to ensure the asset maintains performance, particularly when premature degradation occurs, and may also extend the asset's TUL.

More information on Hydro Ottawa's testing, inspection, and maintenance programs can be found in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

5.1.2.3. Performance Metrics

Hydro Ottawa monitors the performance of its assets and systems to ensure the successful delivery of its Asset Management Objectives. Continuous improvement is achieved through the use of KPIs. Schedule 2-5-3 - Performance Measurement for Continuous Improvement outlines Hydro Ottawa's DSP performance measurement framework and associated KPIs.

5.1.3. Growth Identification

To power a growing community, Hydro Ottawa needs to expand grid capacity while ensuring the reliability and efficiency of its electrical network. Growth identification for Hydro Ottawa's service territory is informed by two types of forecasts — Hydro Ottawa Planning forecast and IRRP forecast.

Hydro Ottawa's planning forecast uses available information of known developments to predict future load increases at the station level, excluding systemic electrification impacts but including known large load requests, see Section 9.4.1 - Hydro Ottawa Planning Forecast for more details. These large load requests, ranging from 5 MVA to 57 MVA, are primarily driven by electrification of heating and transportation in large institutions and companies. The forecast also includes initial-stage customer requests to anticipate future load impacts, providing the foundation for capacity investment needs in the near term (until 2030) primarily driven by existing capacity constraints and committed load requests. However, this forecast, relying on historical consumption patterns and projected growth based on known and observable trends, fails to capture the impacts of decarbonization goals and the resulting electrification of space heating, water heating, and transportation.

Hydro Ottawa's IRRP forecast incorporates the Decarbonization Study's hourly system coincident peak forecasts to reflect the impact of electrification on future energy demands, see Section 9.4.2 IRRP Forecast for more details. This strategic shift is essential for medium to long-term (beyond 2030) transmission planning, as investments in the provincial grid require lead times exceeding five years. By aligning with the Decarbonization Reference Scenario, Hydro Ottawa ensures that immediate capacity investments are consistent with anticipated long-term needs, optimizing asset utilization and enabling efficient capital deployment. This approach facilitates a more robust and forward-looking planning process, critical for navigating the evolving energy landscape driven by decarbonization goals.

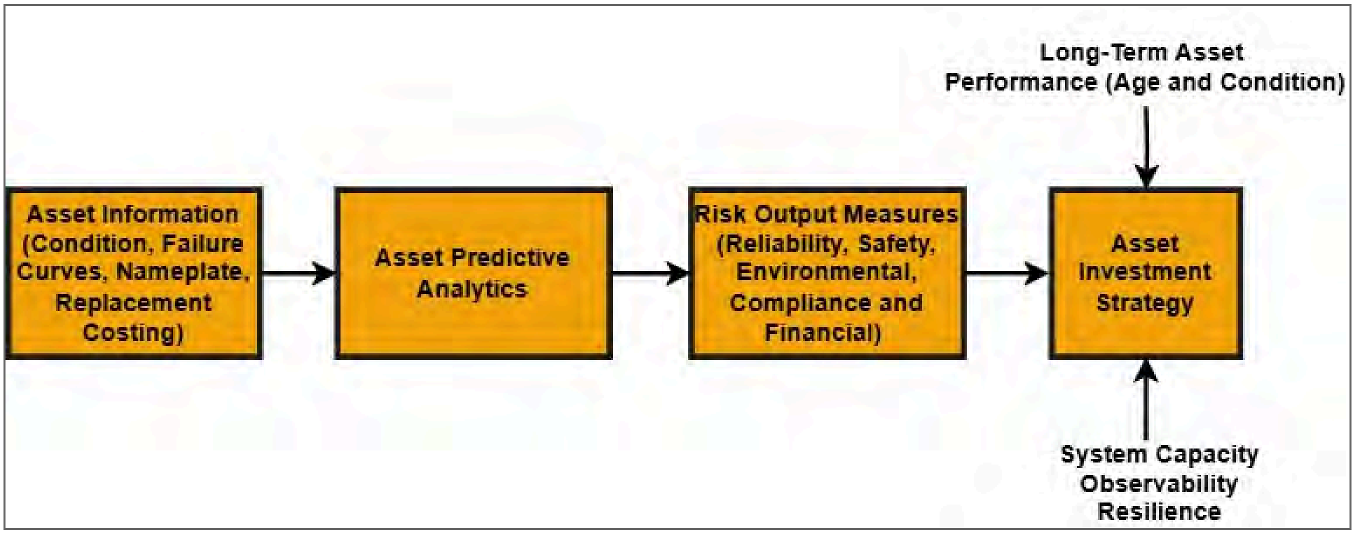
More details on the load forecasting approach are available in Section 9.4 - Planning Load Forecasting and details on capacity assessment in Section 9.1 - Capacity Needs Assessment.

5.1.4. Asset Risk Assessment

Risk assessments are performed to identify and evaluate the risks associated with asset failures. Factors such as asset criticality, failure consequences, and likelihood of failure are considered. Risk assessments help to prioritize assets requiring intervention based on their potential impact on service reliability, public safety, and financial implications.

Hydro Ottawa systematically follows the asset management process to ensure that its physical assets are managed proactively, risks are mitigated, and capital investments are made strategically to maintain a reliable and efficient electricity distribution system for its customers. Hydro Ottawa utilized the PA module within Copperleaf Asset to perform a comprehensive risk assessment considering various risk measures for capital investment planning, as shown in Figure 9.

Figure 9 - Asset Risk Assessment Framework



Hydro Ottawa's risk assessment framework is two-fold:

- **Part One: Asset Risk Evaluation**
  The initial stage of the framework focuses on evaluating the risk associated with each asset. This is achieved through the application of the PA module within Copperleaf Asset.
  - **Asset Information (Condition, Failure Curves, Nameplate, Replacement Costing):** PA considers various factors such as the asset condition, failure curves, nameplate information, and replacement costing.
  - **Asset Predictive Analytics:** By quantifying the likelihood and consequence of asset failure in addition to the asset's criticality to the system, PA provides a risk score for each asset, enabling a comparative analysis and prioritization based on risk levels.
- **Part Two: Asset Investment Strategy Development**
  The second stage builds upon the risk assessment conducted in the first part. It involves formulating an asset investment strategy that aligns with Hydro Ottawa's overarching asset management objectives.
  - **Risk Output Measures (Reliability, Safety, Environmental, Compliance and Financial):** The PA module calculates the overall value of intervening on an asset

based on key risk output measures - reliability, safety, environmental, compliance and financial.

- **Long-Term Asset Performance (Age and Condition):** Long-term asset performance, in terms of the age and condition projections by PA into 2040 is a key consideration in defining underlying system renewal investment alternatives, to decide on the most optimal investment strategy.
- **Asset Investment Strategy:** The most optimal investment alternative or strategy is finalized based on the objective of balancing long-term affordability and minimizing the failure risk associated with assets in degraded condition.

In addition to risk mitigation, the asset investment strategy considers other crucial factors that influence asset management decisions. These factors include:

- **System Capacity**: Ensuring that the system has sufficient capacity to meet current and future demand, while considering potential expansion and upgrades.
- **Observability:** Implementing monitoring and control systems that provide real-time visibility into asset performance, enabling proactive maintenance and issue detection.
- **Resilience:** Evaluating the ability to enhance the resilience of distribution assets (specifically OH infrastructure), in response to the increasing impact of extreme weather events such as ice storms, Derechos, and tornadoes.

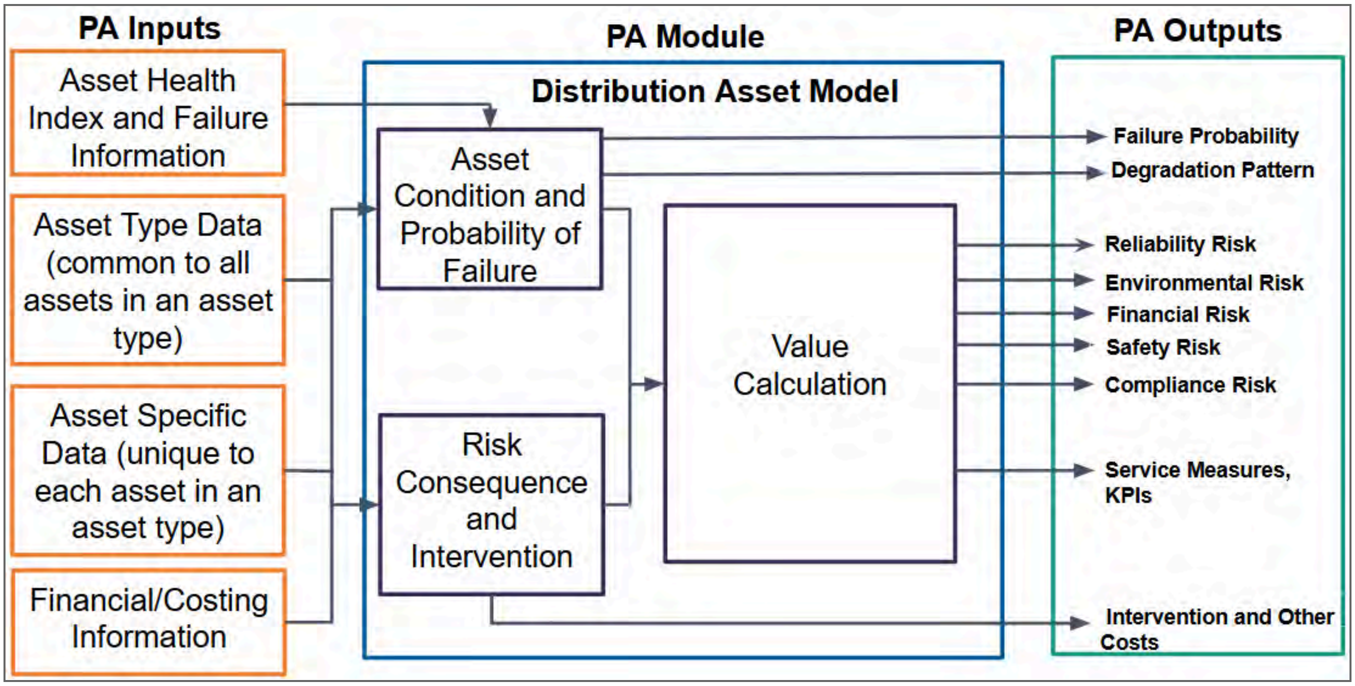
Table 6 provides the assets that are integrated into the PA module for each of the asset classes - Stations, Distribution Overhead, and Distribution Underground:

Table 6 - Assets Integrated with Predictive Analytics

Stations	Distribution Overhead	Distribution Underground
Batteries	Composite Poles	EPR Cables
Circuit Switchers	Concrete Poles	PILC Cables
HV SF_6 Breakers	Metal Poles	XLPE Cables
Metalclad Air Breakers	Wood Poles	Manholes
Metalclad Oil Breakers	Polemount Transformers	Underground Primary Pedestals
Metalclad SF_6 Breakers	Manual Loadbreak Switches	Padmount Switchgear (Air)
Metalclad Vacuum Breakers	SCADA Loadbreak Switches	Padmount Switchgear (Gas)
Station Outdoor Reclosers	Overhead Reclosers	Padmount Transformers
Station Transformers		Vault Switchgears
Station Transformer Tap Changers		Vault Transformers

Hydro Ottawa developed a distribution asset model within the PA module to determine its asset renewal needs, as shown in Figure 10. Asset information (including financial/costing), condition, probability of failure curves, risk consequences, and intervention data gets used in the distribution asset model towards calculating an overall value for risk assessment. Based on the calculated value, the distribution asset model determines the optimal replacement date for a given asset. This is achieved by balancing value maximization with risk and cost minimization, to establish the recommended asset replacement timeline. Utilizing the distribution asset model developed within PA allows Hydro Ottawa to minimize impact to customers by factoring in key risk measures as a part of asset renewal decision-making.

Figure 10 - Distribution Asset Model Architecture



The following sections describe in detail the inputs that feed into PA, the PA module, and the resulting outputs.

5.1.4.1. PA Inputs

Diverse inputs enable the distribution asset model within the PA Module to generate a comprehensive assessment of the asset's condition, risks, and associated costs. These inputs are described below:

a) **Asset Health Index and Failure Information:** PA considers the health index of an asset to establish the baseline condition. It further requires the probability of failure curves unique to each asset type to forecast the degradation pattern and future risk values. In the absence of health index information, it translates the age of an asset to its equivalent condition, based on the established age-condition curves.

b) **Asset Type and Asset Specific Data:** PA considers data pertaining to all asset types (e.g. age, condition, manufacturer, voltage, etc.) in addition to asset-specific data (e.g. oil quantity of oil-filled equipment, SF_6 quantity related to gas-filled equipment etc.).

c) **Financial & Costing Information:** PA considers the replacement cost of an asset between planned and corrective renewals (critical/emergency replacements) for like-for-like or like-for-better scenarios. It also considers the maintenance cost of an asset, to recommend the relevant intervention strategy that derives the maximum value.

5.1.4.2. PA Module

a) **Asset Condition and Probability of Failure:** PA uses the asset health index information/age of an asset to establish the failure probability/degradation pattern, unique to each individual asset in the system.

b) **Risk Consequence and Intervention:** Within PA, the risk consequence calculations are performed unique to each individual risk being considered (reliability, safety, environmental, financial, and compliance). The relevant intervention strategy can also be defined in PA based on constraints and the nature of replacement required (like-for-like or like-for-better).

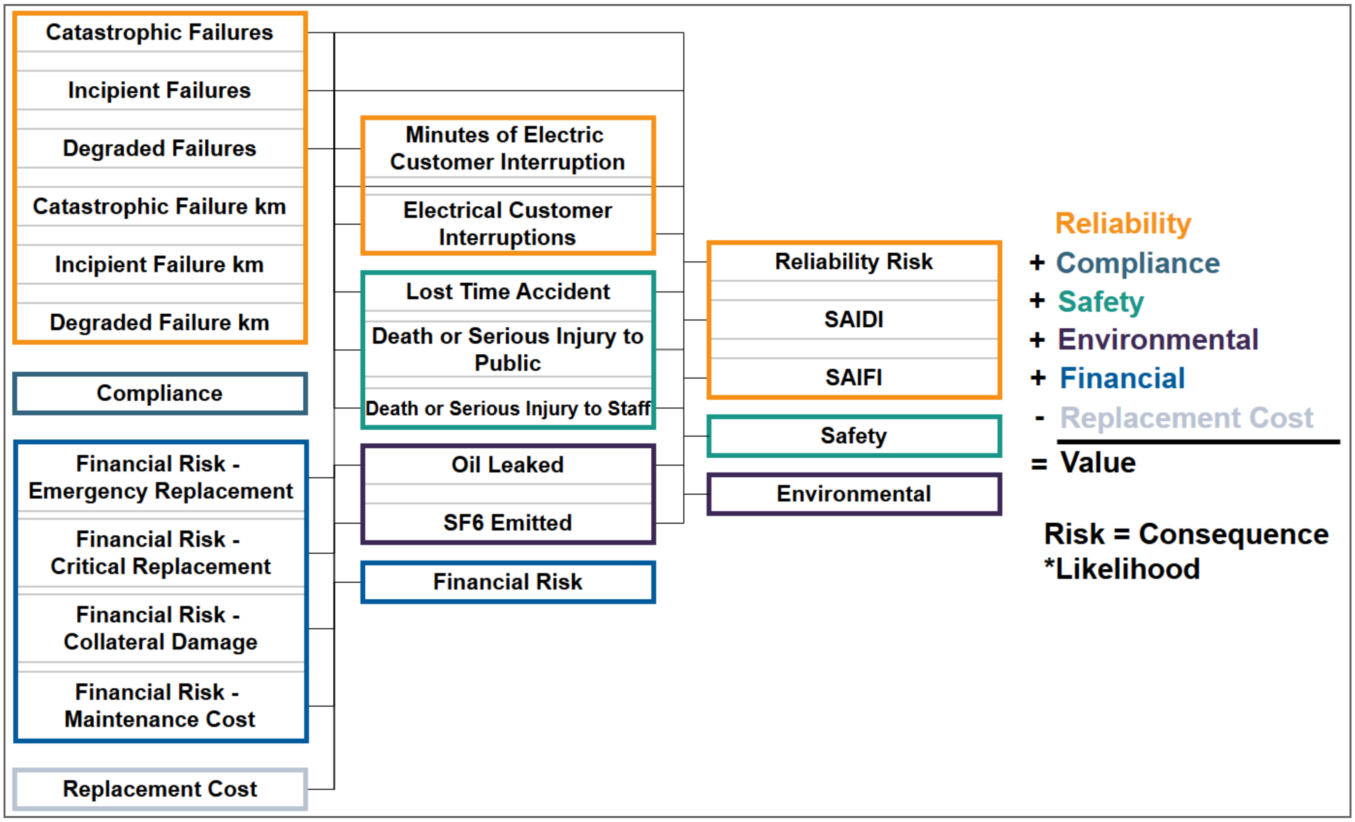
c) **Value Calculation:** PA calculates the overall value of intervening on an asset at a given point in time based on the probability and consequence of the risk measures considered (reliability, safety, environmental, financial, and compliance).

5.1.4.3. PA Outputs

a) **Asset Failure Probability and Degradation Pattern:** Based on the asset condition and probability of failure curve, PA provides an output of the asset failure probability and the expected degradation pattern over time.

b) **Value Measures:** The value measures determined by PA are shown in Figure 11. These value measures are used to calculate the overall value of asset replacement at a given point in time and also support relevant asset renewal decisions.

Figure 11 - PA Module Value Measures



i) Risk Measures: The key risk measures (calculated by the PA module) used to compare the relative value of replacing different assets are shown below:

- **Reliability Risk** is the risk associated with the asset's ability to perform its intended function. It is calculated based on the consequences of failure (outage duration, lost redundancy duration, number and type of customers affected, peak load, and worst performing feeder) and the likelihood of failure (based on individual asset failure curves and the probability of emergency, critical, or expected failures).
- **Compliance Risk** is the risk associated with the asset not complying with regulations. The consequence is calculated based on the financial penalty for non-compliance and

the likelihood that the asset will need to be replaced to maintain compliance by a certain date.

- **Safety Risk** is the risk associated with the asset causing harm to the public or Hydro Ottawa crews. It is calculated based on the consequences of an incident (number of lost time accidents, deaths, or serious injuries to Hydro Ottawa staff and the public that occur per incident) and the likelihood of an incident (based on asset location, individual asset failure curves and the probability of emergency, critical, or expected failures).
- **Environmental Risk** is the risk associated with the asset causing environmental contamination or damage. It is calculated based on the consequences of an environmental incident (oil leaked, SF_6 emitted and oil containment present or not) and the likelihood of an incident (based on individual asset failure curves and the probability of emergency, critical, or expected failures).
- **Financial Risk** is the risk associated with the cost of replacing or repairing a given asset. It is calculated based on the consequences of different types of replacement (Planned Renewal, Emergency Renewal, Critical Renewal, Collateral Damage (tied to other widespread damages not limited to the asset failure alone) and Planned Maintenance Costs) and the likelihood of those replacements (based on individual asset failure curves and the probability of emergency, critical, or expected failures).

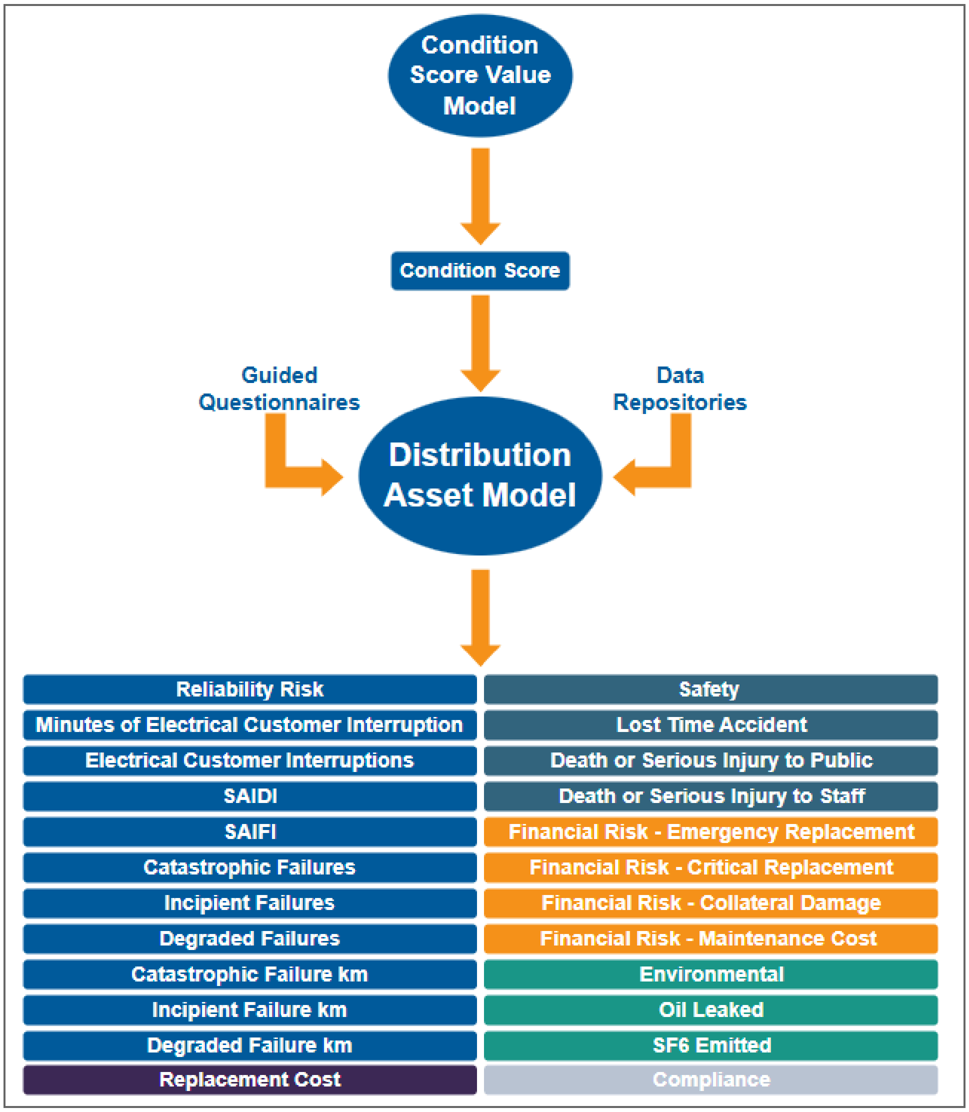
ii) Replacement Cost: PA considers the cost of replacing an asset under normal (planned) or emergency/critical conditions based on the desired nature of replacement (like-for-like or like-for-better).

c) **Service Measures:** Based on the distribution asset model calculation within PA, service measures such as SAIDI, SAIFI, Customer Minutes of Interruption or CMI, Customer Interruptions, forecasted number of failures, lost time accident, death or serious injury to staff/public, amount of oil leak, and amount of SF_6 emitted can be obtained. These service measures can be used as constraints within the distribution asset model to further optimize an investment scenario (e.g. defining SAIDI, SAIFI thresholds to establish the investment level required each year).

d) **Intervention and Other Costs:** PA forecasts the risk impact of asset deterioration over time. It optimizes asset remediation timing by evaluating the overall value of intervention strategies, guiding investment decisions. It shows the optimal and recommended intervention date for each individual asset in the system and the related costs.

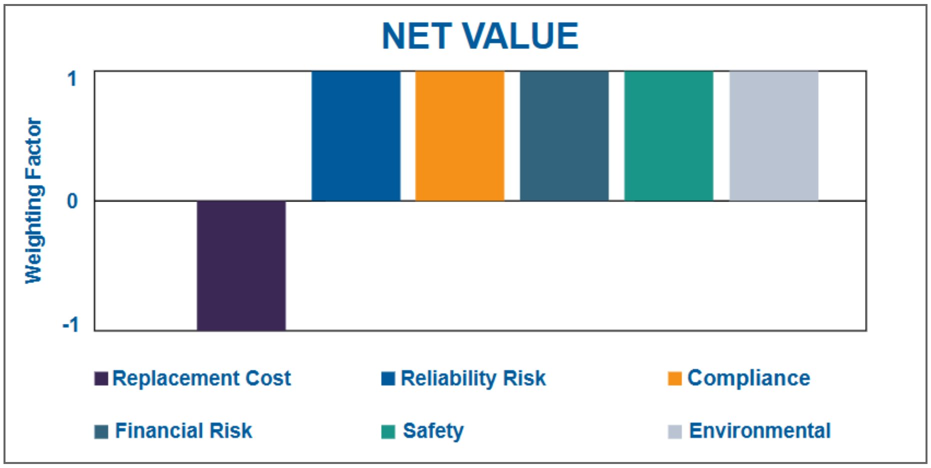
The distribution asset model within the PA module, including inputs and output measures, is illustrated in Figure 12 and details the specific inputs and calculations used to determine these output measures.

Figure 12 - Distribution Asset Model in Copperleaf PA Value Measures



Based on the distribution asset model implemented in Copperleaf Asset, the net value of intervening on any given asset is computed as a function of the various risk measures: reliability, safety, environmental, financial and compliance compared against the replacement cost. Figure 13 shows the weighting factors that are applied to the six value measures that contribute to the value function.

Figure 13 - Weighting Factors of Value Measures that Contribute to the Value Function



PA aligns Hydro Ottawa's investment plans with strategic goals, improves efficiency, integrates planning, and manages deteriorating infrastructure risk. This leads to higher-value decisions, improved business performance, and optimized resource allocation.

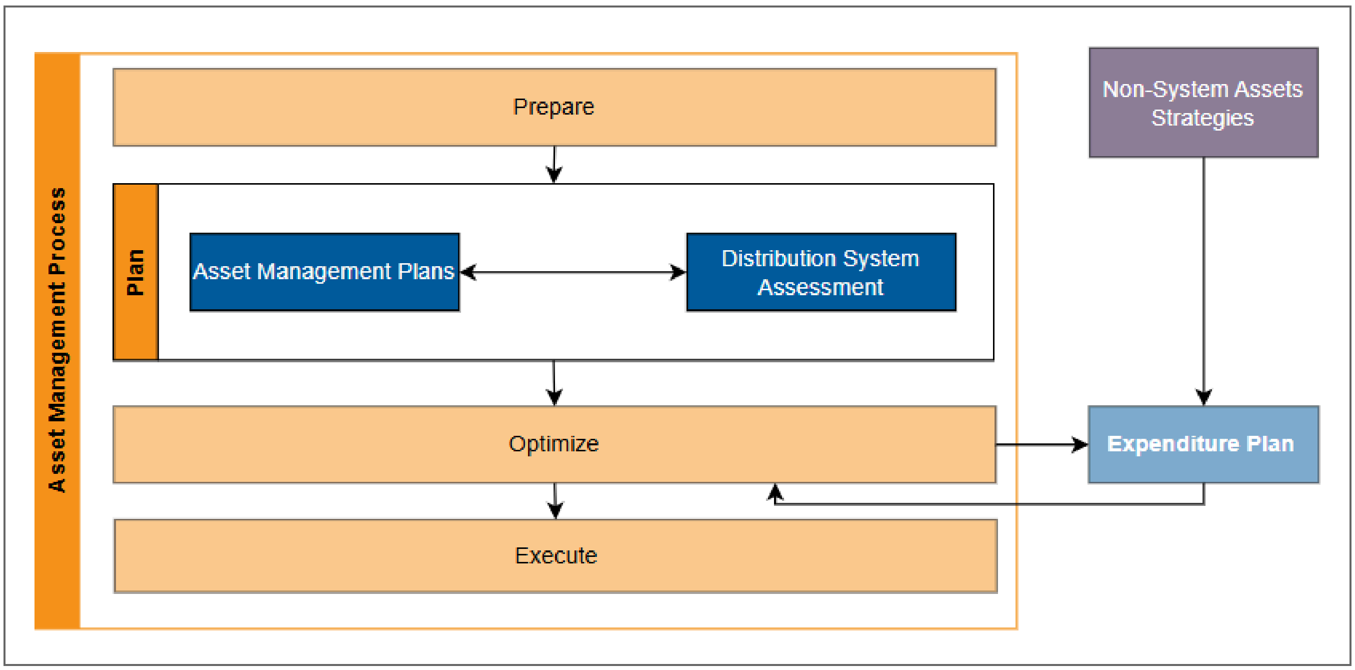
Hydro Ottawa's asset intervention assessment process in Copperleaf PA is centered around three primary alternatives at the program level: Cost Containment, Short Term Risk Mitigation, and Long Term Risk Mitigation. The alternatives undergo a thorough evaluation to review the ability to balance long term affordability and minimize the failure risk associated with assets in a degraded condition.

5.2. PLAN

This stage encompasses the creation of detailed AMPs that strategically align with the overarching system requirements while effectively addressing identified risks and objectives as shown in Figure 14. These plans take into account a multitude of factors such as capacity constraints, reliability requirements, resilience needs, and grid modernization initiatives. Furthermore, this stage includes a thorough analysis and identification of the necessary capital investments and OM&A expenditures that are essential to support the proposed asset management strategy and ultimately achieve the desired outcomes.

By meticulously considering these various aspects, the AMPs developed in this phase will provide a comprehensive roadmap for optimizing the performance, reliability, and longevity of assets while ensuring they are aligned with the broader system needs and objectives. This approach to asset management will not only mitigate risks but also enhance the overall efficiency and effectiveness of the system, leading to improved operational outcomes and long-term sustainability.

Figure 14 - Asset Management Process: Plan Stage



5.2.1. Asset Management Plans

Hydro Ottawa prepares AMPs for each asset group or class. An AMP is a comprehensive, multi-year plan designed to guide Hydro Ottawa in achieving its asset management objectives, outlined in Section 4.2 - Asset Management Scope, Strategy and Objectives. An AMP outlines the necessary activities, strategies, and timeframes, drawing upon principles stated in Section 4.2 - Asset Management Scope, Strategy and Objectives. AMPs incorporate insights from internal stakeholders, ensuring a thorough understanding of specific asset needs and management requirements.

AMPs focus on defining the required level of service for assets and ensuring alignment with the broader asset management objectives and performance measures. AMPs also include a detailed assessment of the current condition and performance of assets, enabling the identification of areas where improvements can be made. By pinpointing these gaps, the AMPs help to identify remedial actions to enhance asset performance and reliability.

AMPs are also forward looking and consider future demand and various drivers that may influence asset management practices. This forward-looking perspective allows Hydro Ottawa to anticipate changes and adapt its strategies accordingly. Finally, AMPs outline the lifecycle strategies and activities associated with managing assets effectively. They identify the resources needed to execute these strategies and present a financial plan that supports the overall asset management approach. AMPs serve as roadmaps for Hydro Ottawa to optimize asset performance, mitigate risks, and ensure the long-term sustainability of its infrastructure.

Hydro Ottawa has developed AMPs categorized as follows:

1. Underground Transformers
2. Underground Switchgear
3. Station Transformers
4. Station Switchgear and Breakers
5. Poles, Fixtures and Overhead Conductors
6. Overhead Switches
7. Overhead Transformers
8. Civil Structures
9. Underground Cables
10. Station Batteries, Protection and Control Equipment

11. Vault Transformers
12. Telecommunications
13. Revenue Meters

5.2.1.1. Program Planning Approach

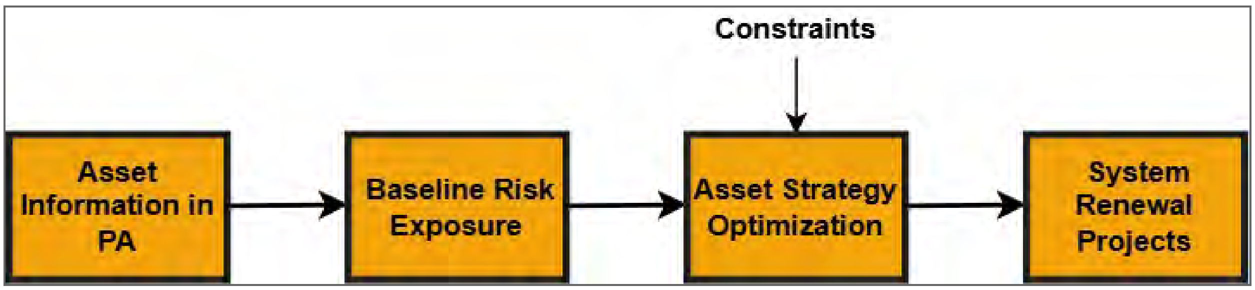
The AMPs are strategically aligned with the overall system requirements while proactively addressing identified risks and objectives. They serve as a comprehensive and actionable roadmap for optimizing asset performance, reliability, and longevity. Furthermore, they encompass a detailed analysis of the capital expenditures necessary to effectively support the overarching asset management strategy. Hydro Ottawa's DSP is informed by the AMPs, which also ensure that the resulting capital programs are monitored, implemented, and reported on annually through relevant AMP updates. Hydro Ottawa monitors the asset demographics (in terms of age/condition) and other impacts/risks to an asset type through the AMPs, which are key factors that drive the program planning process, in addition to the risk-based assessment outlined below for system renewal investments.

Hydro Ottawa leveraged the Copperleaf PA module to facilitate and enhance the decision-making process surrounding the allocation of financial resources towards system renewal program-level expenditures. As described in Section 5.1.4 - Asset Risk Assessment, Hydro Ottawa developed a distribution asset model by utilizing asset condition to forecast the degradation pattern based on the probability of failure. Asset-specific consequences and exposure factors were also established based on asset criticality with higher granularity.

Figure 15 below shows the system renewal planning process with Copperleaf PA. Hydro Ottawa loads asset information in PA, and the asset data is automatically run through the established distribution asset model. The PA module computes the baseline risk for all assets and establishes the risk exposure for Hydro Ottawa if no intervention were to be executed. PA also determines the most effective sustainment strategy to mitigate baseline risk exposure while considering constraints such as financial budgets, risk, resources, and service levels/measures. Copperleaf PA allows

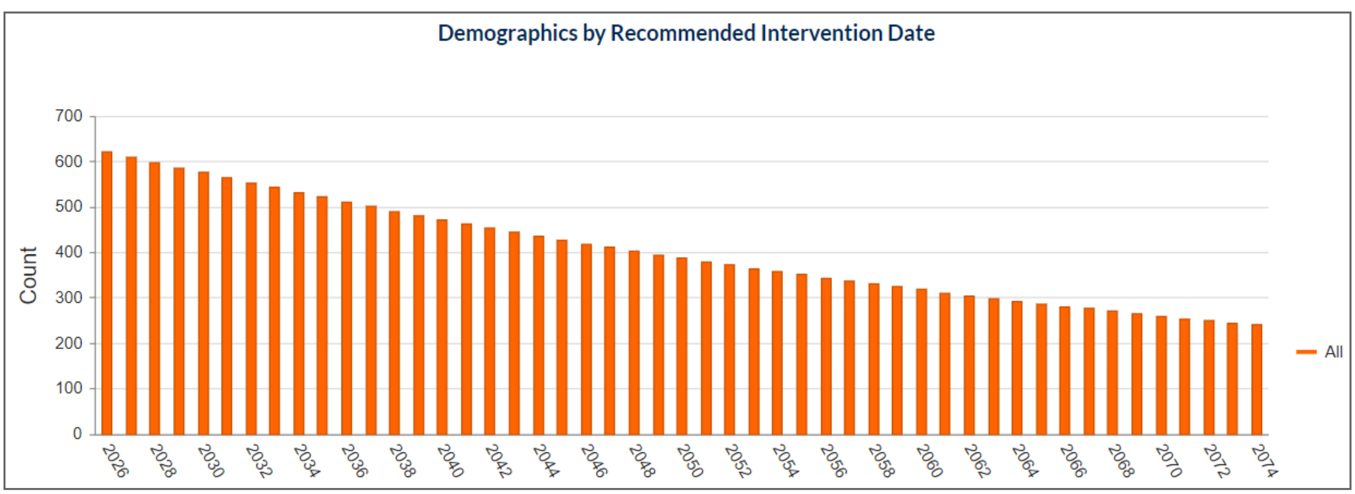
Hydro Ottawa to evaluate multiple scenarios, looking at various interventions and constraint levels on the asset sustainment strategy.

Figure 15 - System Renewal Planning Process with Copperleaf PA



Only direct asset replacement costs are considered in Copperleaf PA as a part of system renewal investment planning and establishing the recommended number of units to be replaced per year. Copperleaf PA determines an optimized spending level based on the underlying constraints in order to realize maximum value. Based on the example shown in Figure 16, for a given asset type, PA recommends more replacements in the initial years (driven by asset condition and risk), so the investment required tapers down in the future, as a part of the most optimal investment strategy.

Figure 16 - Yearly Recommended Interventions with Copperleaf PA



As a part of the optimization process in Copperleaf PA, Hydro Ottawa primarily considered the age and condition demographic projections into 2040, to develop three main alternatives with varying replacement levels. The major objective behind developing these alternatives was to balance long-term cost impacts to customers with the failure risk of assets in a degraded condition.

The following three alternatives were considered to plan the system renewal investments across the major distribution asset renewal programs:

1. **Cost Containment:** Cost impacts are minimized during the 2026-2030 period, however replacement rates will not allow Hydro Ottawa to balance long-term affordability or effectively manage risk associated with assets in degraded condition
2. **Short Term Risk Mitigation:** Cost impacts are more significant and replacement rates will allow Hydro Ottawa to mitigate only short term risk associated with assets in degraded condition
3. **Long Term Risk Mitigation:** Cost impacts are highest however replacement rates will allow Hydro Ottawa to most effectively balance long-term affordability and risk associated with assets in degraded condition

The aforementioned alternatives are evaluated against the corresponding evaluation criteria considered (such as safety, reliability, financial, system observability, resilience, etc.), to finalize an optimal investment alternative for a given asset type.

For additional details regarding investments planned for asset replacements for 2026-2030, refer to Schedule 2-5-7 - Asset Renewal Investments, Sections 1 through 5. The information from the Distribution System Assessment phase described in Section 5.2.2 - Distribution System Assessment is also considered to determine final investment asset renewal needs.

5.2.2. Distribution System Assessment

The distribution system assessment phase involves analyzing system constraints using the planning forecast from the growth identification phase to determine the need for capacity upgrades or reinforcements. The identification of system constraints is determined through evaluating the existing distribution system's capacity to meet the forecasted planning demand to identify bottlenecks and areas where upgrades or reinforcements may be needed. The assessments also aim to improve the reliability and resilience of the system. Hydro Ottawa's resilience assessment aligns with the OEB's future VASH framework by taking an asset-based approach that relies on data derived from climate forecast models developed by a third-party consultant. A quantitative analysis comparing asset threshold criteria to the probability of extreme weather events within the project evaluation stage ensures investments improve climate resilience within the distribution system. Section 5.2.2.4 - Resilience Assessment provides more detail on the resilience assessment.

5.2.2.1. Grid Modernization

Hydro Ottawa routinely reviews the existing system to identify opportunities for Distribution Enhancement projects that reduce operational constraints and improve system operability, through observability and controllability. Efficiency-driven projects are designed to reduce restoration times and reduce the number of personnel required for switching. As per Section 3.4.2 - Grid Modernization Strategy, the operability of the distribution system will be enhanced through advanced monitoring, rapid fault detection and localization, improved overload detectability, and automated/remote system restoration. System operability will also benefit from resilience measures that strengthen the distribution system and reduce the impact of outages from weather events.

The following criteria are used to identify areas that will benefit from projects related to operability:

- Asset Vulnerability
  - Areas prone to weather impacts
  - Areas with deteriorating infrastructure
  - Areas which are difficult to access or patrol
- Asset Criticality
  - Frequency of historical switching operations

    - Criticality of connected load
    - Number of customers connected and/or customer density
- Regional Considerations
    - Areas with loading constraints
    - Historical reliability performance
    - Density of DERs
    - Areas with high growth projections

These criteria are assessed within the grid modernization and resilience strategies for the purpose of increasing system observability and controllability where applicable. The aim of these initiatives is to bring greater real-time awareness of system performance to support both daily operations and inform system planning.

The following are the results of the system operability review process; these projects are further described in Section 3 of Schedule 2-5-8 - System Service Investment and Schedule 2-5-7 - System Renewal Investments:

- Critical switches identified for upgrades to remote operable units
- Decommissioning redundant/unused legacy equipment from the system upon renewal
- Relocation of equipment or normal-open points
- Installation of Fault Current Indicators (FCIs) to localize faults on long feeders and to optimize the use of remote switches

In addition to the immediate benefits around system operability, the installation of intelligent observation and control devices in the system will set the stage for future grid modernization, laying the foundation for future improvements and functionality contributing to further system operability improvements.

5.2.2.2. System Constraints

Transmission

The distribution system is designed and planned to supply existing and future customers reliably while conforming to system design constraints. These constraints include equipment thermal and short-circuit limitations, power quality, and restoration capability standards. System constraints must be considered in the design of the transmission supply network, station equipment, and distribution feeder configuration. Due to the large load and number of customers impacted by transmission system failures, the transmission system is constrained by standards designed to ensure a high level of reliability. To ensure the reliability of the bulk power system, transmission planning must consider both the adequacy and the security of wires and resources, as well as the supply mix requirements set out in the government’s Powering Ontario’s Growth plan. Planning and operation of the bulk power system must comply with all applicable standards and criteria established by IESO Ontario Resource and Transmission Assessment Criteria (ORTAC), North American Electric Reliability Corporation (NERC), Northeast Power Coordinating Council (NPCC) and the IESO Market Rules. Projects to address transmission system constraints are often driven by growth within the distribution system. Hydro Ottawa provides the IESO with updated growth forecasts for the distribution system to help identify and address transmission capacity and ORTAC constraints as part of the regional planning process. Details regarding the regional planning process can be found in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Station

Hydro Ottawa’s station planning criteria are based on the worst-case N-1 contingency scenario, which ensures the grid can continue operating after the failure of any single major component. The loading limit in this scenario is calculated by summing the capabilities of the remaining transformers after the largest one fails. For planning purposes, the 10-day limited time ratings (LTR) are used when available, which represent the load a transformer can handle for 10 days under peak conditions with less than 1% life loss. If the LTR isn’t provided, the highest fan rating is used. Hydro Ottawa designs stations to ensure that transformers - rather than cables, buses, or breakers - set the limit on capacity. In stations with only one transformer, the load is transferred to nearby stations through feeder lines.

Feeder

At the feeder level, the system is constrained by conductor thermal limitations and voltage drop. Each feeder is planned to supply connected customers and/or back up other connected feeders in an N-1 contingency while remaining under the thermal limitation of the conductor. On the 4kV system, this is achieved by having a dedicated backup feeder available at the station, while for all other systems, this is achieved through feeder ties. Additionally, conductor properties, size of loads, and location of loads may lead to voltage drop concerns. Feeders must be configured to deliver voltage levels within the limits stated in Canadian Standards Association Standard (CSA) CAN3-C235-83 - Preferred Voltage Levels for AC Systems, 0 to 50 000 V.

Constraints of various equipment types are determined by the equipment properties information stored in Hydro Ottawa's Asset Register. Projects and operation guidelines are created to address equipment forecasted to exceed their constraints. Current capacity limitations of Hydro Ottawa's electrical infrastructure are monitored through SLI and FLI calculations, see more details in Section 8.4 - Asset Utilization Policies and Practices. The system capacity assessment and the resulting needs for each planning region are described in Section 9 - System Capacity Assessment. Alternatives to mitigate capacity needs are evaluated in Material Investment Plans (MIPs), Section 2 of Schedule 2-5-8 - System Service Investments.

The following key variables inform the capacity planning process:

- Historical station transformer loading from the system-wide annual peak day (weather-normalized and adjusted to a one-in-ten-year peak for forecasting)
- Historical feeder loading from the system-wide annual peak day (weather-normalized and adjusted to a one-in-ten-year peak for forecasting)
- Station, station transformer, and feeder planning capacity and ratings

- Asset condition
- System configuration and operating characteristics (and restrictions)
- Number of Hydro Ottawa customers
- Historical energy purchased and delivered
- Summer and winter peak load
- City of Ottawa Official Plans and Community Development Plans
- Land use designation and population and employment projections
- Known developments through conversations with developers and City of Ottawa
- Forecasted load growth triggered by decarbonization driven electrification
- DER connections and capacity
- Station capacity to connect generation and plans in place to address any restrictions
- Details and plans resulting from the IRRP process with the IESO and Hydro One Networks Inc. (Hydro One)
- Details relating to Connection Cost Recovery Agreements (CCRAs) with Hydro One for station or transmission projects

For more detail, refer to Section 9 – System Capacity Assessment.

5.2.2.3. Reliability Assessment

Distribution system assessments also aim at bolstering the overall performance and reliability of the distribution system. These initiatives include strategic endeavors to augment system reliability, elevate system observability through advanced monitoring and control technologies, and foster technological innovations. By strategically investing in these multifaceted initiatives, Hydro Ottawa aims to proactively address existing challenges, such as feeders exceeding planning limits, feeder phase imbalances, and neutral ties in the 13.2kV delta subtransmission system. The lack of 13.2kV neutral ties on the subtransmission system causes reliability concerns when connecting pad mount transformers without a delta primary as there is no return path for current, potentially causing an imbalance on phase voltage and subsequent overvoltage or undervoltage. Through these targeted investments, Hydro Ottawa seeks to not only enhance the reliability of the electrical grid but also to improve operational efficiency, reduce energy losses, and ensure the overall longevity and sustainability of the distribution system. These assessments feed into investment planning and provide input to System Service Investments.

Reliability-driven projects are those designed to reduce outage frequency or duration. In general, work considered as part of the system reliability plan includes the following:

- Feeder reconfiguration and addition of feeder ties for feeders experiencing poor reliability and/or capacity constraints
- Phase balancing of feeders with high phase imbalance
- Deployment of remote sensors
- Deployment of remotely operable and autonomous devices
- Deployment of field devices to provide fault indications locally
- Supporting technologies for automation (e.g., communication & SCADA)
- Modifications of existing installations to address specific interference (e.g., animal guards, circuit spacing)

The reliability assessment process may also identify required asset replacements. Successful lifecycle management of Hydro Ottawa's assets has a direct impact on system reliability. These activities focus on assets that are optimally maintained throughout their life, asset replacement before failure, and system planning to increase operability and reduce downtime.

The following key variables inform the reliability planning process:

- Historical outage statistics (primary cause, secondary cause, duration, number of customers affected, circuit affected, station affected, date of interruption, number of momentary interruptions)
- Worst Feeder evaluation

The following are the results of the reliability assessment process; these projects are further described in Section 2 of Schedule 2-5-8 - System Service Investment:

- Projects to improve the Worst Feeders' reliability performance
- Initiatives to improve overall reliability (specifically targeting the top three causes of interruption from the previous year)
- Details on automation plans and how they will impact reliability

5.2.2.4. Resilience Assessment

Ottawa has become the weather-alert capital of Canada.[6] Extreme weather events such as high heat, high winds, flooding, and ice storms are increasingly straining and damaging the electricity grid. Due to this, focusing on enhancing grid resilience through proactive measures and infrastructure upgrades is essential to protect against the increasing frequency and intensity of severe weather events.

Hydro Ottawa's service territory has been impacted by adverse weather events in recent years as described in Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. In 2019, Hydro Ottawa commissioned Stantec to complete a Distribution System Climate Risk and Vulnerability Assessment, as well as a Climate Change Adaptation Plan due to the increasing number of extreme weather events. Stantec reaffirmed the results from these reports in 2023 to include more recent weather events and updated climate models, refer to Section 6.4.2 - Future Climate.

Leveraging the findings from the 2023 Stantec report, Hydro Ottawa engaged Burns & McDonnell's subsidiary, 1898 & Co, to complete a Resilience Investment Business Case Assessment to identify investments that would increase grid resilience focusing on strategic undergrounding. These reports were used to establish resilience criteria that align with the OEB's VASH framework and ensure the greatest value from resilience investments. The criteria were used to create a new resilience risk

[6] Environment and Climate Change Canada.

value measure to quantify the risk associated with the frequency and intensity of major weather events on the distribution system, calculated based on a storm's impact on the reliability of a given section of feeder. This feeds into the Project Evaluation process detailed in Section 5.3.2.2 - Project Evaluation. The orientation, configuration, vegetation encroachment, and historical outage information for a given section was assessed against the ability of those assets to withstand major weather events such as high winds, winter storms, and tornadoes. The impact of a major weather event was quantified using a climate change forecast correlated against historical customer outage times. Reliability risks such as types of customers, average number of customers impacted, expected peak lost load, worst performing feeders, number of failures per year, duration of outages, and redundancy lost were referenced to assess the project value. Investments identified by the Resilience Business Case report were evaluated using this new resilience value measure to prioritize projects with the greatest resilience benefit.

Attachment 2-5-4(E) - Resilience Investment Business Case Report underscores the escalating significance of grid resilience. This emphasis was made in light of the increasing frequency of major weather events, with the report documenting the findings of the assessment. It emphasizes that resilience is not just a technical issue, but a societal one, as the modern customer and integrated society are increasingly reliant on a consistent power supply. The impact of power outages today is far greater than in the past, necessitating proactive investment in grid resilience. The report provides a conceptual framework for understanding resilience, breaking it down into three components: stressors (major events), the state of the system (vulnerabilities), and utility actions (prepare, mitigate, respond, recover). It underscores the importance of a future-focused approach to resilience, considering the 'universe' of potential events and system vulnerabilities.

The core of the report lies in its Resilience Investment Model, a data-centric approach to identify, prioritize, and justify resilience investments. The model focuses on converting overhead lines to underground systems and considers factors like vegetation density, asset age, and customer type to identify projects with the highest potential benefits. The analysis presents the results of a resilience evaluation for Hydro Ottawa, focusing on overhead to underground resilience investments. The benefits of these investments are quantified in reduced storm recovery costs and reduced customer outages, measured in Customer Minutes Interrupted (CMI). The results highlight the potential for significant customer benefits through strategic resilience investments.

Hydro Ottawa has adopted a proactive and comprehensive approach to resilience investment. Inputs from the Resilience Investment Business Case Report were considered to frame Hydro Ottawa's resilience strategy.

The report identifies 1,743 projects to underground lines, with 57 projects having a Benefit to Cost Ratio (BCR) greater than 0.8. Projects with a BCR >1 offer a positive business case, with benefits outweighing the costs, and are therefore recommended to undergo a scope evaluation. To have a larger pool of projects for scope evaluation, and consideration for other resilience measures for inclusion under the Resilience program, Hydro Ottawa considered projects with a BCR threshold greater than 0.8. These projects significantly reduce both storm restoration costs and CMI. The projects proposed have been reviewed by Hydro Ottawa and used as a starting point to frame resilience investments. Adjustments to the investments proposed by the consultant were mainly based on Hydro Ottawa's knowledge of the distribution system, such as updating project costs based on unique site conditions, and to drive efficiencies by collating project scope where it provides greater benefit.

In addition, while the report focuses on undergrounding, it acknowledges that other resilience investment options could be considered as part of a larger resilience plan such as stronger pole structures, enhanced switching, and improved access to deep right of ways. Hydro Ottawa adopted this approach to build resilience criteria that not only look at undergrounding but an overarching strategy to make the grid more resilient. Based on this, the resilience investments plans cover:

- Strategic Undergrounding - Based on Undergrounding Study results, BCR larger than 0.8 and passing of Hydro Ottawa screening
- Line Reinforcement - strong structure poles, guying and anchoring

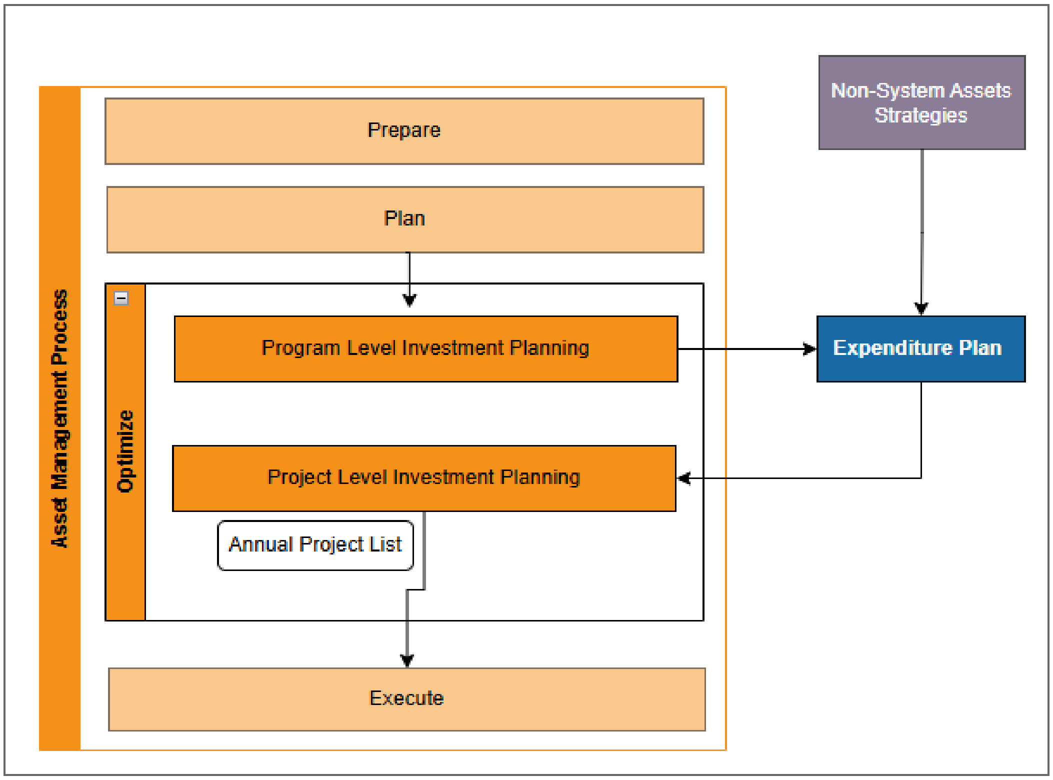
- Feeder Reconfiguration - reduce customer count on feeders heavily impacted by adverse weather conditions (radially fed customers, north-south arterials)
- Station Egress Undergrounding - undergrounding of overhead egress with more than two circuits up to a point where system flexibility increases
- Line Relocation - relocate lines with high vegetation and/or improve access to deep right of way.

More details on resilience investments can be found in Section 3 of Schedule 2-5-8 - System Service Investments.

5.3. OPTIMIZE

Hydro Ottawa organizes its Capital Expenditure Plan into four investment categories: System Access, System Renewal, System Service, and General Plant. Each category is divided into Capital Programs based on primary drivers, and then further subdivided into Budget Programs based on specific asset type or system need. Individual projects are created under Budget Programs for assets at specific geographic locations that require intervention or for specific initiatives. The investment planning process, which includes assessments at both the program and project levels, is part of the optimization stage. Figure 17 shows the components of the optimize stage for investment planning.

Figure 17 - Components of the Optimize Stage



During the program level assessment phase, the needs identified in the AMPs and the distribution system assessment during the planning stage are assigned to investment categories. Then, alternative solutions to address program needs are evaluated to select the solution that best meets asset management objectives. Selected programs are evaluated along with other non-system asset needs (IT, Facilities, and Fleet) through the Capital Expenditure Planning Process, described in Section 3.5, to create a balanced expenditure plan for rate application submission. After the Capital Expenditure Plan is finalized and approved, identified projects within each program are evaluated and scored for annual assessment during the project-level investment planning phase. A portfolio optimization tool is used to refine and optimize project selection using approved program-level constraints.

The optimization stage ensures a balanced and optimized investment approach that addresses system and asset needs identified through the distribution asset management process. This results in a Capital Expenditure Plan that prioritizes system capacity enhancements, renewal of deteriorating infrastructure, grid modernization, and increased overall resilience.

5.3.1. Program Level Investment Planning

The program-level investment planning phase involves a comprehensive integration of asset and system requirements that have been identified through the asset management process planning stage. This phase takes into account a multitude of factors, including but not limited to: investment priorities, risk mitigation strategies, regulatory compliance mandates, resource availability, and financial viability. Furthermore, the plan extends its purview to encompass requirements emanating from other non-system assets, ensuring a holistic alignment with the overarching needs of the distribution system.

The first step of this process, program definition, involves a thorough examination of the primary factors that influence each program within every investment category. This comprehensive analysis serves two key purposes:

- Ensuring that the budget is allocated appropriately and effectively to achieve the desired outcomes.
- Identifying areas where programs can be streamlined or optimized to enhance efficiency. These improvements in efficiency may also have the added benefit of addressing secondary drivers.

The second step of this process, program portfolio optimization, involves a comprehensive evaluation of how well identified programs align with the overarching investment priorities. These priorities, which include Growth and Electrification, Renewing Deteriorating Infrastructure, Grid Modernization, and Enhancing Resilience, serve as the guiding principles for investment decisions. Each of these priorities is further supported by underlying focus areas, such as Managing Rising

Costs and Investing in the Workforce, which highlight specific areas of concern within the broader strategic framework.

To facilitate the optimization process, MIPs are developed for each program. These plans provide a detailed breakdown of the financial resources required to implement the program to enable the assessment of the feasibility of different alternatives and their ability to meet the identified priorities. The assessment process involves a rigorous evaluation of the potential costs and benefits associated with each program, as well as its potential contribution to the overall strategic objectives. The evaluation criteria used to determine the preferred alternative differ depending on the program under consideration, but all follow components of the themes outlined in Table 7 below.

1 **Table 7 – Alternative Evaluation Criteria**

Evaluation Theme	Description
Regulatory and Legal Compliance	Adherence to all applicable laws, regulations, and industry standards, including specific acts, codes, and board requirements. Ensures legal operation and fulfills obligations to provide safe and reliable services.
Economic and Community Impact	Contribution to the city's growth and sustainability, supporting development projects, business expansion, and enhancing community well-being through reliable infrastructure and sustainable initiatives.
Environmental Sustainability	Promotion of environmental sustainability by supporting electrification, renewable energy integration, and energy efficiency initiatives. Aims to minimize environmental footprint, reduce greenhouse gas emissions, and promote clean energy sources.
Customer Experience and Empowerment	Enhancement of customer satisfaction through accurate billing, personalized service, transparent energy management, and providing direct control over energy usage and billing, fostering energy awareness.
Operational Efficiency and System Performance	Impact on operational processes and system capacity, focusing on optimizing power flow and ensuring the system can handle increasing loads without compromising service quality.
System Reliability	Management of asset performance to reduce the risk of failure and ensure consistent power delivery. Focuses on minimizing the frequency and duration of outages.
System Resilience	Evaluating the systems ability to withstand disruptions and quickly recover from extreme weather or unexpected events.
System Observability	Enhancement of the monitoring and diagnosis of system conditions to support grid modernization initiatives, real-time monitoring, and fault detection, enabling informed decision-making.
Financial Viability and Cost-Effectiveness	Financial implications, including upfront costs, ongoing maintenance, and risk mitigation, balancing infrastructure enhancements with minimizing rate impacts.
Safety and Public/Employee Protection	Mitigation of risks to employees and public safety, prioritizing the protection of both from electrical hazards and other potential dangers.
Asset Management and Renewal	Management of asset performance, including renewal, maintenance, and addressing aging infrastructure to ensure reliability and prevent failures.
Resource and Material Procurement	Ability to achieve successful project execution through optimized resource management and timely procurement of materials.
Cyber Security and Data Protection	Protection of customer data and safeguarding the grid from cyber threats through adherence to high industry standards for data security and privacy.

The results of the program-level investment planning assessment for the 2026-2030 rate period, which are detailed in Schedules 2-5-6 through 2-5-9, provide valuable insights into the effectiveness of the current program portfolio and its alignment with the strategic investment priorities.

5.3.1.1. Program Definition

Hydro Ottawa's Capital Expenditure Plan is broken into four Investment Categories, which are summarized in Table 8. These investment categories and definitions are in alignment with OEB Chapter 5 filing requirements.

Table 8 – Capital Investment Categories

Investment Category	Description
System Access	Modifications (including asset relocation) to a distributor's system to provide customers (including generator customers) with access to electricity services via the distribution system.
System Renewal	Replacing and/or refurbishing system assets to extend their original service life, maintaining the ability of the distribution system to provide customers with reliable and safe electricity services.
System Service	Modifications to the distribution system to ensure that it continues to meet the distributor's operational objectives while addressing anticipated future customer electricity demand and service requirements.
General Plant	Modifications, replacements, or additions to a distributor's assets that are not part of its distribution power delivery system, including land and buildings; tools and equipment; rolling stock, and electronic devices and software used to support day-to-day business and operations activities.

Table 9 outlines the description of the drivers by Investment Category. The Program Definition process assigns programs to appropriate investment categories based on the program's primary driver.

1 **Table 9 – Driver Description**

Investment Category	Driver	Description
System Access	Customer Service Request	Customer request for new connection (load or generation)
	Third Party Requirements	Request by a third party for plant relocation
	Mandated Service Obligation	Regulatory requirement to maintain distribution license under the OEB's Distribution System Code or requirement as per Hydro Ottawa's Conditions of Service
System Renewal	Failure	Asset no longer meets functional requirement
	Failure Risk	Asset is at risk to no longer meet functional requirements
	High Performance Risk	Asset is at risk of failure in a way that can cause harm or damage to other equipment or assets or would put the distribution system in a detrimental state
	Functional Obsolescence	Asset is functionally obsolete with no spare parts, tools, and/or software to continue operation
System Service	Capacity Constraints	Requirement for additional capacity (station transformation or circuit) due to planned or realized load increases
	Reliability	Requirements driven by poor distribution system performance such as abnormally high duration or frequency of interruptions
	System Efficiency	Requirements to improve both resource efficiency and power delivery reliability through strategic automation that minimizes manual intervention and streamlines data workflows.
	Observability	Requirements for improved system operability and visibility
	Resilience	Requirements for improved system resilience during major events.
General Plant	System Investment Support	Capital contributions to Hydro One for connection projects Requirement for fleet/vehicle acquisition
	Business Operations Support	Requirements for IT software and systems

5.3.1.1.1. System Access

System Access investments are obligatory activities. For this reason, they are not prioritized through the Capital Investment Planning Process, but rather based on available resources and in collaboration with the requesting party.

The main drivers for programs under System Access are:

- **Customer Service Requests:** Customer Service Requests arise from the needs of load or generation customers for new connections. This category includes servicing for new commercial buildings, residential subdivisions, or generators, and encompasses any system expansion required to supply the development site.
- **Third Party Requirements:** Third Party Requirements are initiated from requests received for the relocation or upgrade (modifications) of assets or infrastructure (e.g., pole relocation for road widening).
- **Mandated Service Obligations:** Mandated Service Obligations are requirements of a distributor as defined by the Distribution System Code (DSC), as well as any additional obligations outlined in Hydro Ottawa's Conditions of Service.

The System Access investment category is further broken down into Capital Programs and subsequent Budget Program. Table 10 shows the allocation of System Access drivers to programs.

Table 10 – System Access Programs

Capital Program	Budget Program	Primary Driver
Plant Relocation & Upgrade	Plant Relocation & Upgrade	Third Party Requirements
Customer Connections	Residential Subdivision	Customer Service Request
	New Commercial Development	Customer Service Request
	Infill (Res & Small Com)	Third Party Requirements
System Expansion	System Expansion Demand	Customer Service Request
	Asset Transfer	Third Party Requirements
Generation Connections	Embedded Generation	Customer Service Request
Metering	Suite Metering	Customer Service Request

5.3.1.1.2. System Renewal

System Renewal investments are identified through the distribution system assessment process described in Section 5.2.1 - Asset Management Plans. The objective of the comprehensive risk assessment is to confirm that the assets deliver the required functions at the desired level of performance, and that this level of performance is sustainable for the foreseeable future while operating within acceptable risk levels.

The System Renewal program is driven by a number of primary factors related to asset risk levels, each indicating a need for intervention to maintain the integrity and functionality of distribution assets. A description of Hydro Ottawa's methodology to determine asset risk is provided in Section 5.1.4 - Asset Risk Assessment. These factors include:

- **Failure:** This refers to an asset that has ceased to operate or function as intended. This may be due to a variety of reasons such as age, condition, or damage.
- **Failure Risk:** This indicates an asset that is at risk of imminent failure. This may be due to observed signs of deterioration, performance issues, or the results of predictive maintenance analysis.

- **High Performance Risk:** This refers to an asset that, while currently functional, poses a significant risk of failure that could have severe consequences. This may include damage to other equipment or assets, disruption of the distribution system, or safety hazards.
- **Functional Obsolescence:** This refers to an asset that, while still operational, is no longer considered efficient or effective. This may be due to technological advancements, the unavailability of spare parts or supporting software, or changes in operational requirements.

These factors are used to identify assets that require attention under the System Renewal program, ensuring the continued reliability, safety, and efficiency of the system.

The System Renewal investment category is further broken down into Capital Programs and subsequent Budget Program. Table 11 shows the allocation of System Renewal drivers to programs.

Table 11 – System Renewal Programs

Capital Program	Budget Program	Primary Driver
Stations and Buildings Infrastructure Renewal	Station Transformer Renewal	Failure Risk
	Station Switchgear Renewal	Failure Risk
	Station Major Rebuild	Failure Risk
	Station P&C Renewal	Failure Risk
	Station Battery Renewal	Failure Risk
	Station & Building Minor Asset Renewal	Failure Risk
	EOL Voltage Conversion	Failure Risk
OH Distribution Assets Renewal	Pole Renewal	Failure Risk
	OH Switch/Recloser Renewal	Failure Risk
UG Distribution Assets Renewal	Vault Renewal	Failure Risk
	Civil Renewal	Failure Risk
	Cable Replacement	Failure Risk
	UG Switchgear Renewal	Failure Risk
	UG Transformer Renewal	Failure Risk
Corrective Renewal	Damage to Plant	Failure
	Emergency Renewal	Failure
	Critical Renewal	Failure
Metering Renewal	Metering Upgrades	Functional Obsolescence

5.3.1.1.3. System Service

System Service investments are identified through the asset management plan process described in Section 5.2 - Plan. The main drivers for programs under System Service are:

- **Capacity Constraints:** The capability and reliability of the distribution system is regularly evaluated to ensure a stable and dependable power supply for customers. When gaps are found, the utility develops plans for system upgrades or expansions, ensuring compliance with regulatory standards and considering safety, environmental impact, costs, and the reliability and security of the power supply. The results of this process are outlined in Section 9 - System Capacity Assessment, which identifies both short and long-term capacity needs.

To maintain adequate system capacity, Hydro Ottawa evaluates the current and future supply demands in its service area. The system is divided into subsystems based on voltage levels and geographic boundaries for capacity planning purposes. The process factors in projected growth, asset replacement schedules, reliability, and modernization technologies to develop both short-term and long-term solutions.

- **Reliability:** Hydro Ottawa continuously assesses the distribution system's service reliability. When issues are identified, appropriate actions are taken. Service reliability is integral to all work undertaken as part of system planning and asset management. The reliability assessment process described in Section 5.2.2 - Distribution System Assessment provides a platform for a thorough review of system reliability and identifies planned work designed to directly impact system reliability.
- **System Observability:** As per Section 3.4.2 - Grid Modernization Strategy, the observability and controllability of the distribution system will be enhanced through advanced monitoring, rapid fault detection and localization, improved overload detectability, and automated/remote system restoration. The aim of this driver is to bring greater real-time awareness of system performance to support both daily operations and inform system planning.

The System Service investment category is further broken down into Capital Programs and subsequent Budget Program. Table 12 shows the allocation of System Service drivers to programs.

Table 12 – System Service Programs

Capital Program	Budget Program	Primary Driver
Capacity Upgrades	Stations Capacity Upgrades	Capacity Constraints
	Distribution Capacity Upgrades	Capacity Constraints
	Non-Wire Upgrades	Capacity Constraints
Distribution Enhancements	Distribution System Reliability	Reliability
	Capacity Voltage Conversion	Capacity Constraints
	Distribution Enhancements	Reliability
	Distribution System Observability	Observability
	Distribution System Resilience	Resilience
Station Enhancements	Stations Enhancements	Reliability
Grid Technologies	SCADA Upgrades	System Efficiency
	RTU Upgrades	N/A
	Communication Infrastructure	System Efficiency
Control and Optimization	Control and Optimization	Observability
Field Area Network	Physical Fiber Extension	System Efficiency
	Wireless Communication	System Efficiency
	Management of Grid-Edge Device	System Efficiency
	SCADA Network Cyber Security	System Efficiency

5.3.1.1.4. General Plant

The General Plant category encompasses a diverse set of capital programs essential for maintaining and advancing Hydro Ottawa's infrastructure, operational capabilities, and customer service excellence. These investments address areas such as critical infrastructure reliability, fleet renewal, IT and cyber security infrastructure, and customer engagement.

The main drivers for programs under General Plant are:

- **System Investment Support:** Capital contributions to Hydro One for transmission upgrades required to service new and upgraded stations, in addition to requirements for fleet/vehicle acquisition.
- **Business Operations Support**: Requirements for IT software and systems

Table 13 lists the programs and primary drivers within General Plant.

Table 13 – General Plant Programs

Capital Program	Budget Program	Primary Driver
CCRA	CCRA	System Investment Support
Fleet Replacement	Fleet Replacement	System Investment Support
Tools Replacement	Tools Replacement	System Investment Support
Buildings - Facilities	Buildings -Facilities	System Investment Support
Grid Technology	Grid Technology	Business Operations Support
Meter to Cash	Meter to Cash	Business Operations Support
Customer Engagement Platform	Customer Engagement Platform	Business Operations Support
Enterprise Solutions	Enterprise Solutions	Business Operations Support
Infrastructure and Cyber Security	Infrastructure and Cyber Security	Business Operations Support
Data and System Integrations	Data and System Integrations	Business Operations Support

5.3.1.2. Program Optimization

Strategic planning involves optimizing the program portfolio by evaluating how well the identified programs align with key investment priorities. These priorities, including Growth and Electrification, Renewing Deteriorating Infrastructure, Grid Modernization, and Enhancing Resilience, guide investment decisions, supported by the focus areas of Managing Rising Costs and Investing in the Workforce.

MIPs are developed for each program to facilitate optimization, detailing financial resources required for implementation and enabling decision-makers to assess feasibility and alignment with priorities. The assessment process rigorously evaluates potential costs, benefits, and contributions to strategic objectives.

Results from the program level investment planning for 2026-2030, detailed in Schedules 2-5-6 through 2-5-9, provide insights into the current program portfolio effectiveness and alignment with strategic investment priorities.

5.3.1.2.1. System Access

Investments under System Access are necessary to support growth and electrification. This investment category includes programs like Customer Connections to facilitate new residential and commercial developments, System Expansion to address major infrastructure projects like new stations, and Generation Connections to enable the connection of customer-owned DERs.

MIP are developed for each Capital Program and included in Schedule 2-5-6 - System Access Investments. Program drivers under this category are mainly impacted by the growing number and complexity of customer connections, reflected in expenditures for the Customer Connections and System Expansion Capital programs. These programs are defined by assessing historical spending, historical connections and projects, and industry trends as well as known upcoming committed projects for the 2026-2030 rate period.

5.3.1.2.2. System Renewal

System Renewal investments are required to support the renewal of deteriorating infrastructure. This investment category includes programs like Station and Buildings Infrastructure Renewal, Overhead Distribution Asset Renewal, Underground Asset Renewal, Corrective Renewal, and Metering Renewal.

MIPs are developed for each Capital Program and included in Schedule 2-5-7 - System Renewal Investments. Hydro Ottawa's System Renewal investment planning uses a strategic, forward-looking approach with levelized spending to mitigate the long-term impacts of asset degradation or failure. While safety, financial, environmental, and compliance risks are considered, reliability is the primary driver of the overall risk value (based on actual data available). System Renewal investments have been scaled to reduce the corresponding risk values and maintain overall system reliability. Hydro Ottawa's asset renewal strategy is to mitigate and manage asset risks, considering long-term impacts, through strategic replacement of deteriorating infrastructure, and therefore not to outright replace all aged or deteriorated assets.

Programs for each asset type are defined through the AMPs, as described in Section 5.2.1 - Asset Management Plans and then evaluated at the asset class level (Stations, Overhead, Underground, and Metering assets) through MIPs. Similar alternatives to the asset-type level are used: cost containment, short-term risk mitigation, and long-term risk mitigation as described in Section 5.2.1.1 Program Planning Approach.

5.3.1.2.3. System Service

System Service investments are required to support growth and electrification and grid modernization to enable the energy transition as well as enhancing resilience. This investment category includes programs like Capacity Upgrades, Distribution Enhancements, Station Enhancements, Grid Technologies, Control and Optimization, and Field Area Network.

The System Service investment category focuses on strategic spending to enhance the overall functionality and capability of the distribution system. Key areas of investment include:

- **Expanding Distribution System Capacity:** This involves upgrading and expanding the existing infrastructure to accommodate increased demand and future growth.
- **Improving System Reliability and Resilience:** Investments are made to minimize outages, reduce downtime, and ensure the system can withstand and recover quickly from disruptions caused by natural events or other unforeseen circumstances.

- **Grid Modernization:** This encompasses the integration of advanced technologies and intelligent systems to optimize grid performance, enable better demand management, and support the integration of renewable energy sources.

The allocation of spending within the System Service category is guided by MIPs. These plans are developed for each Capital Program and are detailed in Schedule 2-5-8 - System Service Investments. They provide a structured framework for prioritizing and implementing projects that align with overall investment priorities.

A key component of the System Service investment strategy is the selection of specific station capacity projects for capacity upgrade programs based on capacity system needs described in Section 9 - System Capacity Assessment. These projects are carefully chosen based on several factors, including recommendations from the IRRP and aligned with supporting distribution and NWSs programs. This ensures that capacity upgrades are implemented strategically and in a way that maximizes benefits for the overall system.

5.3.1.2.4. General Plant

MIPs guide the allocation of spending within the General Plant category. These plans, which are detailed in Schedule 2-5-9 - General Plant Investments, are developed for each Capital Program and provide a structured framework for prioritizing and implementing projects that align with overall investment priorities.

Investments in CCRAs with Hydro One are included in the System Service planning process and are thus evaluated using the same criteria. See Section 5.3.1.2.3 - System Service for more details.

General Plant investments in IT, Fleet, and Facilities follow a similar approach to the distribution asset management processes. These investments are typically large replacement or enhancement initiatives for assets reaching the end of their useful life. As such, they generally span several years. Therefore, they are initiated and justified with detailed business cases.

Information Technology

All new IT requirements must be communicated to the IT team prior to purchase and/or implementation. The IT Engagement model outlines the appropriate contact for IT services when the nature of the request is not obvious or lacks an established communication channel. This process is designed to promote optimal use of technology assets, track and plan project demand, and to ensure objectives align with company priorities and the IT strategy.

Facilities

Hydro Ottawa engages consultants to complete building condition assessments for all its office buildings every five years. The building condition assessments include information about asset age and condition and represent the main component of Hydro Ottawa's five-year facility renewal plan. Hydro Ottawa performs alternating roofing and building envelope inspections on its substations in five-year cycles as well as monthly field inspections and safety checks to ensure its facilities assets remain in good working condition. Any defects found are catalogued and repaired or replaced as needed. To align with Hydro Ottawa's sustainability goals and level of organizational growth, the Facilities program will focus on maintaining and upgrading office and operational facilities to support workforce needs, improving energy efficiency, and providing a safe working environment.

Fleet

Every five years, a plan is devised for replacements and additions. Replacement decisions and timing are assessed unit-by-unit using a set of quantitative replacement criteria combined, a physical assessment, and judgement. See Schedule 2-5-9 - General Plant Investments for more details on evaluation criteria. Planned additions are informed by the operational needs of the business and ultimately determined through an iterative process with multiple stakeholders. Operation requirements inform projected staffing levels which are used to create an initial estimate of vehicles with preliminary specifications. The initial estimate is reviewed with operational staff to refine requirements and identify opportunities for efficiencies. Ultimately, the required number of vehicles by category are aligned and agreed between the business and operations.

5.3.2. Project Level Investment Planning

Following the approval of the overall Capital Expenditure Plan, Hydro Ottawa conducts an annual project-level assessment to refine and optimize the selection of individual projects within each program. Using Hydro Ottawa's investment optimization software (Copperleaf Portfolio), projects are prioritized based on their value, and constraints like budget limitations are applied to create a realistic and achievable project list. This process generates preliminary and final project lists, with the latter containing more refined cost estimates. The final project list is then presented for approval, marking the final step before project execution can begin. Essentially, this stage focuses on determining which specific projects will be funded within the already-approved budget allocations, maximizing the return on investment for Hydro Ottawa and its customers.

It is noteworthy that projects under the System Renewal and System Service investment categories only go through the capital investment planning process completed in Hydro Ottawa's investment optimization software (Copperleaf Portfolio) and as detailed in Sections 5.3.2.1 - Project Concept Definition to 5.3.2.4 - Portfolio Optimization below. Projects under the System Access investment category are obligatory in nature and hence not prioritized through Copperleaf Portfolio, but rather based on available resources and in collaboration with the requesting party. Similarly, projects under the General Plant investment category are also not evaluated within the Copperleaf Portfolio. These investments are typically large replacement or enhancement initiatives for assets reaching the end of their useful life. As such, they generally span several years. Therefore, they are initiated and justified with detailed business cases.

5.3.2.1. Project Concept Definition

Two distinct processes drive System Renewal and System Service project creation within Copperleaf Portfolio. These processes differ in their origin, data utilization, and scope definition. System Renewal projects leverage the power of data and PA for proactive asset management. They originate from insights derived from Copperleaf Assets and PA. The process begins with ACA information, which is used to identify assets that need intervention. The focus is on proactively minimizing risk based on predicted asset failure.

System Renewal projects born out of Copperleaf Assets and PA move to Copperleaf Portfolio, where they are reviewed to identify opportunities for synergy. For example, a pole renewal project might be expanded to include capacity upgrades in the same area, maximizing efficiency and minimizing disruption. System Renewal projects are then evaluated based on their contribution to system resilience. This includes comparing alternatives for "like-for-like" replacements with storm hardening upgrades or undergrounding assets, allowing for informed decisions regarding long-term resilience.

System Service projects, in contrast, are created on an individual basis within Copperleaf Portfolio. These projects address specific needs as they arise from capacity assessments detailed in Section 9 - System Capacity Assessment. Information for these projects is gathered on a case-by-case basis, and supporting documentation is manually entered into Copperleaf Portfolio. Value measures are assigned across various risk categories (capacity, reliability, compliance, resilience, etc.) to quantify the project's potential benefits. Where applicable, alternative solutions are identified and documented within Copperleaf Portfolio, enabling a comparative assessment of different approaches to mitigate the identified risk.

These two distinct processes contribute to a well-rounded and optimized project portfolio with System Renewal projects providing a proactive, data-driven approach to long-term asset management, ensuring system reliability and resilience while maximizing efficiency through synergy identification. Conversely, System Service projects address specific needs, ensuring responsiveness to emerging challenges. Their focus on individual project value allows for prioritization based on risk and potential impact.

By integrating both System Renewal and System Service projects within Copperleaf, Hydro Ottawa achieves a balanced portfolio. This approach allows for proactive asset management and timely problem-solving, ultimately leading to improved system performance, reduced risk, and optimized resource allocation. The ability to score projects across consistent metrics, regardless of origin from either Copperleaf Asset or Copperleaf Portfolio, allows for a holistic view and facilitates data-driven decision-making.

5.3.2.2. Project Evaluation

The Project Evaluation phase creates business cases supporting the project alternatives. Each alternative is valued based on Hydro Ottawa's Asset Management Objectives using the Value Framework Model to assess the project's alternatives. The evaluation of project alternatives is completed within the Copperleaf Portfolio.

For System Renewal investments, Copperleaf Assets' predictive asset analytics plays a critical role in investment planning for the system renewal portfolio as it identifies the assets that require intervention in a given year. The process begins with PA that assesses the condition and performance of assets, helping to forecast when they might fail or underperform. When an asset is flagged as requiring intervention, an investment proposal is created within Copperleaf Assets and pushed to Copperleaf Portfolio through the Capture Module in Copperleaf. For more details on Predictive Analytics see Section 5.1.4 - Asset Risk Assessment.

The value of the proposed investment is determined by evaluating the risk that would be mitigated by the intervention. This risk value reflects the potential consequences of asset failure, including financial, safety, and operational impacts. The benefits of the intervention are assessed against the replacement or repair costs. The combination of risk mitigation and benefits realization forms the basis for justifying and prioritizing the investment within the broader asset management strategy. This ensures that resources are allocated efficiently, focusing on projects that offer the most value in terms of risk reduction and cost-effectiveness.

For System Service investments, project concepts and their alternatives are conceptualized. Project alternatives are then scored by identifying their risk and/or benefit value measures as it relates to Hydro Ottawa's Asset Management Objectives through the use of the Copperleaf Value Model. The evaluation Value Model comprises twelve Value Measures grouped into three Value Categories, as shown in the Table 14 below.

Table 14 – Copperleaf Value Model

Asset Management Objective	Value Measure	Value Category
Resource Efficiency	Financial Benefits & Costs	Benefit Value Measures
Levels of Service	Program Effects	
Levels of Service	Distributed Generation	
Asset Value	Technological Innovation	
Levels of Service	Capacity Risk	Risk Value Measures
Compliance	Compliance Risk	
Health, Safety & Environment	Environmental Risk	
Resource Efficiency	Financial Risk	
Levels of Service	Reliability Risk	
Levels of Service	Resilience Risk	
Health, Safety & Environment	Safety Risk	
Resource Efficiency	Total Investment Cost	Cost Value Measure

Benefit Value Measures

- **Financial Benefits & Costs**: measures the financial benefits or costs to the organization in the form of annual Capital and OM&A cost savings/increases, cost avoidance or revenue increase (i.e. would result in a budget decrease/increase).
- **Program Effects**: captures the value of all programs not otherwise tracked in Copperleaf.
- **Distributed Generation**: measures the impact of whether a project enables distributed generation. Projects that enable distributed generation are given an additional 30 value units.
- **Technological Innovation**: measures the impact of whether a project introduces technological innovation to the corporation. Projects that introduce technological innovation are given an additional 10 value units.

Risk Value Measures

- **Capacity Risk**: measures the societal cost associated with an interrupted electrical supply and assigns a positive value to projects that help mitigate a proportion of this risk.
- **Compliance Risk**: measures the mitigation of the risk of non-compliance with federal regulations, namely the risk of annual fines, additional compliance costs, or the subsequent cost of operating restrictions.
- **Environmental Risk**: measures the mitigation of incidents that can lead to environmental damage.
- **Financial Risk**: measures the mitigation of financial risk due to damage to equipment, loss of company assets, financial errors, or other factors resulting in monetary loss.
- **Reliability Risk**: measures the mitigation of risk due to customer outages on the distribution system. The reliability value is based on the maximum of three computations: cost of outage duration, cost of outage frequency, and customer minutes of interruption. This Value Model also differentiates between residential, commercial, industrial, and mixed customers and between redundant & non-redundant equipment.
- **Resilience Risk**: measures the improved ability of distribution assets to resist damage due to inclement weather and the corresponding reduction in customer interruptions. This may be added to investments that move equipment underground or improve weather resistance in any way.
- **Safety Risk**: measures the mitigation of the risk of public safety incidents. This risk is intended for use in a Value Function and the avoided risk is a positive contributor to project value.

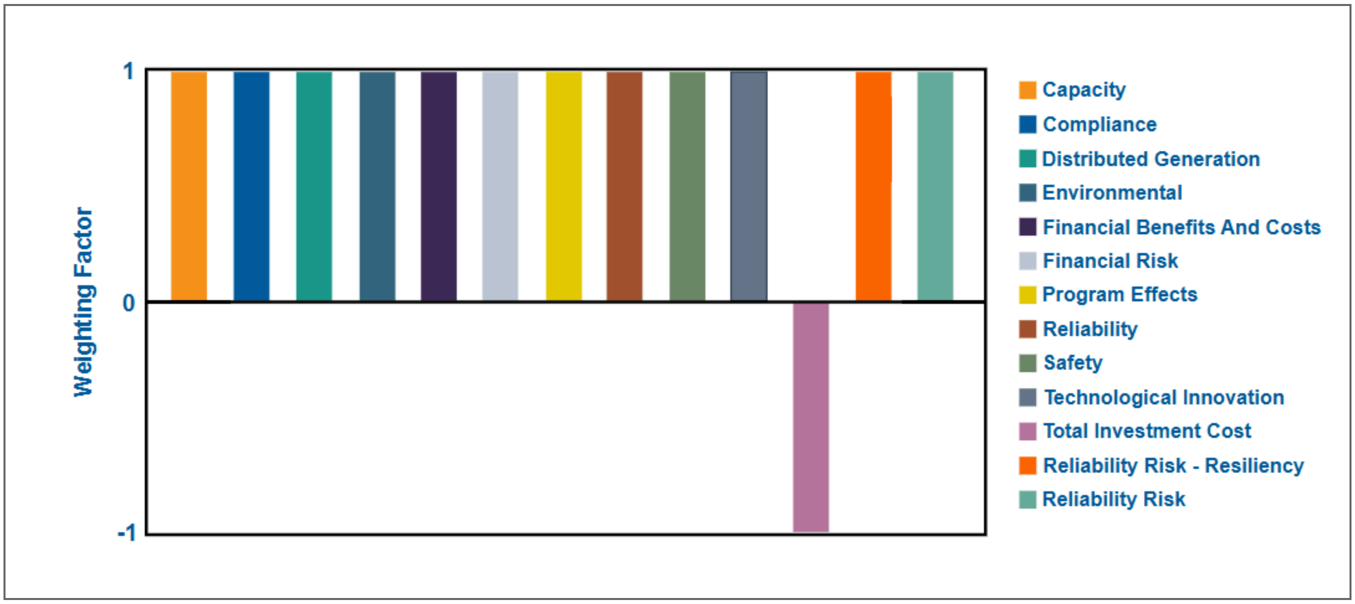
Cost Value Measure

- **Total Investment Cost**: measures the total spending from year to year on proposed projects.

In Figure 18, each Value Measure is normalized to the same scale, where one value point equals approximately $1,000. This means that within the Value Function, each Value Measure (except

Investment Cost) is weighted with the same value of +1. Investment Cost is a negative contributor to the Value Measure and, as such, is weighted with a value of -1.

Figure 18 - Value Category Weighting



The Value Measures for each project are computed for each year (the benefits or risks in one year can be different than the next – for example, the risk of a poor-condition asset failing increases with time). They are then converted into a single number by taking the present value back to the current fiscal year using the system-defined discount rate. This means that if a project has a negative value, the cost of the project outweighs its benefits.

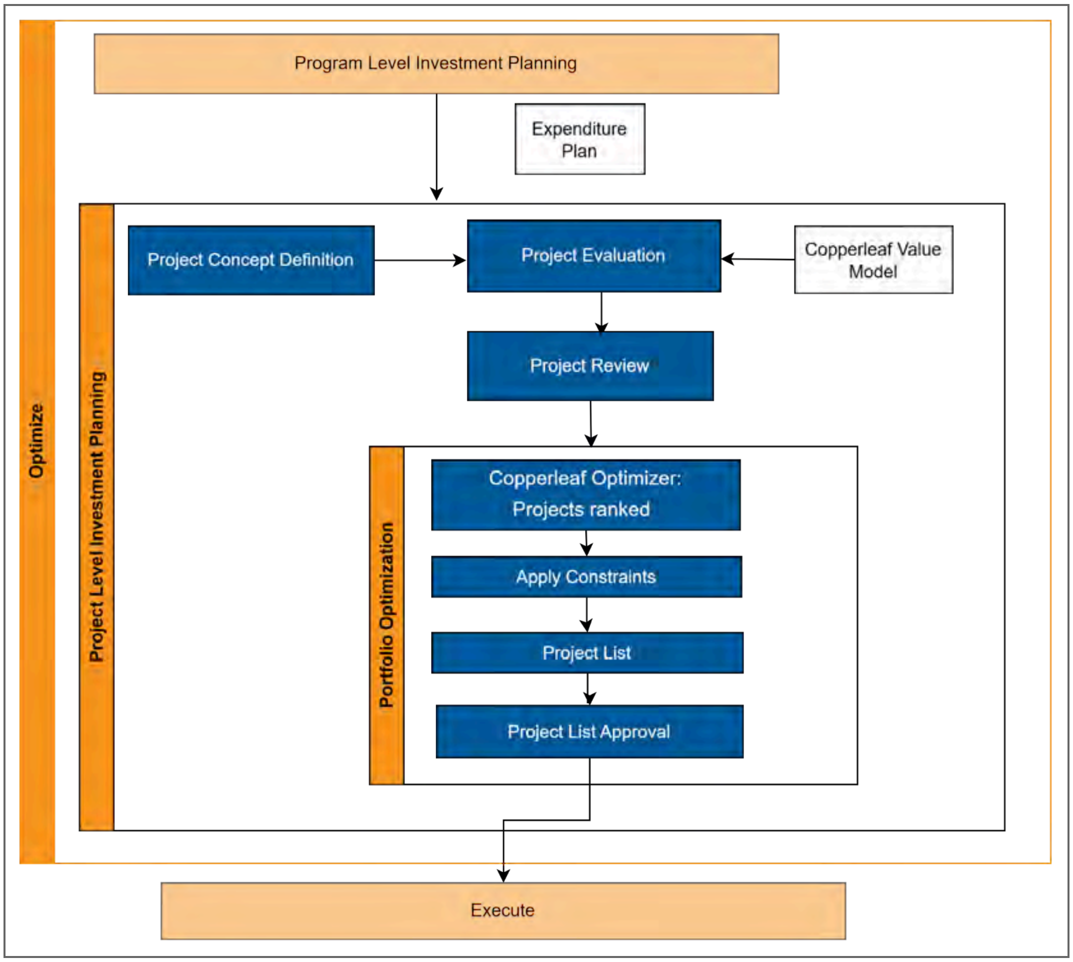
5.3.2.3. Project Review

During the project review phase, the valuation of each project is reviewed and compared to similar projects before the projects are optimized to ensure a consistent approach.

5.3.2.4. Portfolio Optimization

The portfolio optimization phase, depicted in Figure 19, uses Copperleaf to prioritize projects based on their value. Project Prioritization Procedure ensures consistent prioritization of projects to deliver on Asset Management Objectives. This phase utilizes the Copperleaf Portfolio module to rank projects based on their value, calculated through the Project Evaluation phase. The Optimizer algorithm within Copperleaf selects the optimal project portfolio based on value and constraints applied. This leads to the creation of a preliminary project list. Cost estimates are refined for projects in the preliminary list and a second phase of optimization is completed in Copperleaf Portfolio to produce the final project list with refined cost estimates. This final list is presented to Hydro Ottawa's Executive Management Team and Board of Directors for approval before project execution begins.

Figure 19 - Portfolio Optimization



5.4. EXECUTE

5.4.1. Portfolio Implementation and Monitoring

The Execution phase follows Hydro Ottawa's internal project management methodology called "Project Coach," which defines the core lifecycle for projects. Project Coach is based on the internationally accepted standard for project management: Project Management Body of Knowledge (PMBOK) issued by the Project Management Institute.[7] An ongoing effort titled "Project X" is in

[7] Project Management Institute, "PMBOK(R) Guide," https://www.pmi.org/standards/pmbok.

progress, with the goal of updating Hydro Ottawa's project delivery methodology. Further detail regarding "Project X" can be found in Section 3.1.1 of Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement.

Project Coach, and Project X, provide specific guidelines, procedures, work instructions, and industry best practices that allow Hydro Ottawa personnel to perform project work efficiently, effectively, and with high quality. Processes described in Project Coach are intended to be scalable and applicable to all projects, regardless of complexity. By standardizing on a project delivery model, a consistent approach to planning, scheduling, and execution of projects can be implemented.

Project Coach describes six steps in the execution of the project:

1. Planning & Project Initiation (Plan): The project charter, scope, and objectives are created. Key players take steps to initiate the project and engage any needed authorization.
2. Design: The project charter, scope, and objectives are reviewed and approved. Preliminary and detailed project design and estimates are created.
3. Procurement & Circulation (Procure): The project design is approved. Material and services are procured.
4. Scheduling (Schedule): The project is scheduled with key milestones and deliverable dates.
5. Construction (Construct): The project is executed with a continuous review of progress and risk to completion.
6. Closure (Close): The project documentation, financials, and reviewed lessons learned are completed. Feedback and lessons learned are registered and communicated for continuous improvement.

Project X will serve to streamline the six steps in the project delivery methodology. More specifically, Project X aims to improve the Distribution Design team's project management expertise, improve organizational efficiency and capacity, update the delivery model (with enhanced reporting), and ensure smooth adoption of new processes through a change management plan.

Key activities include defining the strategy, establishing a project delivery model with stage gates, standardizing artifacts, reviewing tools and infrastructure, establishing clear roles, responsibilities and organizational structure to support the updated project delivery model, comprehensive reporting, and creating training and change management plans.

5.4.2. Performance Measurement and Continuous Improvement

Hydro Ottawa prioritizes continuous improvement in its asset management practices to ensure reliable and resilient electricity service. Recognizing the challenges posed by deteriorating infrastructure, climate change, and increasing demand, the company utilizes performance measurements to regularly evaluate the effectiveness of its asset management process. A key focus is on mitigating the risks associated with infrastructure nearing or exceeding its TUL. For the 2026-2030 DSP, Hydro Ottawa has implemented a refined set of performance outcomes specifically designed to evaluate plan performance at the MIP level. This targeted approach, combined with strategic investments in data analytics, enables a more precise assessment of network assets and facilitates data-driven decision-making. The performance framework for the 2026-2030 DSP, detailed in Schedule 2-5-3 - Performance Measurement for Continuous Improvement, will drive continuous improvement and ensure alignment with Hydro Ottawa's evolving operational context, ultimately supporting the company's commitment to delivering reliable service to its customers.

6. OVERVIEW OF DISTRIBUTION SYSTEM

Section 6 provides an overview of Hydro Ottawa’s distribution system, including information such as characteristics of the service area. The subsections are organized as follows:

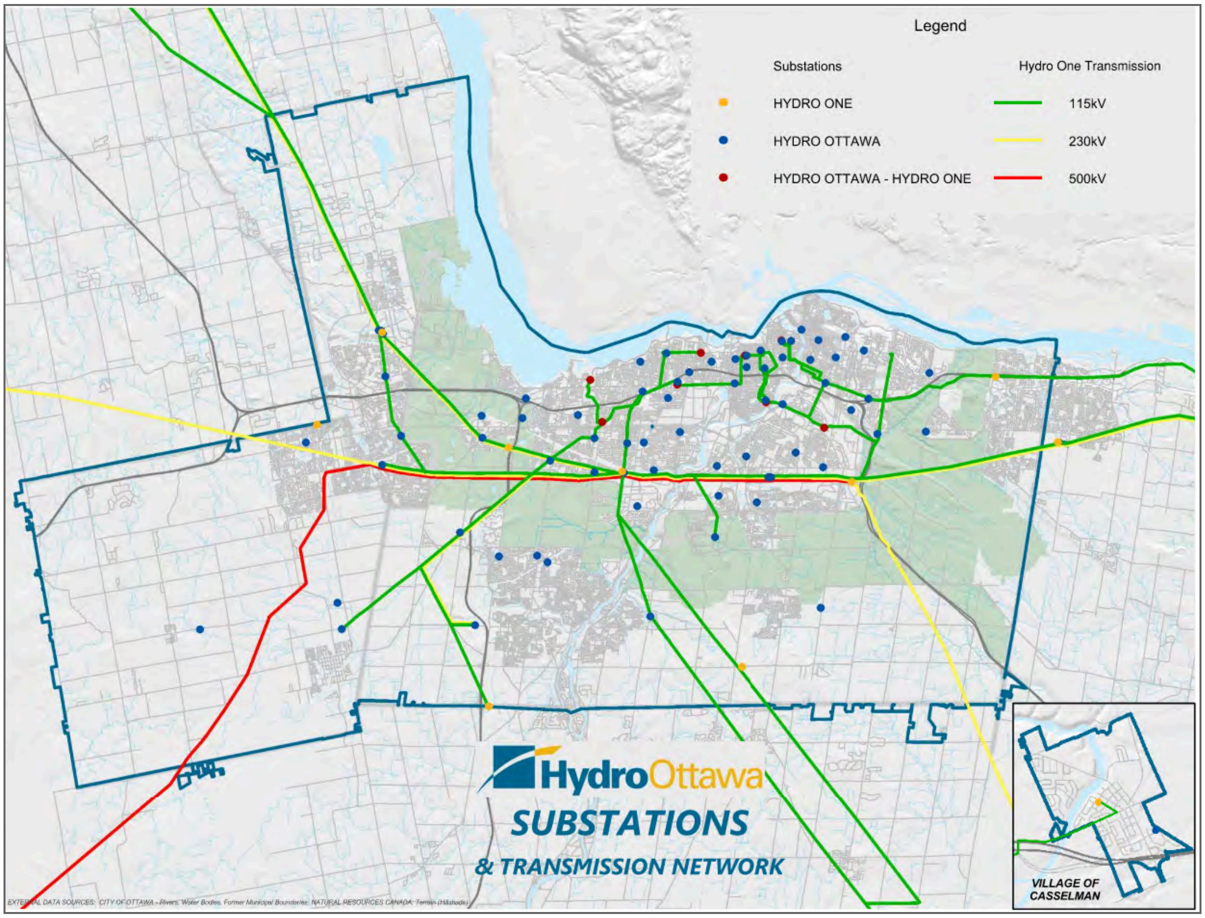
- 6.1 - Overview of Distribution System: provides a high-level description and a map of the Hydro Ottawa service territory.

- 6.2 - System Configuration: describes how the system is configured, including voltages and ownership of stations and transformers.
- 6.3 - Geographic Planning Considerations: looks at the geographic and physical characteristics of the Hydro Ottawa service area.
- 6.4 - Historical and Future Climate: provides historical weather details, including recent extreme weather events, as well as climate change impacts.
- 6.5 - System Demand and Growth Planning Considerations: discusses historical system peaks and details on anticipated customer growth within the service areas.

6.1. OVERVIEW OF DISTRIBUTION SYSTEM

Hydro Ottawa is one of the five largest electric distribution utilities in Ontario and, as of the end of 2023, distributes electricity to approximately 364,000 metered customers within the City of Ottawa and the Municipality of Casselman. The service area covers 1,116 square kilometers and is supplied by an even mix of overhead and underground distribution lines. Figure 20 illustrates Hydro Ottawa's service territory boundaries and its connection to the Hydro One transmission network.

Figure 20 - Hydro Ottawa Service Territory



6.2. SYSTEM CONFIGURATION

6.2.1. Asset Overview

Hydro Ottawa's formation in 2000 resulted from the amalgamation of five municipally owned electric utilities: Gloucester Hydro, Goulbourn Hydro, Kanata Hydro, Nepean Hydro, and Ottawa Hydro. This consolidation stemmed from the restructuring of Ontario's electricity sector, driven by the *Electricity Act, 1998*. The integration of utilities from the former region of Ottawa-Carleton. Casselman Hydro was subsequently acquired in 2002, further expanding Hydro Ottawa's service area. This amalgamation of six distinct utilities created a diverse distribution system characterized by six different operating voltages and a mix of overhead and underground infrastructure. The underground systems are predominantly located in urban areas. Table 15 details the length of overhead and underground lines within Hydro Ottawa's distribution system.

Table 15 - Length of Underground & Overhead Lines[8]

Orientation	Total Length (km)	Total Length (%)
Underground	3,515	55.9%
Overhead	2,768	44.1%
TOTAL	**6,283**	**100%**

Table 16 presents the number of circuits and length of overhead and underground cables by voltage level in Hydro Ottawa's distribution system.

[8] The km shown in this section pertain to primary circuits only, for information on the calculation of secondary lines, refer to Attachment 1-3-3 (A) - PEG Benchmarking Analysis, the total km including both primary and secondary are approximately 7,900 km of underground cable and 4,800 km of overhead lines

Table 16 - Number & Length of Circuits by Voltage Level

<table>
<tr><th>Orientation</th><th>Number of Circuits</th><th>Total Overhead (km)</th><th>Total Underground (km)</th></tr>
<tr><td>4 kV</td><td>310</td><td>609</td><td>288</td></tr>
<tr><td>8 kV</td><td>119</td><td>672</td><td>565</td></tr>
<tr><td>12 kV</td><td>6</td><td rowspan="2">456</td><td rowspan="2">943</td></tr>
<tr><td>13 kV</td><td>334</td></tr>
<tr><td>28 kV</td><td>66</td><td>838</td><td>1,711</td></tr>
<tr><td>44 kV</td><td>16</td><td>193</td><td>8</td></tr>
<tr><td>TOTAL</td><td>851</td><td>2,768</td><td>3,515</td></tr>
</table>

The service area is supplied by a combination of stations and transformers owned by both Hydro Ottawa and Hydro One. Table 17 details the number of station transformers serving Hydro Ottawa customers, categorized by secondary voltage level and ownership.

Table 17 - Number of Stations and Transformers Owned by Hydro Ottawa and Hydro One

Secondary Voltage	Number of Stations	Number of Hydro Ottawa Owned Transformers	Number of Hydro One Owned Transformers
4 kV	35	95	0
8 kV	23	42	1
12 kV	2	3	0
13 kV	12	2	23
28 kV	17	28	5
44 kV	3	0	6
TOTAL	**92**	**170**	**35**

6.2.2. Embedded Feeders

Embedded feeders within Hydro Ottawa's distribution network are sections of Hydro One infrastructure that, upon entering Hydro Ottawa's service territory, transition to Hydro Ottawa ownership. Table 18 provides details on embedded feeders, including the connecting Hydro One Station, the corresponding Hydro Ottawa feeder name, and their respective voltages. Of the 13 embedded feeders listed, five serve Hydro Ottawa customers under normal operating conditions, while the remaining eight are reserved for abnormal or contingency situations.

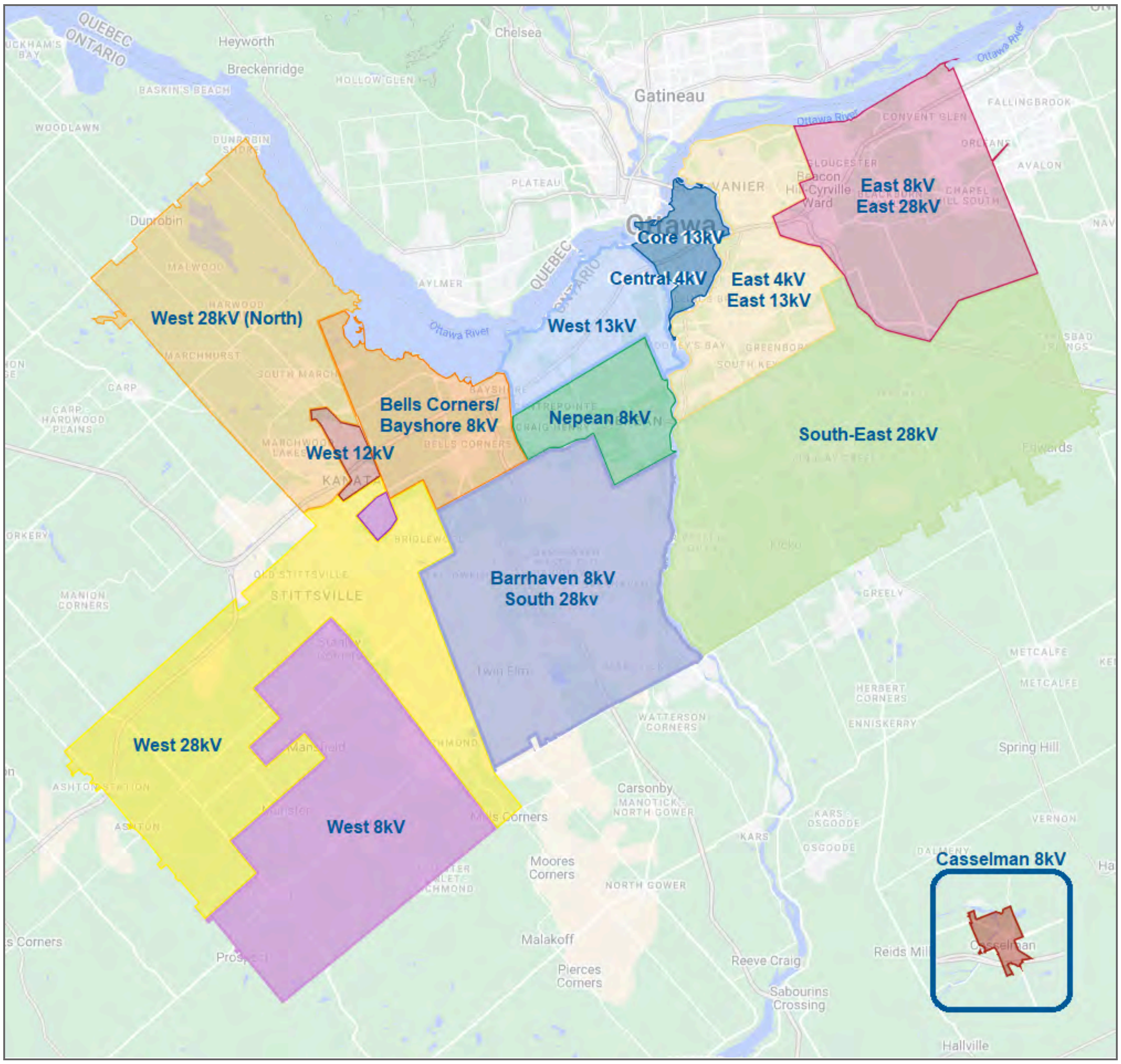
Table 18 - List of Distribution Supply Points

Hydro One Station	Feeder	Voltage	Type
Bilberry TS	77M3	28 kV	Back-up Supply
Bilberry TS	77M4	28 kV	Back-up Supply
South March TS	A9M3	44 kV	Nominal Supply
South March TS	A9M5	44 kV	Nominal Supply
St. Isidore TS	62M2	44 kV	Nominal Supply to Casselman - 62M2
Beckwith DS	BECKF2	28 kV	Nominal Supply
Casselman DS	36F1	8 kV	Back-up Supply
Casselman DS	36F2	8 kV	Back-up Supply
Manotick DS	81F5	8 kV	Back-up Supply
South Gloucester DS	56F3	8 kV	Nominal Supply
South Gloucester DS	56F2	8 kV	Nominal Supply
Alexander DS	ALEXF1	28 kV	Back-up Supply
Alexander DS	ALEXF2	28 kV	Back-up Supply

6.2.3. Planning Regions

Hydro Ottawa's distribution system consists of distinct subsystems, delineated by operating voltage, system interconnections and geographical boundaries, as seen in Figure 21. These subsystem characteristics have informed the definition of planning regions, which are essential for effective infrastructure management, resource allocation, service enhancement, and addressing the diverse needs of customers throughout the service territory. This regional approach facilitates more targeted, efficient, and responsive utility planning and operations.

Figure 21 - Hydro Ottawa Planning Regions



6.3. GEOGRAPHIC PLANNING CONSIDERATIONS

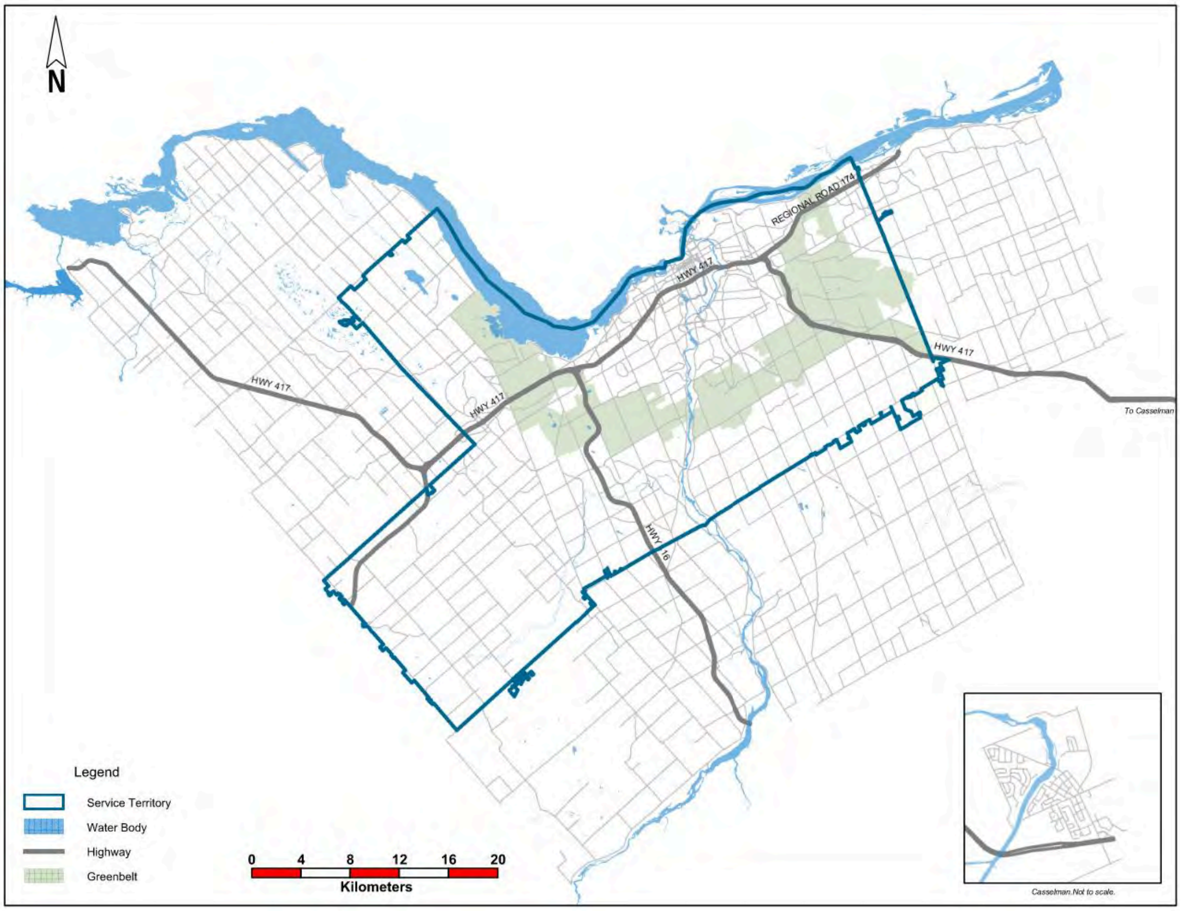
Distribution system planning within Ottawa requires careful consideration of the geographic and physical characteristics of Hydro Ottawa's service territory. The following sections detail key planning considerations and constraints that influence the planning process.

6.3.1. Geographic and Jurisdictional Influences

Hydro Ottawa's service territory encompasses the area surrounding the confluence of the Ottawa and Rideau Rivers. The Ottawa River forms the northern boundary, with the province of Quebec across the river. Hydro One's service territory completely surrounds Hydro Ottawa's remaining boundaries, as illustrated in Figure 22 below. Within the service area, the Rideau River and the Rideau Canal (which bypasses unnavigable sections of the river) traverse the landscape. This creates unique challenges, as certain neighborhoods, such as Old Ottawa, are effectively islanded by both the river and the canal, complicating both service provision and infrastructure maintenance.

The City of Ottawa's main urban area is encircled by a substantial Greenbelt, consisting primarily of forests, farmlands, and marshlands. Beyond the Greenbelt, numerous suburban communities are experiencing rapid growth. Furthermore, constructed barriers such as divided highways (Highways 417, 416, and 174) further segment Hydro Ottawa's service territory.

Figure 22 - Geographic and Jurisdictional Boundaries in Hydro Ottawa's Service Territory



As the Nation's Capital, the service territory also includes numerous federal lands managed by various government agencies. These federal land holdings can create administrative barriers due to the time and effort required to obtain environmental, land access, and encroachment permits, as well as to establish access agreements. These requirements create both technical and administrative challenges for the construction and maintenance of distribution interconnections, often resulting in increased cost and time for creating or augmenting such interconnections within the service territory.

6.3.2. Geotechnical Consideration

Soil Conditions

Hydro Ottawa's service territory faces unique geotechnical challenges due to the prevalence of problematic soil conditions. The dominant soil type, Champlain Sea clay, is inherently unstable, susceptible to liquefaction, and exhibits significant volume changes with varying moisture and temperature. These characteristics create poor foundation conditions and necessitate specialized construction techniques. Furthermore, extensive bog areas with compressible organic soils and the presence of shallow bedrock add complexity and cost to infrastructure development. These challenging conditions impact all aspects of electric distribution planning, from pole installations and underground cabling to station construction. Mitigation strategies, such as engineered fill replacement, specialized foundation designs, and robust pole hole standards, are essential for ensuring the long-term stability and reliability of the electrical grid. Careful geotechnical investigations and tailored engineering solutions are implemented on a project-by-project basis to navigate these challenges and deliver a resilient and dependable power supply to the Ottawa region.

Seismic Zone

Hydro Ottawa's service territory lies within the Western Quebec Seismic Zone,[9] requiring specialized engineering to ensure infrastructure resilience against potential seismic events. Through detailed seismic investigations and project-specific engineering solutions, Hydro Ottawa mitigates these risks. These solutions may include enhanced foundation and footing designs with increased reinforcing steel, concrete, and excavation, along with the incorporation of supplementary steel cross bracing. This approach enables Hydro Ottawa to deliver a dependable power supply to the Ottawa region, even in seismically-active conditions.

[9] Natural Resources Canada. (n.d.). *Earthquakes in Eastern Canada*. Retrieved from https://www.seismescanada.rncan.gc.ca/zones/eastcan-en.php#WQSZ

6.4. HISTORICAL AND FUTURE CLIMATE

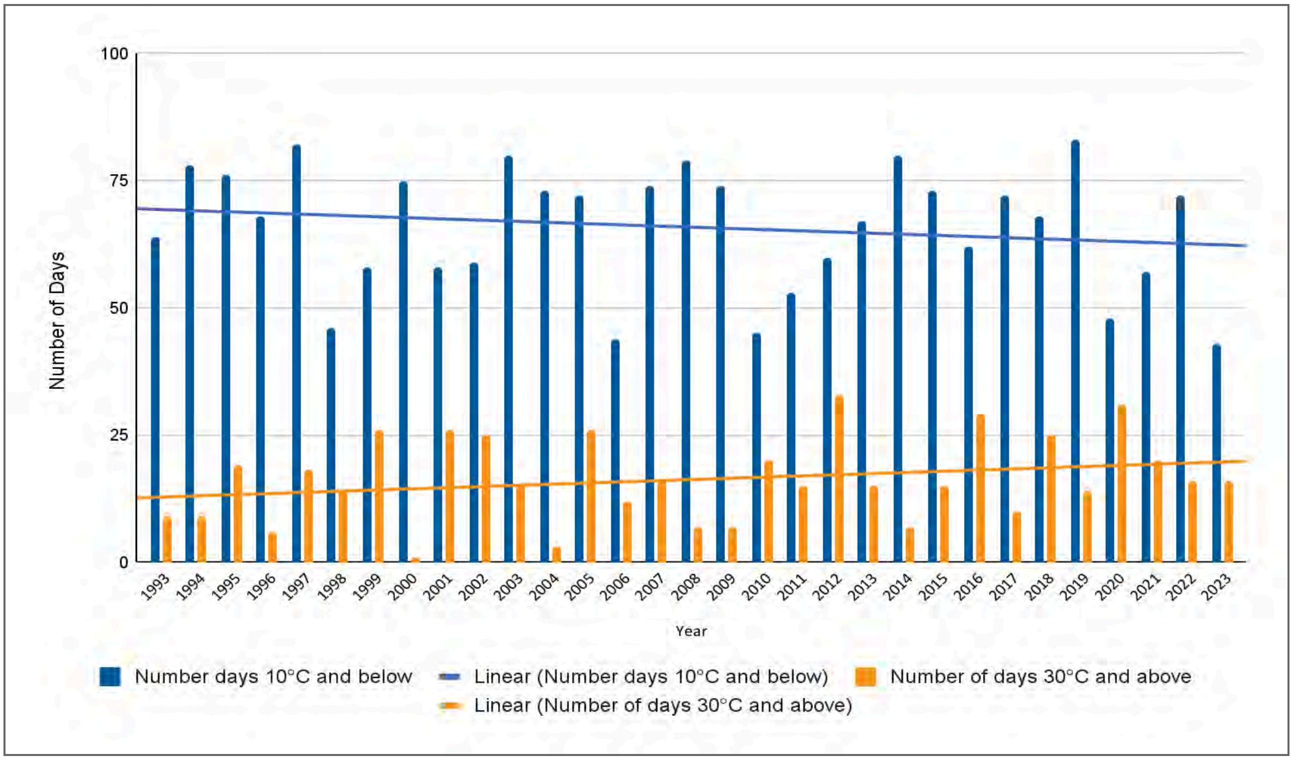
6.4.1. Historical Climate

Climate and weather significantly impact Hydro Ottawa's operations, particularly in planning and managing electricity demand and supply. Temperature variations directly influence consumption, with increased cooling loads in summer and growing heating loads in winter due to electrification trends. Monitoring temperature extremes, such as the increasing frequency of days above 30°C and below -10°C, is crucial for operational planning. Wind speed is another key factor, with high wind events posing challenges to grid stability. Recent severe storms have underscored the vulnerability of the electricity grid to extreme weather. Therefore, Hydro Ottawa's planning process incorporates these climatic considerations to ensure a reliable and resilient electricity supply for its customers.

Temperature

From 1993 to 2023, Hydro Ottawa tracked the annual number of days with temperatures exceeding 30°C and the annual number of days with temperatures falling below -10°C. The data that Hydro Ottawa has tracked is detailed in Figure 23. The near-horizontal slope of the linear trend line indicates a lack of short-term trend in the number of days above 30°C. However, a slight decline is observed in the annual number of days that fall below -10°C.

Figure 23 - Number of Days Below -10° and Below and Number of Days Above 30° and Above



Hydro Ottawa will continue monitoring the frequency of days exceeding 30°C due to the operational challenges that increasing trend presents for electricity distribution systems. Elevated demand from air conditioning usage can strain system capacity, requiring peak load management strategies. Furthermore, equipment is at a higher risk of overloading and reduced efficiency, potentially necessitating increased maintenance and upgrades to transformers, conductors, and substations.

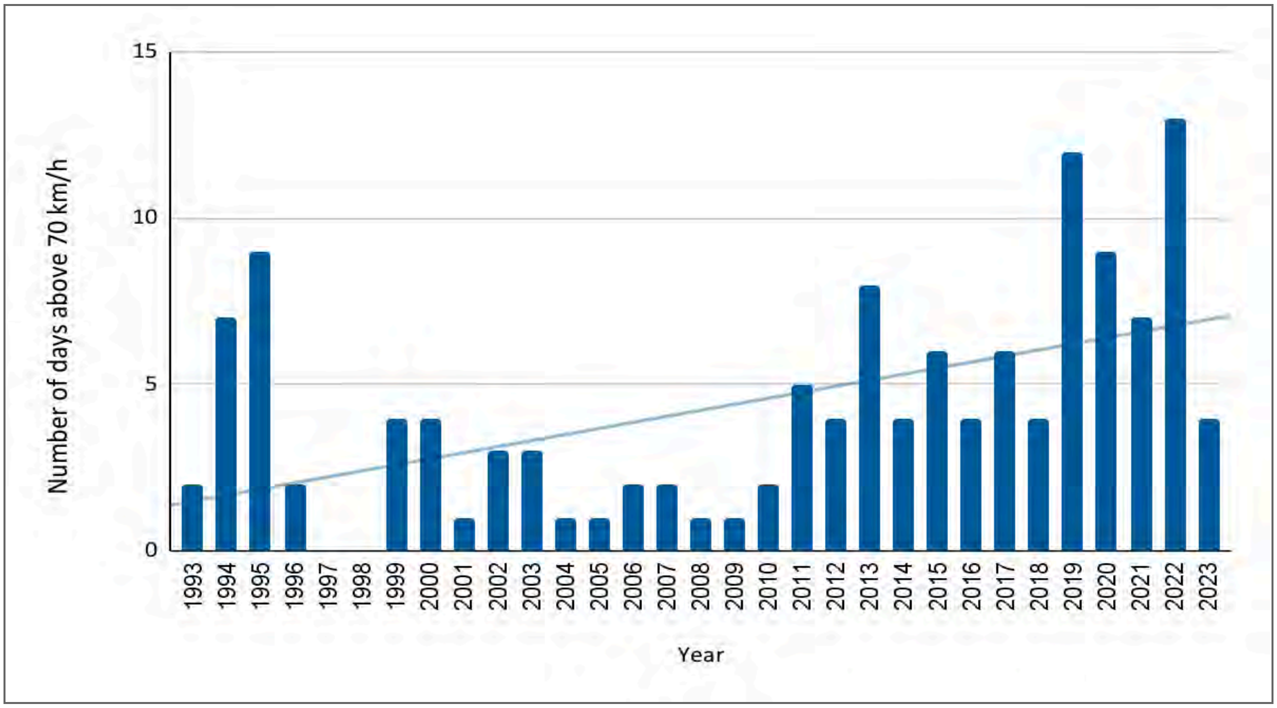
The number of days with temperatures below -10°C is an important metric for Hydro Ottawa, particularly given the increasing adoption of electrified space heating. For example, while heat pumps are efficient, they increase electricity demand significantly during periods of extreme cold, potentially posing operational challenges. Therefore, monitoring days with temperatures below -10°C is essential for accurate demand forecasting and effective system planning. Although no increasing trend in such cold days is currently observed, continued monitoring of this metric remains crucial for adapting to future climate and energy transitions further elaborated in Section 6.4.2 - Future Climate and Section 6.5 - System Demand and Growth Planning Considerations.

Wind Speed

From 1993 to 2023, Hydro Ottawa monitored the number of days when wind gusts exceeded 70 km/h, as illustrated in Figure 24. The graph demonstrates an overall upward trend in the number of days with gusts exceeding 70 km/h since 1993, with 2019 and 2022 in particular showing peaks with more than 10 days.

Figure 24 reveals a notable increase in the frequency of high-wind events, particularly since 2011. This observed trend highlights the need for Hydro Ottawa to maintain a system designed for resilience against such meteorological challenges. The data underscores the importance of ongoing vulnerability assessments and proactive asset hardening in high-risk areas. Given the observed impact of high-wind events on reliability, the data reinforces the need for proactive customer communication regarding outage risks and safety precautions.

Figure 24 - Number of Days Above 70 km/h Winds per Year



Extreme Weather Events

Hydro Ottawa has experienced firsthand the impact of weather events, with a series of severe storms in recent years causing significant damage and disruption to the electricity grid. Between 2017 and 2023, Hydro Ottawa faced multiple major weather events, impacting tens of thousands of customers:

- **2017**: Freezing rain, heavy snow, flooding, and a severe thunderstorm which impacted thousands of customers.
- **2018**: Freezing rain, high winds, and tornadoes caused widespread outages, impacting over 200,000 customers.
- **2019**: A flash storm, flooding, lightning strikes, and high winds which caused repeated disruptions throughout the year.
- **2021**: Lightning strikes caused further outages.

- **2022**: The devastating Derecho, with record-breaking wind speeds, which impacted over 180,000 customers and became the 6th costliest natural disaster in Canada's history. This was followed by a bomb cyclone in December, causing further outages.
- **2023**: An ice storm, freezing rain, and multiple lightning strikes continued the trend of severe weather impacts.

These weather events, excluding the 2019 flood, were categorized as Major Event Days (MEDs). For further information, refer to Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Reliability impacts from weather events classified as MEDs are reported separately from standard reliability metrics. These events highlight the vulnerability of the power distribution network to high wind speeds and emphasize the need for strong adaptation and mitigation strategies to improve resilience.

6.4.2. Future Climate

In 2023, Hydro Ottawa commissioned Stantec to update the 2019 Distribution System Climate Risk and Vulnerability Assessment and the associated 2019 Climate Change Adaptation Plan. The primary objective of this undertaking was to evaluate the continued efficacy of the adaptation and mitigation measures outlined in the 2019 assessment, considering both updated climate projection data and current risk levels.

The 2019 assessment used Coupled Model Intercomparison Project Phase 5 (CMIP5) climate projections, an international project modeling future climate change under different emission scenarios, including temperature, precipitation, sea level, and extreme weather. For the 2023 Climate Reaffirmation report provided in Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan, Stantec incorporated the latest available climate projection data Coupled Model Intercomparison Project Phase 6 (CMIP6) to update the Hydro Ottawa assessment. This update aimed to estimate climate parameter probabilities and determine whether the changes in the projection data significantly impact the risk scores assigned to Hydro Ottawa's infrastructure assets.

The Climate Reaffirmation report included updating the list of climate parameters to consider recent extreme weather events, updating climate parameter probabilities and impact severity based on input from Hydro Ottawa staff, and completing a forensic analysis of the May 2022 Derecho event.

Changes to the climate parameters can be seen in the Climate Reaffirmation report. Specifically, two additional high wind thresholds were established based on updated Environment and Climate Change Canada (ECCC) criteria for severe thunderstorm winds and the damages observed by the Northern Tornadoes Project in surveys following the May 2022 Derecho. The thresholds established included:

- **Wind speeds > 130 km/h**: Based on new ECCC severe thunderstorm winds and a 17% higher loading factor than the 120 km/h gust threshold used in the 2019 study.
- **Wind speeds > 180 km/h** (Derecho event equivalent): based on consistent EF-2 style observed damage in the Ottawa region and Doppler Radar near-surface wind speed recordings.

Climate parameters frequency and probability were updated using downscaled projections for the National Capital Region and CMIP6, where available. Changes were observed in annual and/or 30-year probabilities for several climate parameters in the 2050s. Frequency and probabilities were also established for new high wind thresholds. Increased consequence ratings for higher threshold wind speeds in both current and future climates resulted in increased risk scores. However, most risks did not experience a change in risk level. Table 19 summarizes the changes (highlighted in orange) and additions to consequences and risk scores.

The historical weather trends observed in 6.4.1 Historical Climate provide insight into the past climate patterns and influence future projections by providing baseline climate conditions. The method used in the Climate Reaffirmation report adjusts future climate projections based on similar historical trends presented in Section 6.4.1 - Historical Climate, allowing for shifts in temperature and wind patterns to be incorporated into long-term forecasting. Short-term weather events remain dependent on real-time atmospheric conditions, the approach used in the Climate Reaffirmation ensures that forecasts in temperature extremes and high-wind days reflect both historical variability and projected climate shifts, making the historical trends a factor in shaping the probabilistic forecast over longer timescales.

Table 19 - Summary of Changes and Additions to Consequence and Risk Scores

Climate Parameter: Threshold	Infrastructure Performance Category	Consequence Update	2019 Study		2023 Update	
			Consequence Score	2050s Cumulative Risk Score	Consequence Score	2050s Cumulative Risk Score
High wind: 120 km/hr	Asset Value - Financial score for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Increased consequence scores from 9 to 16 due to recent extreme wind experienced by Hydro Ottawa that led to more operational and capital expenses	9	81	16	102
High wind: 130 km/hr	All categories	Consequence scores mirror those of the 120 km/hr threshold	N/A	N/A	16	102
High wind: 180 km/hr	System accessibility, service quality, and resource efficiency for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Consequence scores assigned a 16 based on UWO's analysis of damage for the 2022 Derecho event	N/A	N/A	16	114
	Financial for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Consequence scores assigned a 25 due to damage experienced by Hydro Ottawa in the 2022 Derecho event	N/A	N/A	25	
Freezing rain: Ice accumulation of 25 mm	Financial for Power Distribution - Overhead (N-S and E-W orientations) Lines	Increased consequence scores for 4 to 9 due to recent freezing rain events experienced by Hydro Ottawa that led to more operational and capital expenses	4	16	9	26

The adaptation and risk mitigation plan was subsequently updated, incorporating input from workshops and addressing any risk scores that had changed to medium-very high under current or future climate scenarios. To ensure consistency, Stantec employed the same methodologies used in the 2019 report for this reassessment. The updated report also reviewed the adaptation measures proposed in the 2019 report. While most of these measures remained relevant, additional recommendations were made for strengthening pole line systems and improving real-time weather monitoring. Hydro Ottawa has made progress in implementing these measures but must continue addressing new and accelerating climate risks. In Attachment 2-5-4(B) - Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan, Appendix B, "2023 Adaptation Status, Next Steps, and Barriers" details Hydro Ottawa's progress in implementing the 2019 adaptation measures.

Hydro Ottawa made significant strides in implementing the 2019 adaptation plan. Examples of the progress made since 2019 include:

- Strengthening North-South pole lines by installing a composite pole every fifth pole, along with additional guying and anchoring.
- Utilizing satellite imaging to monitor tree trimming growth and maintenance.
- Complete a cost/benefit analysis to convert overhead lines to underground infrastructure.
- Implementing wind restrictions for aerial work platforms during high winds.

Due to the substantial impact of the 2022 Derecho on overhead distribution infrastructure, design standards have been revised. Hydro Ottawa's Overhead Design Guideline now includes recommendations for anti-cascading strategies and infrastructure hardening, including installing composite poles with storm guying every five poles in vulnerable areas.

The updated climate study confirmed that continuous adaptation and mitigation strategies are necessary. This assessment supports planning to improve grid resilience and prioritize system reliability due to increasingly frequent severe weather events and growing reliance on stable power.

Hydro Ottawa's climate assessment aligns with the OEB's VASH - Draft Report[10] by developing climate forecast data derived from climate forecast models developed by Stantec. This data allows for a quantitative analysis comparing asset threshold criteria to the probability of extreme weather events during project evaluation, ensuring investments improve climate resilience within the distribution system.

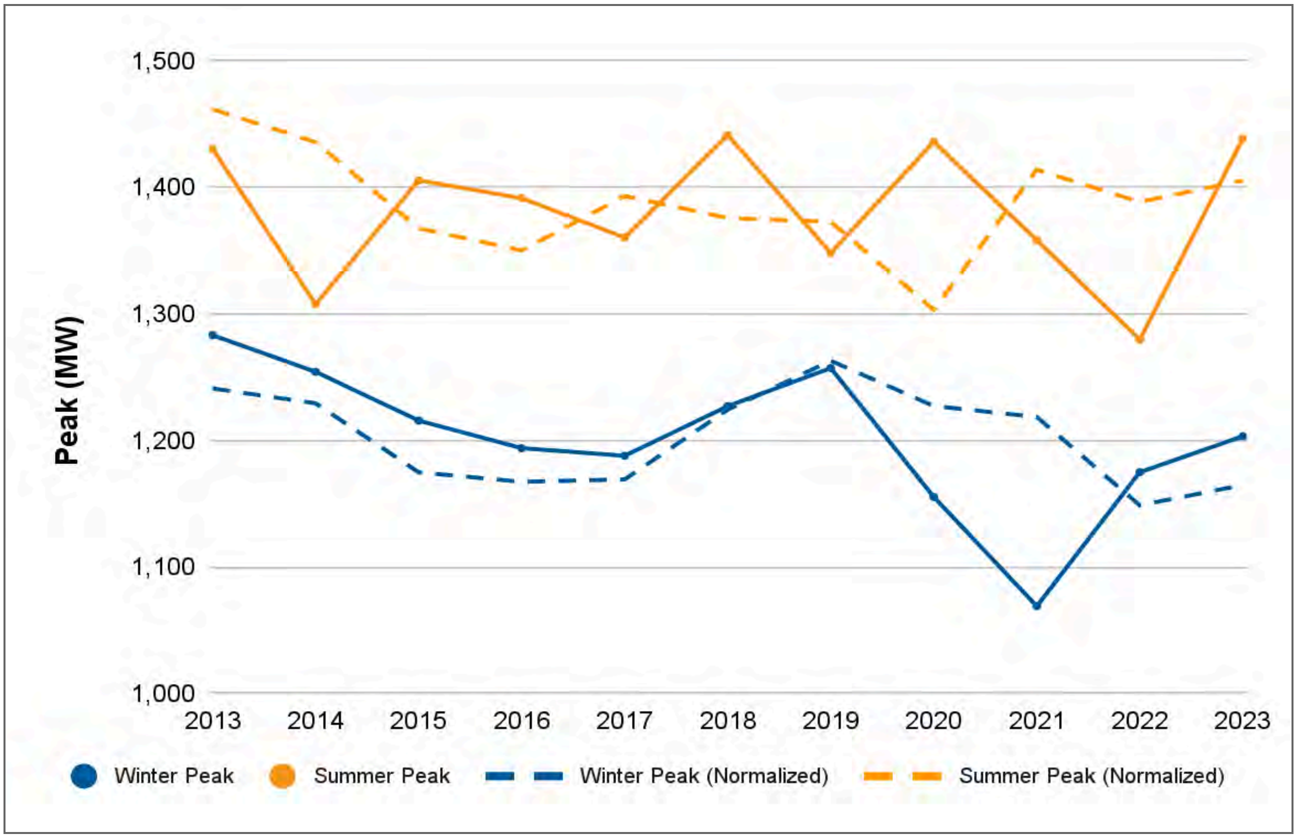
6.5. SYSTEM DEMAND AND GROWTH PLANNING CONSIDERATIONS

6.5.1. System Demand

In 2023, Hydro Ottawa purchased a total of 7,471 gigawatt hours of electricity from the provincial grid to supply customers. Figure 25 illustrates both the summer and winter peak demands from 2013 to 2023. The Hydro Ottawa system has continued to see a higher peak during summer, which has remained relatively stable over the past decade, ranging from a high of 1,441 MW in 2018 to a low of 1,280 MW in 2022.

[10] Ontario Energy Board, *Vulnerability Assessment - Draft Report*, EB-2024-0199 (December 17, 2024).

Figure 25 - Net System Summer & Winter Peak (2013-2023)[11]



To ensure the continued delivery of reliable and resilient electricity services to its expanding customer base, Hydro Ottawa must strategically expand its grid capacity to accommodate unprecedented demand growth. This increased demand is driven by several converging factors, detailed in Table 20, including residential growth, transportation electrification, and the increasing adoption of electrified space heating.

Residential growth, based on the City of Ottawa's population projections, is a primary contributor to increased energy consumption. The ongoing expansion of the City necessitates increased capacity to serve new residential customers. Further detailed in Section 6.5.2 - Residential Growth below.

[11] The values including embedded generation.

The increasing adoption of electric vehicles will also significantly impact electricity demand. Federal legislation mandates a complete transition to electric vehicle sales by 2035. This national shift is mirrored locally by the City of Ottawa's ambitious plan to fully electrify its bus fleet by 2036. Further detailed in Section 6.5.3 - Transportation Electrification below.

Finally, the growing prevalence of electrified space heating, particularly through the use of heat pumps, will further drive electricity consumption. This trend, aligned with broader electrification efforts, represents a substantial increase in demand for electricity. Further detailed in Section 6.5.4 - Electrified Space Heating below.

Table 20 - Ottawa Growth Factors

Factor	Description	Supporting Statistic
Residential Growth	Forecasted increases in housing and population will drive increased energy demand.	Ottawa population Compound Annual Growth Rate (CAGR) of 1.3% and dwelling CAGR of 1.5% between 2026 and 2031 as per the City of Ottawa Official Plan.[12]
Transportation Electrification	Increased adoption of electric vehicles.	Federal Government legislation requires 60%[13] of all light duty vehicles sold in Canada to be electric vehicles by 2030 and 100% by 2035, compared to 9% of vehicles sold in 2021. The City of Ottawa planned to procure 354 electric buses by 2027 and a full transition to electric buses by 2036.[14]
Electrified Space Heating	Increased adoption of electric space heating.	Increase of electric space heating in residential and commercial segments through combination of heat pumps and electric furnaces in Canada's net-zero scenarios, with heat pumps providing more than 50% of residential space heating needs by 2050, up from 6% in 2021.[15]

[12] City of Ottawa, "Growth projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93.
[13] Statistics Canada, "Watt's up? Electric Vehicles and future electricity generation needs," https://www.statcan.gc.ca/o1/en/plus/5497-watts-electric-vehicles-and-future-electricity-generation-needs
[14] Ottawa-Carleton Transportation, "Zero-Emission Bus," https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/
[15] Canada Energy Regulator, "Canada's Energy Future 2023: Energy Supply and Demand Projections to 2050," https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/

6.5.2. Residential Growth

For residential growth planning, Hydro Ottawa utilizes the City of Ottawa's *Growth Projections for Ottawa: 2018-2046* report.[16] This report projects a compound annual growth rate (CAGR) of 1.2% for population and 1.4% for dwellings between 2026 and 2036. Based on these projections, Hydro Ottawa anticipates a 13% population increase within its service area, equivalent to an additional 149,900 residents, between 2026 and 2036. This population growth will fuel a corresponding expansion in housing, with forecasts indicating a 15% increase in the number of dwellings over the same period. This growth is expected to be driven by both intensification and redevelopment initiatives, suggesting a focus on denser housing options within existing urban areas. This combination of population growth and increased housing units will contribute to a rising demand for energy within the residential sector.

As the city grows, formerly rural areas served by long distribution feeders are transitioning into urban centers. These long feeders, originally designed for lower population densities, often experience greater voltage fluctuations and are more susceptible to outages due to their extended length and exposure to environmental factors. This presents a challenge for Hydro Ottawa, as maintaining consistent and reliable service in these newly urbanized areas requires upgrades and potentially redesigning sections of the distribution network to meet the higher service quality expectations of urban customers. These upgrades can be complex and costly, requiring careful planning and execution to minimize disruption to existing customers.

City of Ottawa Growth Projections

The population, household, and employment growth forecasts presented in Table 21 have been obtained from the City of Ottawa Growth Projections for 2021-2036. The City of Ottawa published its New Official Plan as of November 2022, which includes updated growth projects.

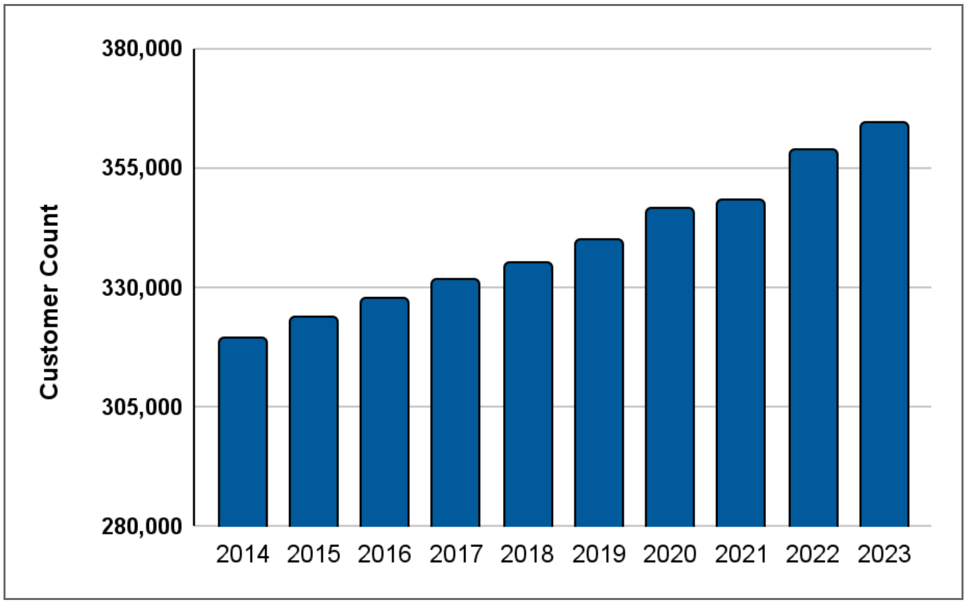
[16] City of Ottawa, "Growth Projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93

Table 21 - Projected Growth in Population, Households & Employment, City of Ottawa, 2021-2036

Population				
Year	**2021**	**2026**	**2031**	**2036**
Total	1,064,100	1,141,800	1,219,200	1,291,700
CAGR		1.4%	1.3%	1.2%
Households				
Year	**2021**	**2026**	**2031**	**2036**
Total	429,800	470,700	509,100	542,900
CAGR		1.8%	1.6%	1.3%
Employment				
Year	**2021**	**2026**	**2031**	**2036**
Total	662,400	698,400	731,500	764,400
CAGR		1.1%	0.9%	0.9%

Hydro Ottawa's customer base has grown at a consistent CAGR of 1.5% between 2014 and 2023, as shown in Figure 26. A comparison of overlapping data from 2018 to 2023 reveals a 1.7% CAGR for both the City of Ottawa's population growth and Hydro Ottawa's customer growth, demonstrating a strong correlation. This alignment with population growth projections supports Hydro Ottawa's expectation of a continuing upward trend in connection requests for residential subdivisions, associated mixed-use centers, and employment centers.

Figure 26 - Historical Customer Count



City of Ottawa Community Design Plans

Hydro Ottawa actively monitors the City of Ottawa's published Community Design Plans (CDPs) to understand projected residential and mixed-use center developments. CDPs are intended to guide change in designated growth areas, as identified in the City of Ottawa's Official Plan. The purpose of CDPs is to translate the City of Ottawa Official Plan's principles and policies to the community level. The City of Ottawa's Official Plan, which came into effect on November 4, 2022, directs the city's growth over time and establishes policies to guide development. Currently, 36 CDPs, encompassing a variety of development types, are available on the City of Ottawa's website[17]. A summary of these CDPs, linked to Hydro Ottawa Planning Regions, is provided in Table 22. Hydro Ottawa will continue to utilize these CDPs to identify areas anticipated to experience significant load growth due to increased density.

[17] City of Ottawa. "Community Design Plans." City of Ottawa, [Feb 2025], [URL: https://ottawa.ca/en/planning-development-and-construction/community-design/community-plans-and-studies/community-design-plans].

1 **Table 22 - City of Ottawa Community Design Plans Summary**

Study	Hydro Ottawa Planning Area	No. Res. Units	Land Use Type
Barrhaven South CDP	Barrhaven 8kV/South 28kV	6,862	Mixed-Use
Barrhaven South Expansion CDP	Barrhaven 8kV/South 28kV	1,752	Mixed-Use
Bank Street CDP	East 4kV & 13kV	990	Mixed-Use
Bayview Station District CDP	West 13kV & Central 4kV	3,594	Mixed-Use
Beechwood CDP	East 4kV & 13kV	819	Mixed-Use
Cardinal Creek Village Concept Plan	N/A (Hydro One Territory)	3,500	Mixed-Use
Carp Road Corridor CDP	N/A (Hydro One Territory)	-	Commercial
Village of Carp CDP	N/A (Hydro One Territory)	543	Mixed-Use
Village of Constance Bay Community Plan	N/A (Hydro One Territory)	204	Mixed-Use
East Urban Community (Phase 1 Area) CDP	East 8kV & 28kV	3,498	Mixed-Use
East Urban Community (Phase 2 Area) CDP	East 8kV & 28kV	1,726	Mixed-Use
East Urban Community (Phase 3 Area) CDP	East 8kV & 28kV	4,050	Mixed-Use
Fernbank CDP	West 28kV	11,000	Mixed-Use
Former CFB Rockcliffe CDP	East 4kV & 13kV	5,350	Residential
Greely CDP	N/A (Hydro One Territory)	729	Mixed-Use
Leitrim CDP	South-East 28kV	5,300	Mixed-Use
Mer Bleue CDP	N/A (Hydro One Territory)	3,000	Mixed-Use
Kanata North CDP	West 28kV (North)	2,900	Residential
Kanata West Concept Plan	West 28kV	5,000	Mixed-Use
North Gower CDP	N/A (Hydro One Territory)	520	Mixed-Use
Old Ottawa East CDP	Core 13kV & Central 4kV	2,250	Mixed-Use
Orleans Industrial Park Study	East 8kV & 28kV	-	Commercial
Richmond Road/Westboro CDP	West 13kV & Central 4kV	2860	Mixed-Use
Riverside South CDP	South-East 28kV	18,300	Mixed-Use
Scott Street CDP	West 13kV & Central 4kV	1,500	Mixed-Use

Study	Hydro Ottawa Planning Area	No. Res. Units	Land Use Type
South Nepean Town Centre CDP	Barrhaven 8kV & South 28kV	11,000	Mixed-Use
Uptown Rideau CDP	Core 13kV & Central 4kV	2,500	Mixed-Use
Transit-Oriented Development (TOD) Plans	East 4kV & 13kV	16,500	Mixed-Use
Village of Richmond CDP	West 28kV	2,700	Mixed-Use
Wellington Street West CDP	West 13kV & Central 4kV	950	Mixed-Use

City of Ottawa Transportation Master Plan

Hydro Ottawa incorporates the City of Ottawa's Transportation Master Plan (TMP)[18] in its planning process, particularly regarding plant relocation, asset renewal, and line upgrades necessitated by transportation projects. The TMP, a two-decade roadmap for the City of Ottawa’s transportation networks, emphasizes affordability and has resulted in the "Affordable Road Network," a prioritized subset of planned road projects focused on fiscal responsibility. Table 23 outlines the City of Ottawa Affordable Road Network projects between 2026 and 2031 that will influence Hydro Ottawa's infrastructure development, ensuring alignment with the City of Ottawa’s transportation priorities.

[18] City of Ottawa, “Transportation Master Plan, Exhibit 7.2: 2031 Affordable Road Network- Project By Phase- https://documents.ottawa.ca/sites/default/files/documents/tmp_en.pdf

Table 23 - City of Ottawa Affordable Road Network Projects 2026-2031

Sector	Project	Description
Southeast	Airport Parkway (2)	Widen from two to four lanes between Hunt Club Road and MacDonald-Cartier International Airport
Rural	Bank Street (2)	Widen from two to four lanes between Earl Armstrong Road extension and Rideau Road
Outer Urban	Blair Road	Widen from two to four lanes between Meadowbrook Road and Innes Road
Outer Urban	Coventry Road	Widen from two to four lanes between Belfast Road and St. Laurent Center
Outer Urban	Cyrville Road	Urbanize existing two-lane rural cross-section between Belfast Road and St. Laurent Center
Southwest	Earl Armstrong Road	Widen from two to four lanes between Limebank Road and Bowesville Road
West	Hope Side Road	Widen from two to four lanes between Eagleson Road and Richmond Road
West	Huntmar Drive	Widen from two to four lanes between Campeau drive extension and Cyclone Taylor Boulevard; widen from two to four lanes between Palladium Drive and Maple Grove Road
Southeast	Stitsville Main Street Extension	New two-lane road between Palladium Drive and Maple Grove Road
Inner Urban	Preston Street	Extend existing two-lane urban roadway Albert Street to Vimy Place (at Kichi Zībī Mīkan)
Southwest	Prince of Wales Drive	Widen from two to four lanes between Hunt Club Road and Merivale Road
Outer Urban	Tremblay Road	Widen from two to four lanes between Pickering Place and St. Laurent Boulevard

6.5.3. Transportation Electrification

The electrification of transportation in Canada, driven by federal and municipal climate targets, is poised to significantly reshape the nation's electricity infrastructure. Federal legislation, including the Canadian Net-Zero Emissions Accountability Act and the 2030 Emission Reduction Plan, mandates a rapid transition to electric vehicles, with targets of 20% of new light-duty vehicle sales being zero-emission by 2026, 60%[19] by 2030, and 100% by 2035. Similar targets exist for medium- and heavy-duty vehicles. This surge in EV adoption, fueled by substantial government incentives like the iZEV program and investments in charging infrastructure, will dramatically increase electricity demand.

In Ottawa, these national trends are amplified by the City's own aggressive climate goals, as outlined in its Climate Change Master Plan.[20] The City aims for 100% community emissions reduction by 2050 and 100% corporate emissions reduction by 2040, with transportation electrification playing a key role. Ottawa's plan includes procuring 354 electric buses by 2027, targeting a full transition to electric buses by 2036,[21] and encouraging residential EV adoption. This increased demand for electricity from both private vehicles and public transit will necessitate significant upgrades and expansion of the electrical distribution grid.

6.5.4. Electrified Space Heating

The increasing adoption of electric space heating, driven by Canada's net-zero targets, will necessitate significant growth in electricity infrastructure. This growth will be fueled by the shift from traditional heating methods to heat pumps and electric furnaces in both residential and commercial sectors. Specifically, heat pumps are projected to provide over 50% of residential space heating needs by 2050, a substantial increase from 6% in 2021.[22]

[19] Statistics Canada, “Watt’s up? Electric Vehicles and future electricity generation needs,” https://www.statcan.gc.ca/o1/en/plus/5497-watts-electric-vehicles-and-future-electricity-generation-needs
[20] City of Ottawa, “Climate Change Master Plan” https://ottawa.ca/en/planning-development-and-construction/official-plan-and-master-plans/climate-change-master-plan#section-08062b40-74a0-4521-b619-93451ff489fe
[21] Ottawa-Carleton Transportation, “Zero-Emission Bus,” https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/
[22] Canada Energy Regulator, “Canada’s Energy Future 2023: Energy Supply and Demand Projections to 2050,” https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/

Projections for this increased demand are based on data from Natural Resources Canada (NRCan),[23] the Canada Energy Regulator (CER),[24] Enbridge,[25] and the City of Ottawa.[26] These analyses consider factors such as expected technology adoption rates (heat pumps vs. electric resistance), weather data (particularly in climates like Ottawa), and the diminished efficiency of air-source heat pumps at temperatures below -10°C.

Electrifying space heating, primarily through heat pump adoption, is crucial for Canada's net-zero goals but will dramatically increase electricity demand, especially in colder climates like Ottawa due to reduced heat pump efficiency. This necessitates significant investment in electricity distribution infrastructure to ensure a capable and reliable energy transition.

[23] NRCan, "Residential Sector Energy Use, Ontario," Residential Sector – Ontario | Natural Resources Canada
[24] Canada Energy Regulator, "Canada's Energy Future 2023: Energy Supply and Demand Projections to 2050," https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/
[25] Enbridge, "Pathways to Net-Zero Emissions in Ontario," Pathways to Net-Zero Emissions In Ontario | Enbridge Gas
[26] City of Ottawa, "Climate Change Master Plan" https://ottawa.ca/en/planning-development-and-construction/official-plan-and-master-plans/climate-change-master-plan#section-08062b40-74a0-4521-b619-93451ff489fe

7. OVERVIEW OF ASSETS MANAGED

This section provides a comprehensive overview of the assets managed by Hydro Ottawa, diving into the asset demographics and conditions, asset failures and performance, asset risk profiles, and system utilization.

The detailed demographics and condition profile of each asset class are presented in the following sections: Station Assets (transformers, switchgear, batteries, and P&C equipment), Overhead Assets (distribution poles, overhead transformers, and switches), and Underground Assets (distribution cables, underground transformers, switchgear, vault transformers, and civil structures).

Asset failures and performance are reviewed further through performance measurement for continuous improvement, observing equipment failure trends to implement risk mitigation strategies.

Asset risk profiles, considering reliability, safety, environmental, financial, and compliance risks, were analyzed through PA modules. Reliability risk was the most significant factor due to its broad applicability and data availability.

Finally, system utilization is monitored through KPIs like the SLI and FLI, demonstrating capacity limitations, and in turn employs strategies such as Load Forecasting, Renewable Energy Integration, and Grid Modernization.

7.1. ASSET DEMOGRAPHICS AND CONDITION

This Section summarizes the demographics and condition profile for the major assets classes within Hydro Ottawa's distribution system. ACA is based upon health index calculations that are unique to each asset class. Hydro Ottawa categorizes and manages assets under four main systems: Stations, Overhead, Underground, and Metering. Each system has distinct types of assets that are specific to the system and are subject to different types of risks.

System Renewal Program investments, as outlined in Schedule 2-5-7 - System Renewal Investments, are focused on managing and mitigating the risk of asset failure within Hydro Ottawa's distribution network by renewing deteriorating asset infrastructure. The underlying asset demographics (in terms of TUL and condition) are a key consideration for system renewal investment planning in addition to the risk at each individual asset level. TUL refers to the expected duration an asset can reliably operate before it requires replacement or refurbishment. As a part of its asset renewal planning, Hydro Ottawa has grouped the asset age demographics into three categories:

1. **More than 10 Years of TUL Remaining:** Assets with a remaining TUL of over 10 years are considered to be in a stable condition and do not require immediate intervention. These assets are typically monitored through routine maintenance and inspections.
2. **Less than 10 Years of TUL Remaining:** Assets with a remaining TUL of less than 10 years are flagged for future intervention. These assets are not yet at the end of their TUL but will require attention and potential replacement or refurbishment within the 10-year timeframe.
3. **Reached or Exceeded TUL:** Assets that have reached or exceeded their TUL require immediate or short-term intervention. These assets are at the highest risk of failure and are prioritized for replacement or refurbishment in the short-term.

In addition to the TUL categorization, Hydro Ottawa also considers the Health Index value ranging from 0-100% to further assess the condition of each asset and the urgency of any required intervention. The Health Index provides a nuanced evaluation of asset health, allowing for more targeted and efficient maintenance and replacement strategies. The Health Index categories are as follows:

- **0-30% (Very Poor):** Assets falling within this range are considered to be in critical condition and pose an immediate risk of failure. These assets require immediate risk assessment and are prioritized for replacement or refurbishment to prevent service disruptions and safety hazards.

- **30-50% (Poor):** Assets within this range are in poor condition and require short-term attention. While not as critical as those in the 0-30% range, these assets are still at risk of failure and are scheduled for replacement or refurbishment based on the specific risk they pose and the potential consequences of failure.
- **50-70% (Fair):** Assets in this range are showing signs of degradation but are not yet at a critical stage. These assets require increased diagnostic testing and monitoring to assess their condition and rate of deterioration. Depending on the criticality of the asset and the nature of the degradation, remedial work or replacement may be necessary.
- **70-85% (Good):** Assets within this range are in good condition and do not require intervention beyond normal maintenance and inspections.
- **85-100% (Very Good):** Assets in this range are in a very good condition and require no intervention beyond normal maintenance and inspections.

Age and condition are among the parameters that drive Hydro Ottawa's overall risk-based asset management framework outlined in Section 5.1.4 - Asset Risk Assessment. The overall extent of investment required under each distribution asset renewal program is primarily driven by the extent of risk mitigated in the short term/long term and the ability for Hydro Ottawa to maintain system reliability through 2026-2030. This is discussed in the corresponding Alternatives Evaluation sections for each distribution asset renewal program in Schedule 2-5-7 - System Renewal Investments.

Hydro Ottawa's condition assessment process has evolved over the years (since 2014). Some key improvements implemented currently (in 2024) as compared to previous years include:

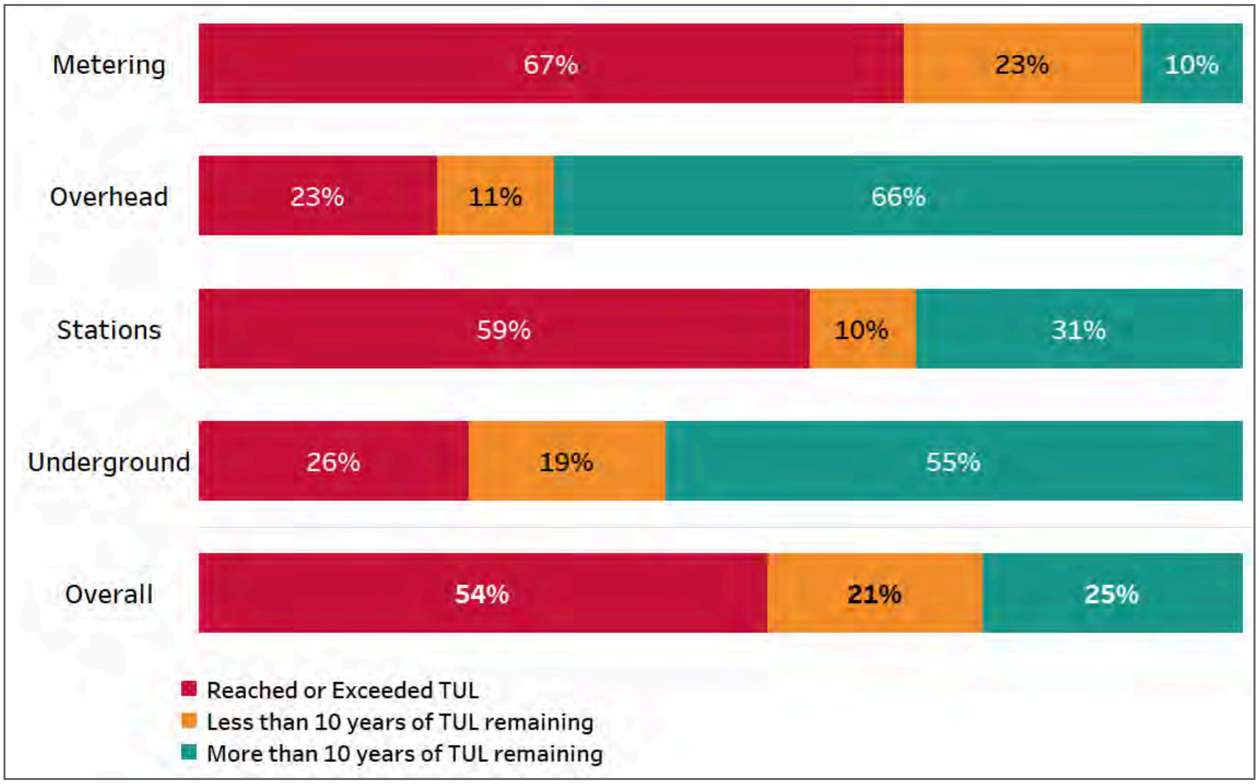
- Updating the health indexing framework to incorporate additional condition parameters gathered through inspection and maintenance programs.
- Reducing the heavy reliance on age as a major contributor to health index. Hydro Ottawa has accomplished this through two ways:
  - Decreasing the weighting assigned to age as a part of the health indexing process.

    - Translating age to condition based on the linear piecewise/linear relationship established between age and condition through the failure curve development exercise outlined in Section 4.4.4 - Failure Curves and Typical Useful Life Update. This approach was used to determine the equivalent condition value for assets that had a known age, but lacked a valid health index.
- Implementing validity to the health index process to ensure that at least 70% of the condition information is available to define a health index value.

These continuous improvement measures have made it difficult to compare Hydro Ottawa's current asset condition state to previous rate periods, as the asset condition profiles have changed since then. A key measure utilized in system renewal planning for 2026-2030 was the ability to forecast asset degradation patterns and risk projections into 2030 through Copperleaf PA, for Hydro Ottawa to intervene on the most impactful and deteriorated assets. The 2030 projections (in terms of age, condition and risk) have been instrumental in deciding on the preferred investment alternative/strategy as outlined in the corresponding Alternatives Evaluation sections for each distribution asset renewal program in Schedule 2-5-7 - System Renewal Investments.

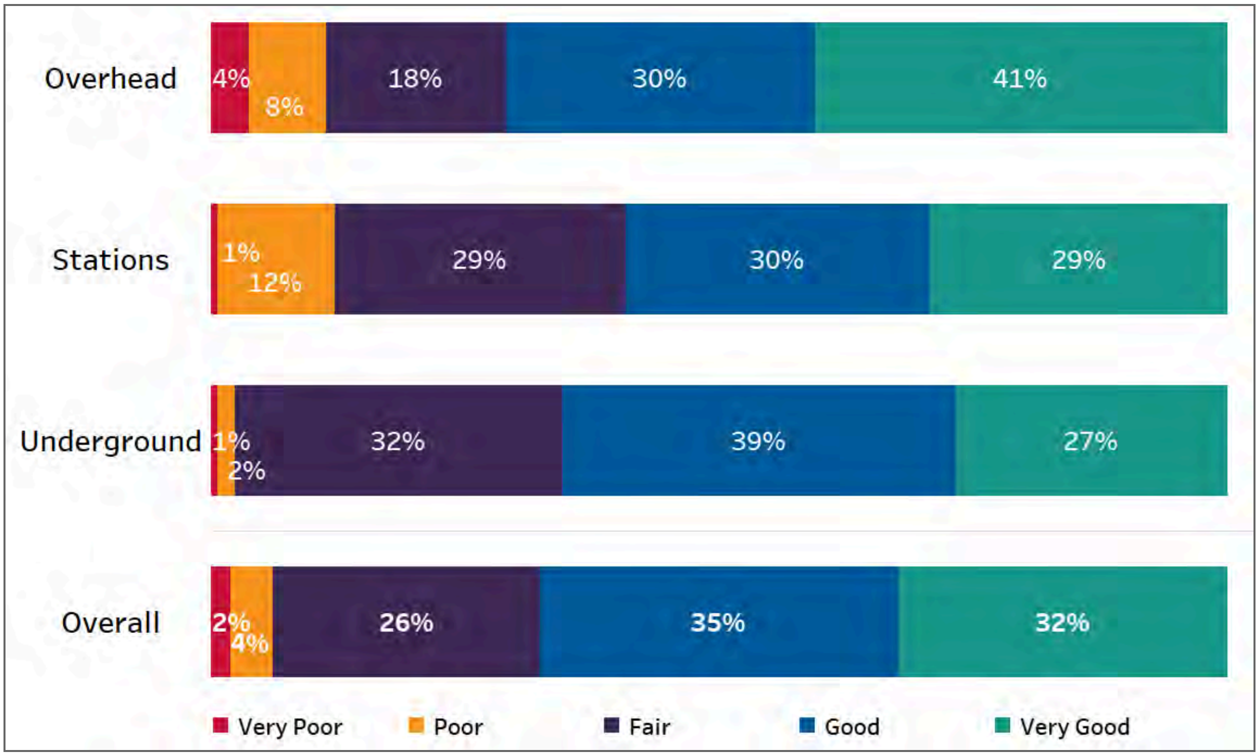
Hydro Ottawa's overall asset demographics, as seen in Figure 27, shows that a large portion (approximately 54%) of the asset population has reached its TUL, posing a higher risk of failure. An additional 21% of assets are within 10 years of reaching their TUL.

Figure 27 - Overall Asset Age Demographics



Hydro Ottawa's overall asset condition ratings are summarized in Figure 28 below. Based on the overall condition profile, approximately 6% of assets are in Poor or Very Poor condition. This presents an immediate and growing risk of asset failure and subsequent reliability impact to the system.

Figure 28 - Overall Asset Condition



The detailed demographics and condition profile of each asset class are presented in the following sections.

7.1.1. Station Assets

Hydro Ottawa station assets are an important part of delivering power to its customers. These assets are located within the fence of an electrical station. Out of the 92 stations that service Hydro Ottawa's customers, Hydro Ottawa fully owns 74. Hydro Ottawa and Hydro One jointly own 12 stations. These stations consist of various assets, some owned by Hydro One, and others owned by Hydro Ottawa. Hydro One wholly owns six stations that supply Hydro Ottawa customers. A list of these stations and their ownership is provided in Attachment 2-5-4(G) - Hydro Ottawa Station Table.

Figure 29 and Figure 30 show the age and condition demographic projections into 2040, without any intervention, as obtained through Copperleaf PA. It can be seen that approximately 65% of the station assets will reach the TUL by 2030, with the proportion increasing to 75% by 2040. On the condition front, approximately one-fourth of the asset population will reach a Very Poor/Poor condition by 2035 and increase to about 35% by 2040. Station renewal projects are complex and require extensive planning, procurement of long-lead equipment and execution over several years (for major station asset renewals).

Figure 29 - Station Asset Age Demographic Projections

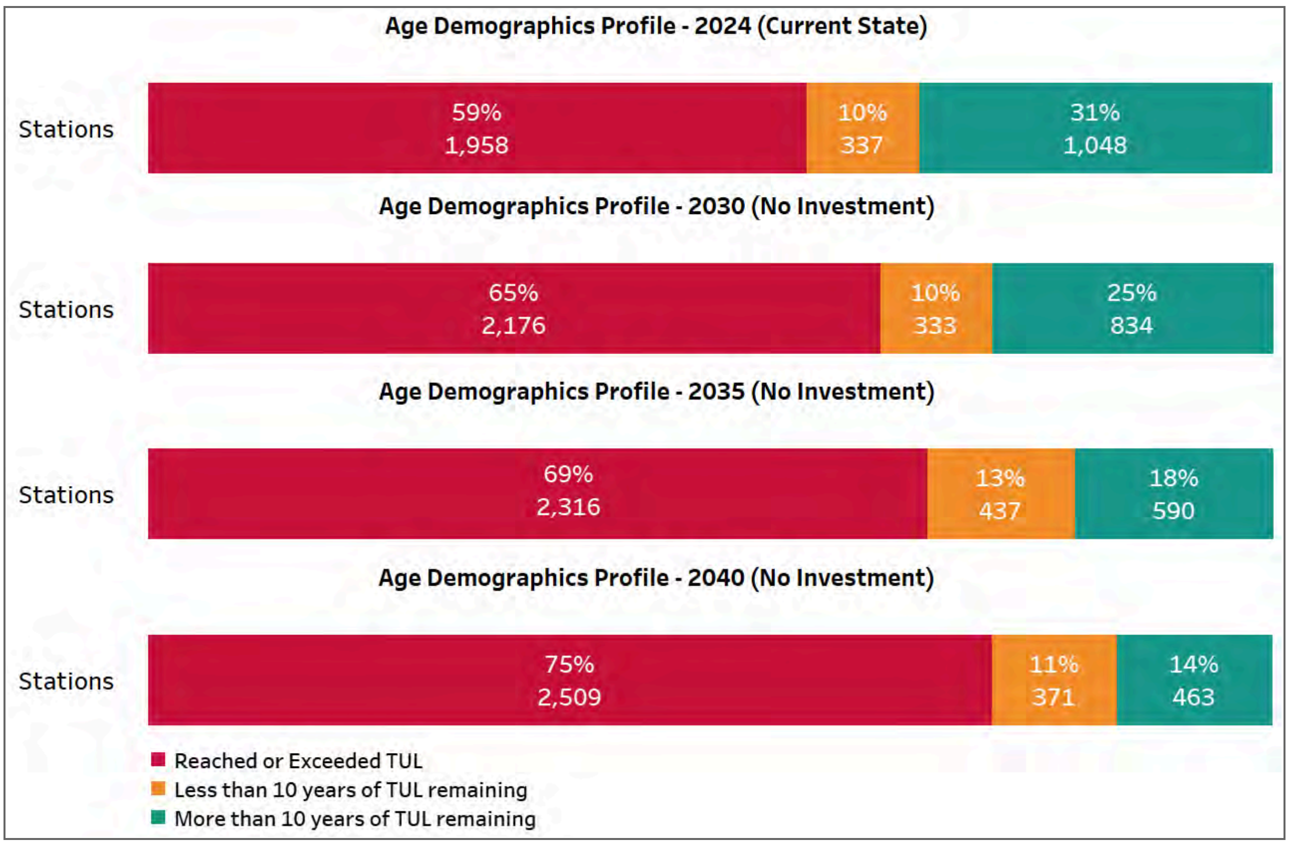
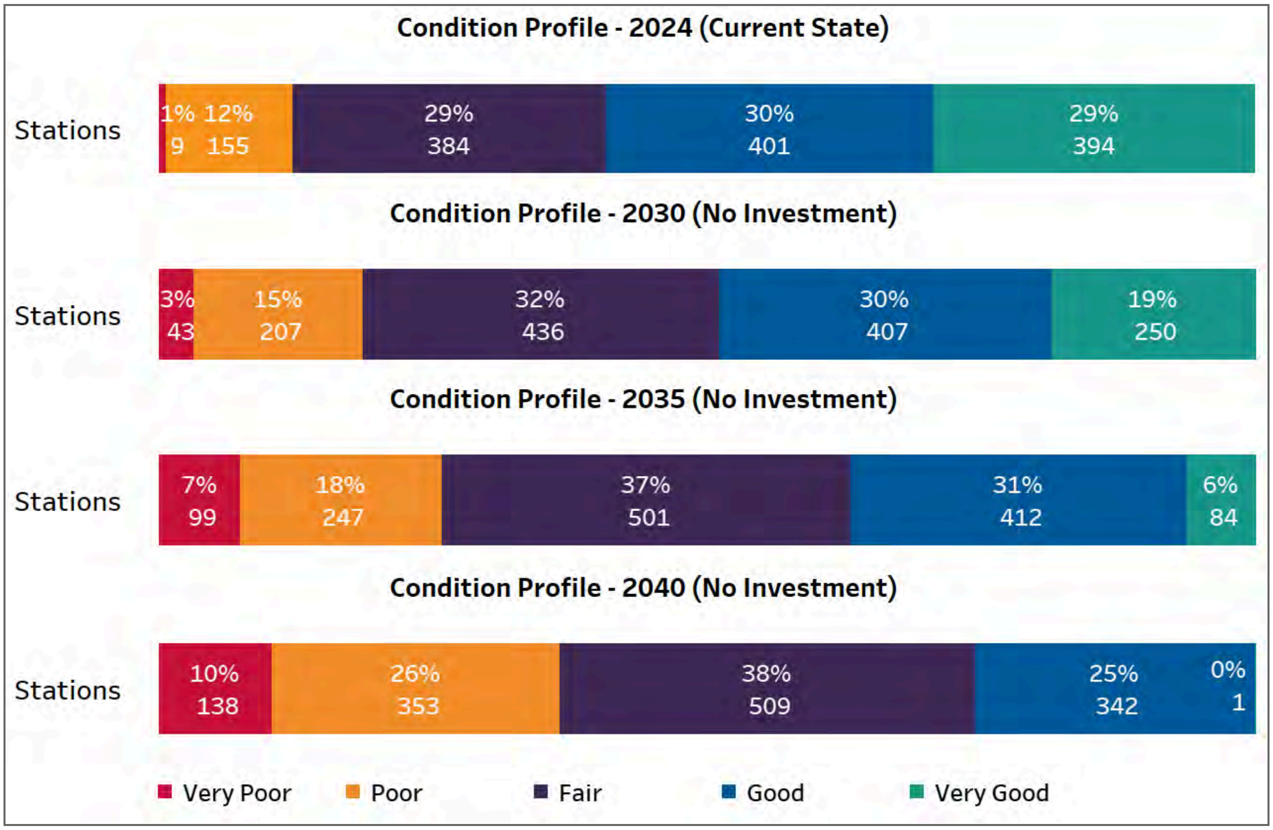


Figure 30 - Station Asset Condition Demographic Projections

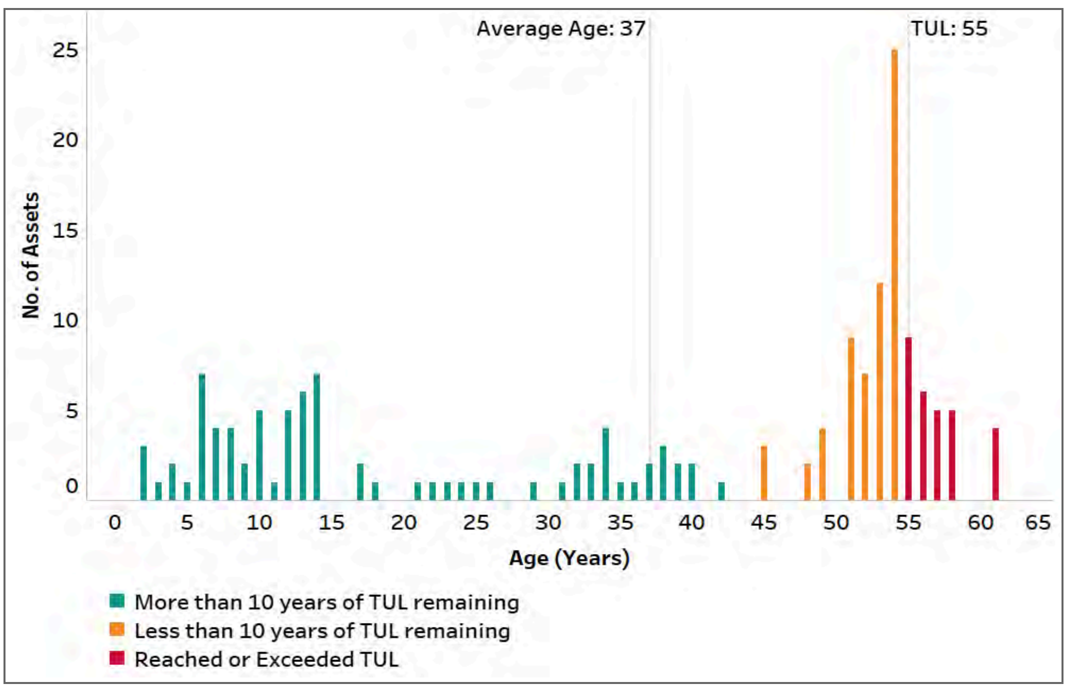


Hydro Ottawa utilized Copperleaf PA to gain a deeper understanding of potential future degradation patterns. This information was used to develop an appropriate, balanced asset renewal investment plan for 2026-2030. Based on these findings, Hydro Ottawa has proposed an increase in station asset renewal spending from the 2021-2025 period. This increase aims to manage long-term asset performance while maintaining affordability for customers. More details regarding Hydro Ottawa's system renewal plan for station assets are outlined in Section 2 of Schedule 2-5-7 - System Renewal Investments.

7.1.1.1. Station Transformers

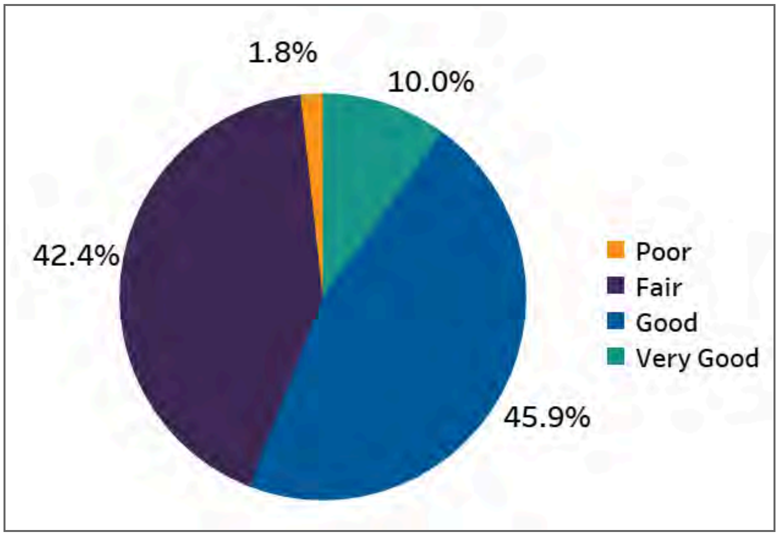
Station transformers are one of Hydro Ottawa's most critical asset classes due to the ability to affect thousands of customers. Hydro Ottawa owns 170 station transformers that operate at various voltages, connected to either Ontario's electric transmission grid or connected to the local sub-transmission system. Hydro Ottawa also supplies distribution stations and customers through 35 station transformers owned and maintained by Hydro One. Hydro Ottawa does not manage Hydro One-owned station transformers. The average age of Hydro Ottawa's station transformers is 37 years, with a TUL of 55 years; Figure 31 illustrates the population demographics.

Figure 31 - Station Transformer Age Demographics



The health index of a transformer is determined through various criteria such as visual inspections, power factor tests, load history, infrared scanning, oil analysis (dissolved gas analysis and degree of polymerization), as well as additional criteria for on-load tap changers, if applicable. The resultant health index is a condition rating from Very Good to Very Poor. This rating is an accurate representation of the current condition of the transformer and is used to drive maintenance and renewal programs. Hydro Ottawa has an active maintenance and monitoring program for its station transformers given their criticality in the system. A summary of Hydro Ottawa's station transformer condition is shown in Figure 32.

Figure 32 - Station Transformer Condition Demographics



7.1.1.2. Station Switchgear

The station switchgear asset class consists of breakers, switches, bus insulation, support structures, protection and control systems, arrestors, control wiring, ventilation, and fuses. Hydro Ottawa owns and maintains approximately 1,057 station breakers, which form the major part of the station switchgear asset class.

Due to the different TUL of each breaker type, it is more appropriate to break out station breakers per type, rather than as one asset group under station switchgear. Figures 33 to 36 illustrate the population demographics of each type. The TUL of air breakers is 42 years, and the average age is 54 years. The TUL of oil breakers is 55 years, and the average age is 60 years. The TUL of gas

(SF_6) breakers is 51 years, and the average age is 28 years. The TUL of vacuum breakers is 46 years, and the average age is 10 years.

Figure 33 - Station Air Breaker Age Demographics

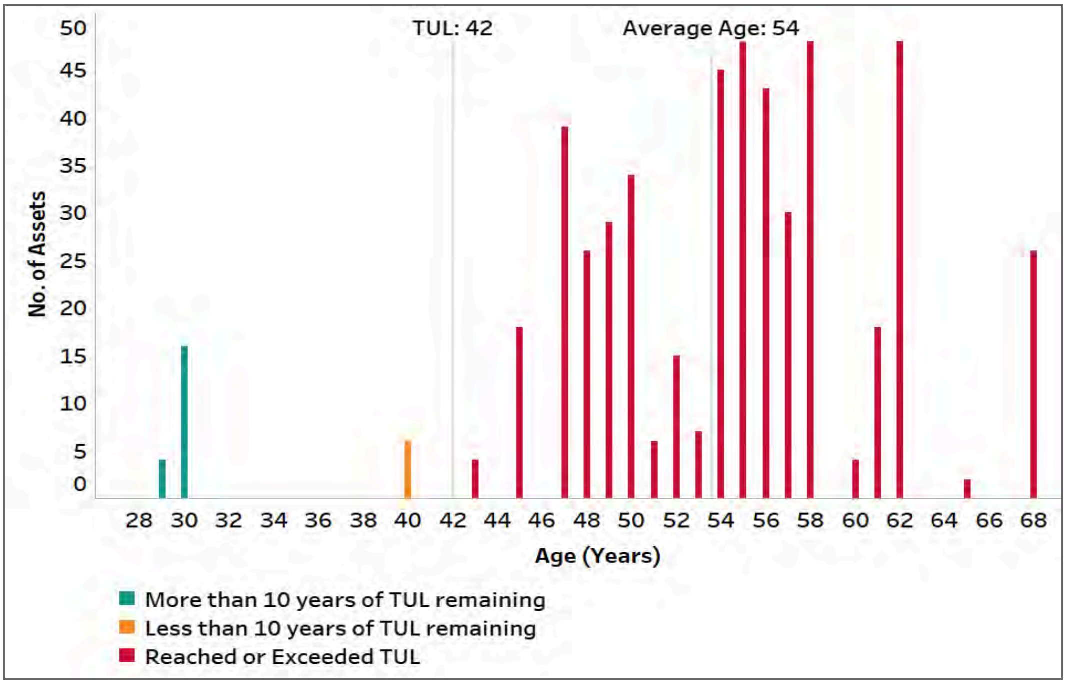


Figure 34 - Station Oil Breaker Age Demographics

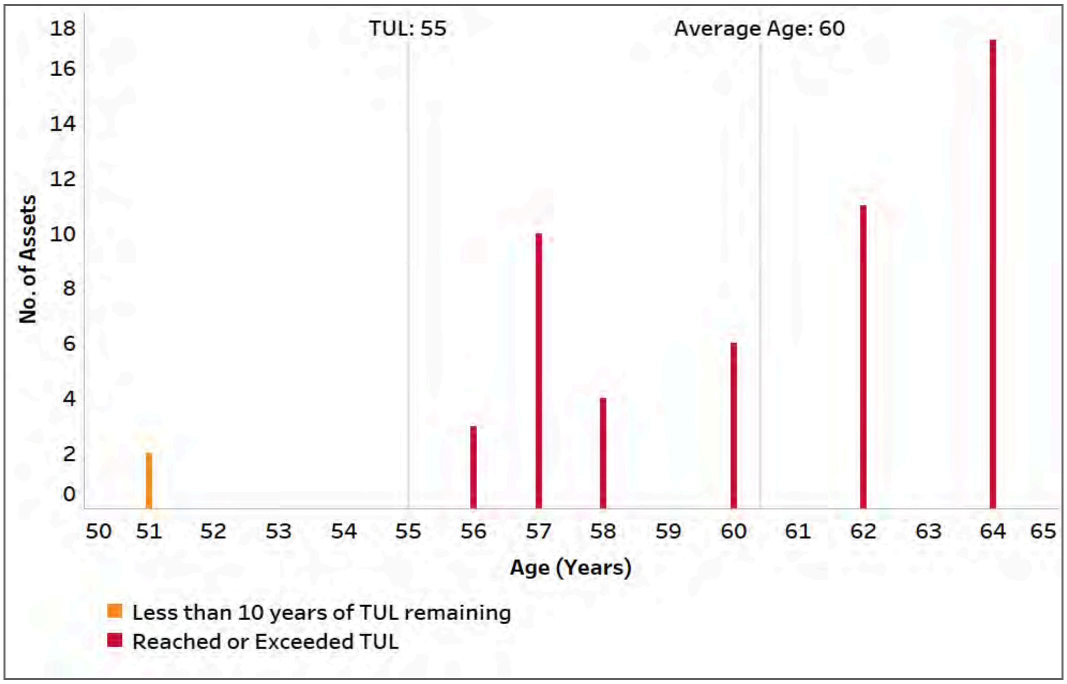


Figure 35 - Station SF6 (Metalclad and HV) Breaker Age Demographics

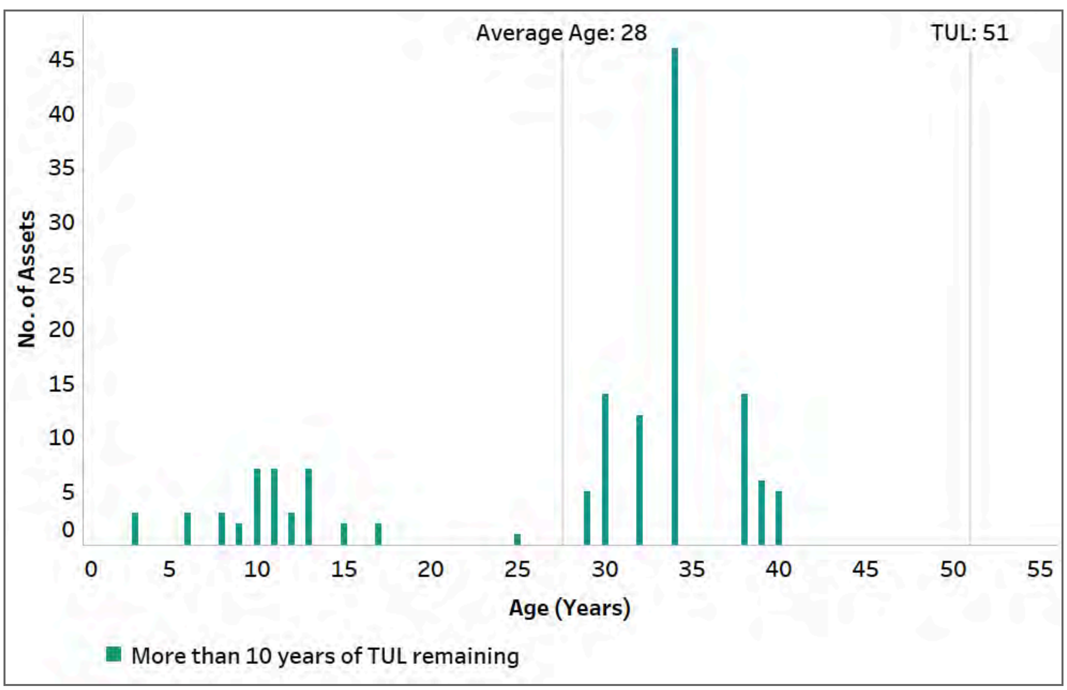
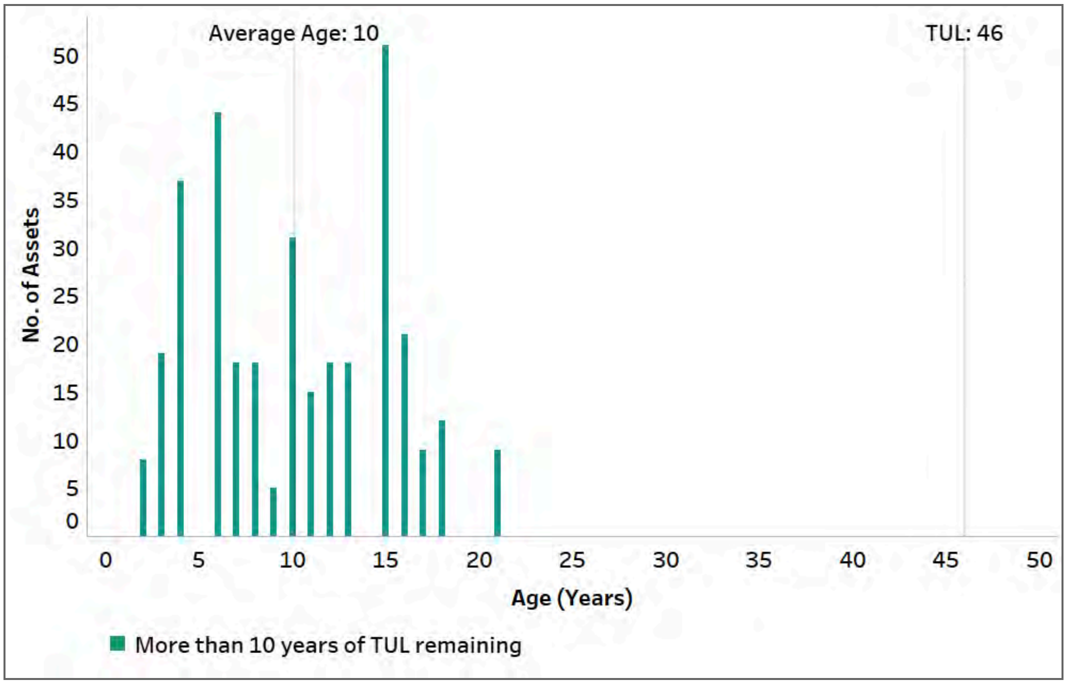
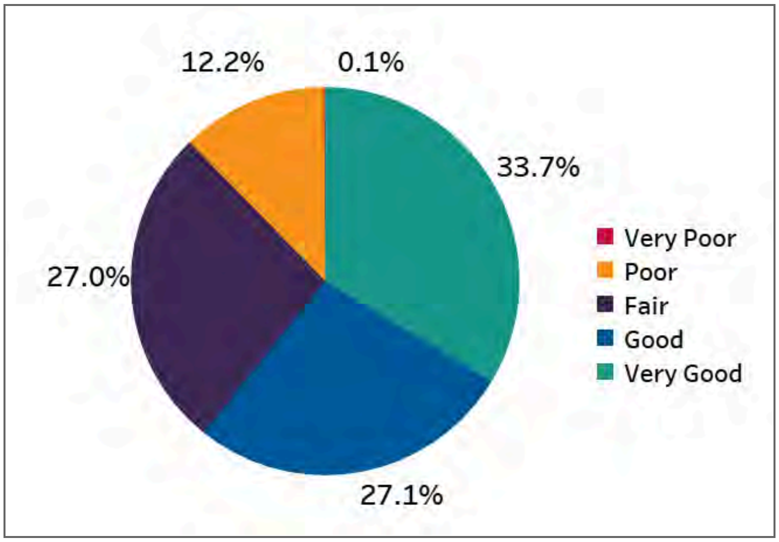


Figure 36 - Station Vacuum Breaker Age Demographics



The health index for station switchgear takes into account the many functional and supporting parts of the equipment. A qualitative assessment of the equipment condition, based on subject matter experience, is done on the switches, breakers, bus, insulation, and supporting structures. The equipment is then reviewed for functional obsolescence and the availability of spare parts. The health index is calculated using this information and the age of the equipment. A summary of Hydro Ottawa's station switchgear condition is shown in Figure 37.

Figure 37 - Station Switchgear Condition Demographics



7.1.1.3. Station Batteries

Hydro Ottawa's station batteries and chargers asset class provide power for operating station breakers and closing coils, DC lights, and relays when the station service power is lost. Hydro Ottawa owns 63 station battery banks and chargers within its stations. Due to the different expected operating life of each battery type, it is more appropriate to break out batteries per type, rather than one asset group. Figure 38 and Figure 39 illustrate the population demographics for each battery type. Vented lead-acid (VLA) batteries have a TUL of 17 years, with an average age of 12 years. Valve-regulated lead-acid (VRLA) batteries have a TUL of 15 years, with an average age of 8 years.

Figure 38 - Station VLA Battery Bank Age Demographics

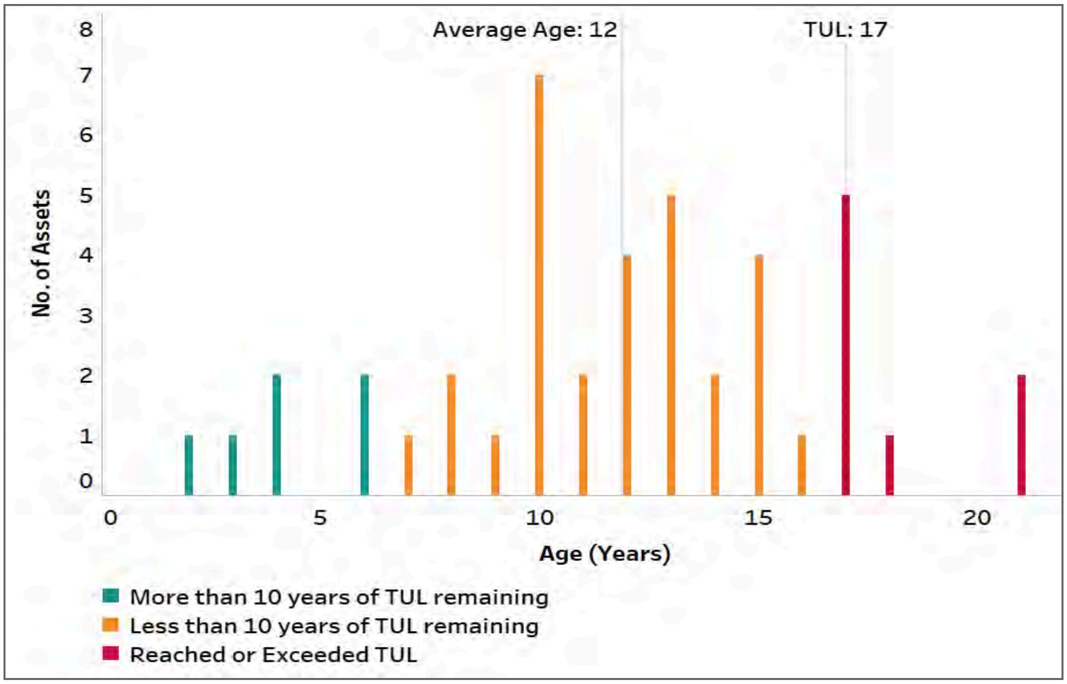
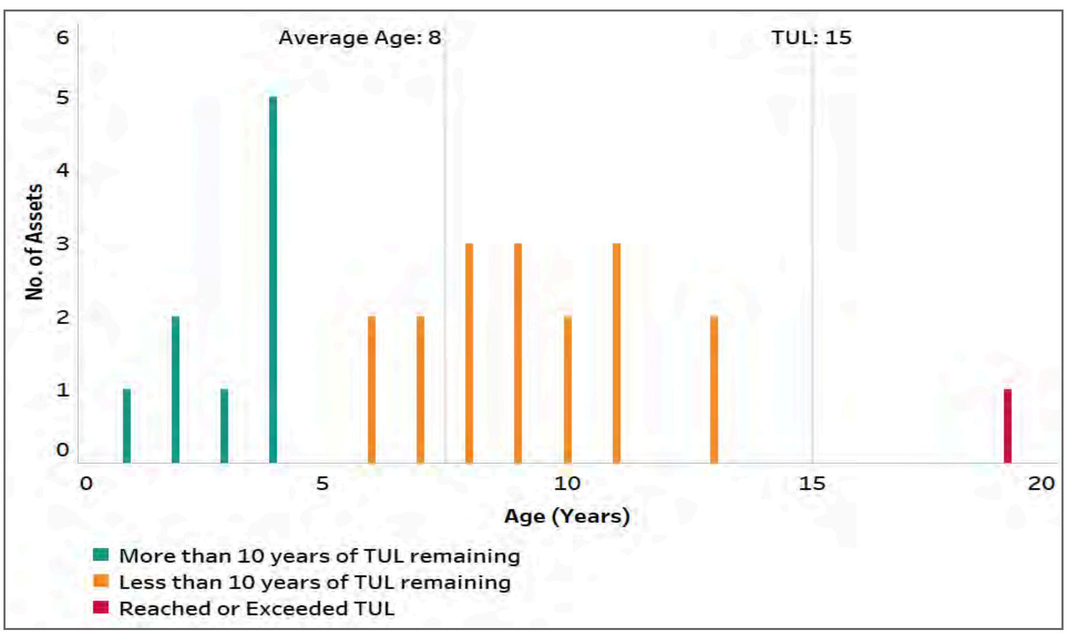


Figure 39 - Station VRLA Battery Bank Age Demographics



7.1.1.4. Station Protection & Control (P&C)

Hydro Ottawa P&C equipment facilitates the control and monitoring of the distribution system. Of the components contained within the P&C asset class, protective relays have a proactive testing and maintenance program. Figures 40 through 42 illustrate the population demographics of protective relay sets and show their average age. The TUL of protective relays is dependent on the relay type, and as such is 40 years for electromechanical, 30 years for electronic, and 25 years for microprocessor based relays.

Figure 40 - Station Electromechanical Relay Age Demographics

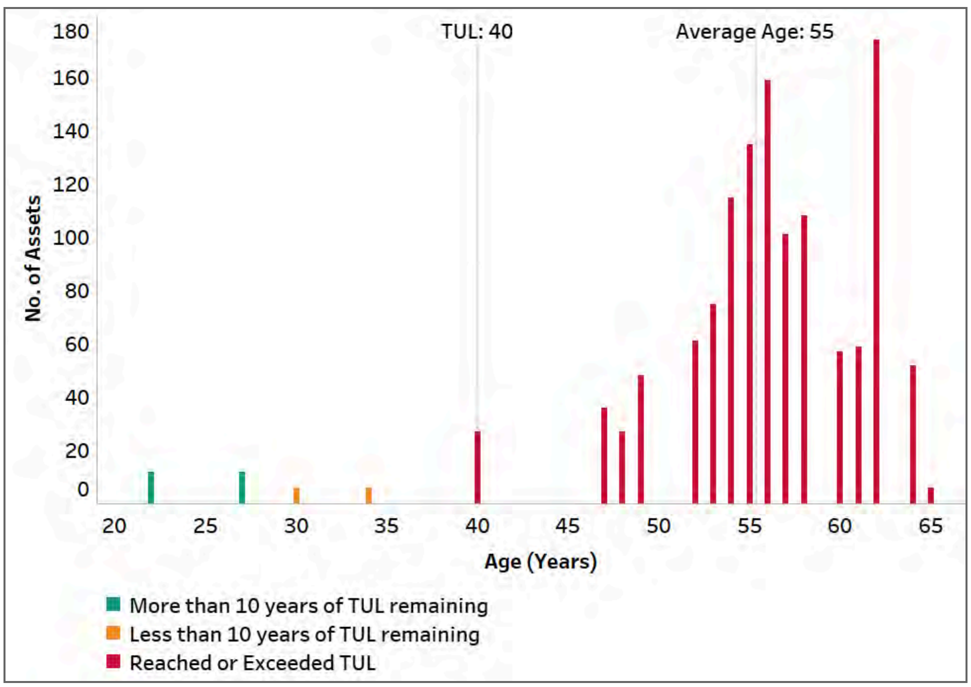


Figure 41 - Station Electronic Relay Age Demographics

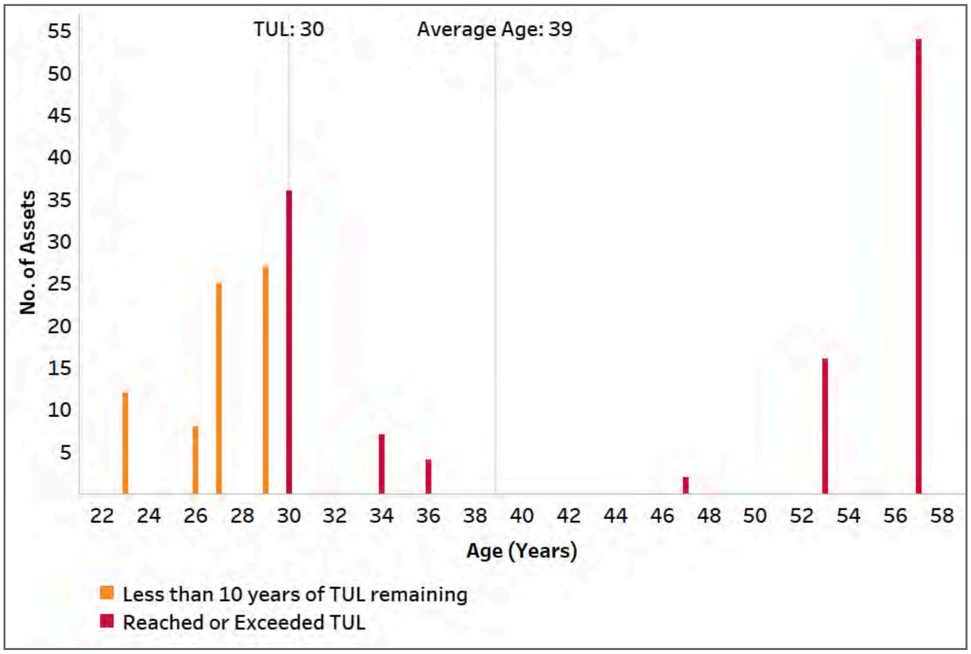
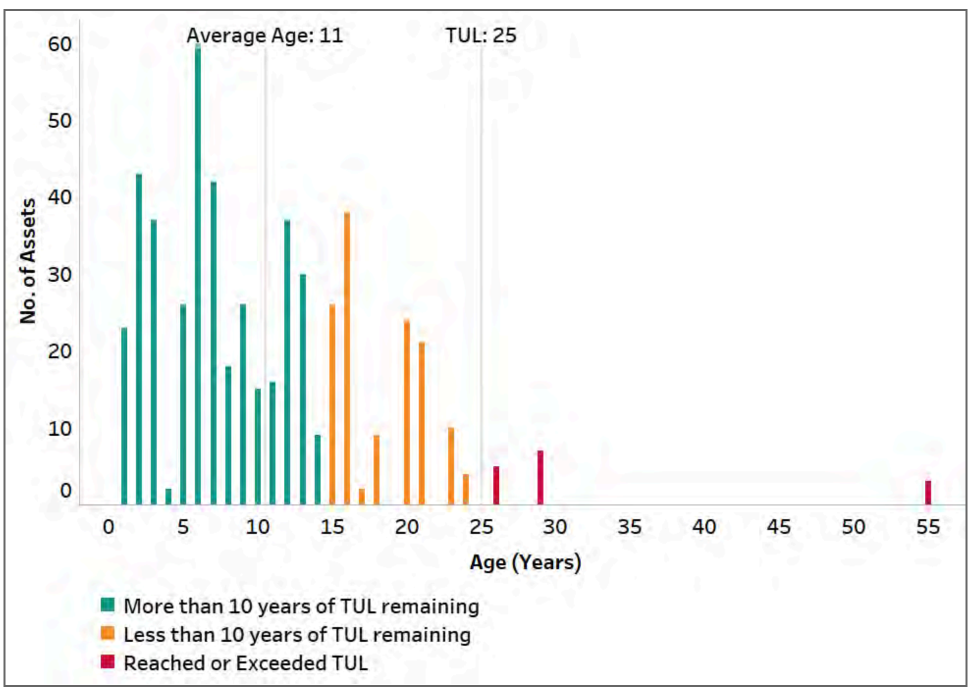


Figure 42 - Station Microprocessor Relay Age Demographics



7.1.2. Overhead Assets

Hydro Ottawa overhead assets are integral for the distribution of electricity. The overhead system, Hydro Ottawa's standard design for delivering power, is built in a range of locations. Overhead assets are broken into the following main asset classes:

- Distribution poles and fixtures
- Overhead distribution transformers
- Overhead distribution switches

Figure 43 and Figure 44 show the age and condition demographic projections of overhead distribution assets into 2040, without any intervention, as obtained through Copperleaf PA. It can be seen that approximately 30% of the overhead assets will reach the TUL by 2030, with the proportion increasing to 46% by 2040. On the condition front, approximately 19% of the asset population will reach a Very Poor/Poor condition by 2035 and increase to about 23% by 2040. Overhead distribution assets are also exposed to and impacted by extreme weather events, thereby impacting reliability and resulting in customer interruptions.

Figure 43 - Overhead Asset Age Demographic Projections

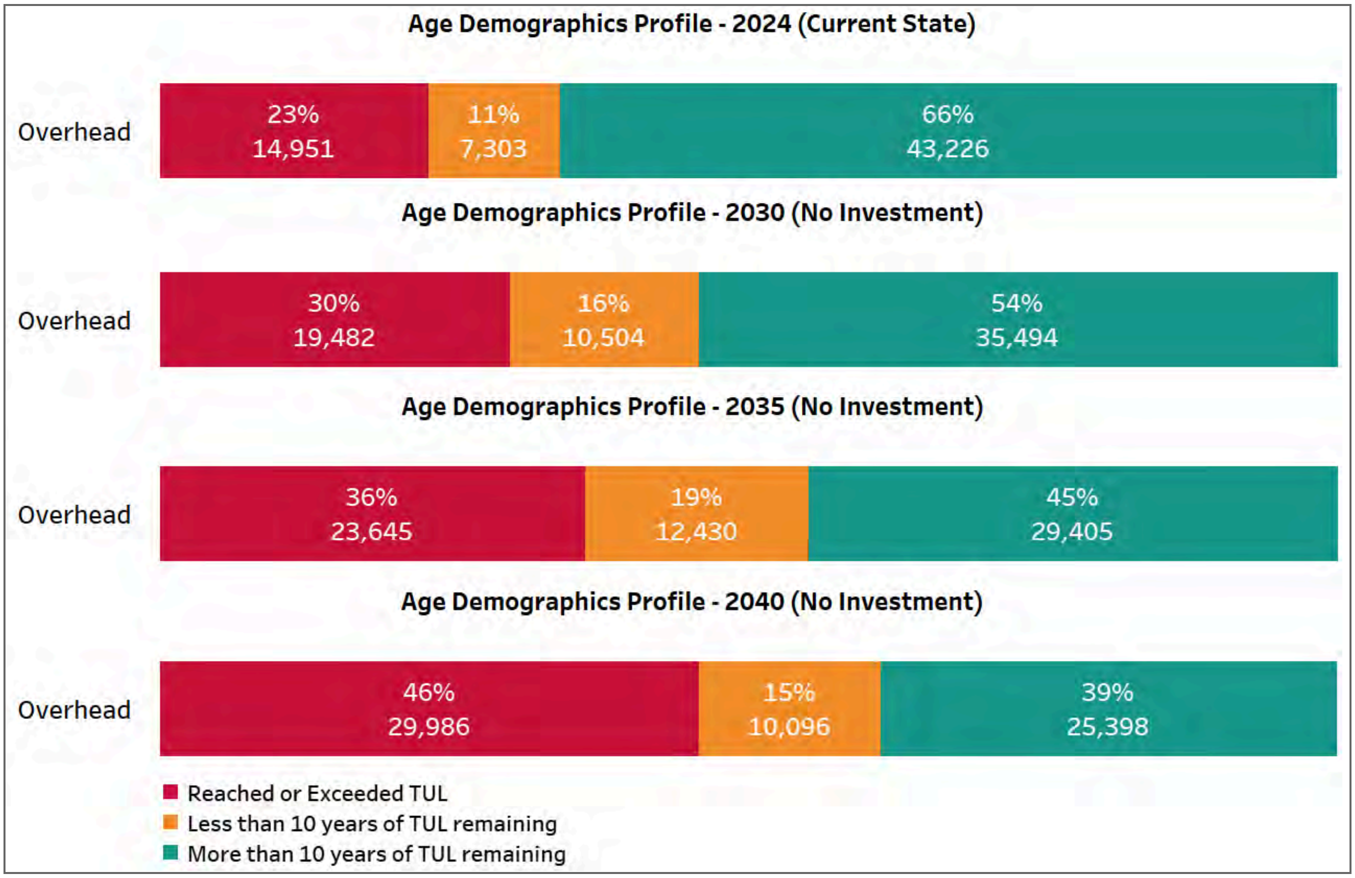
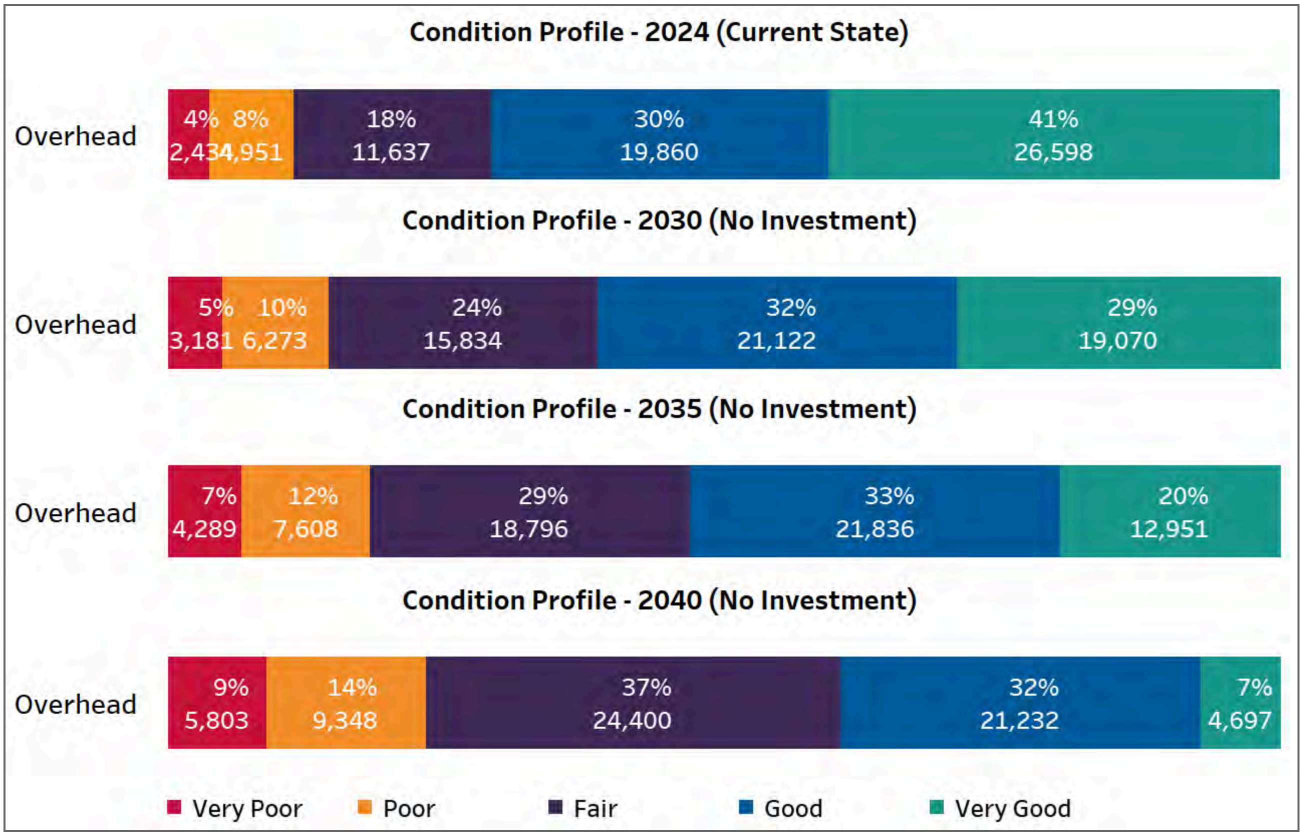


Figure 44 - Overhead Asset Condition Demographic Projections

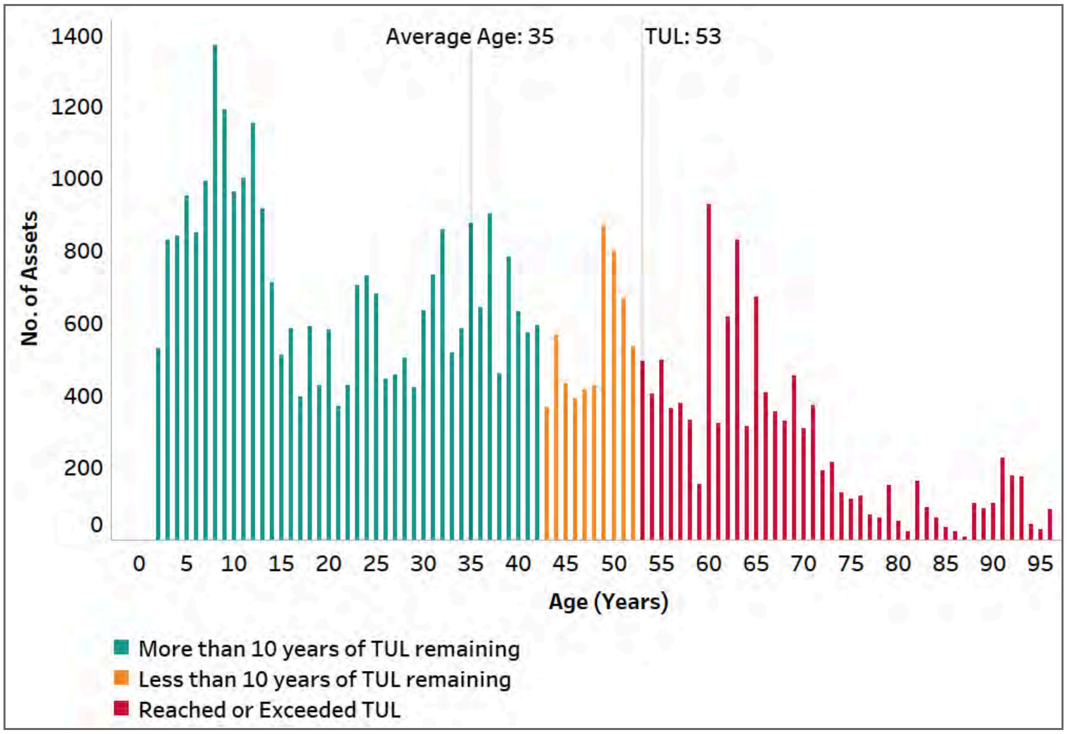


Hydro Ottawa utilized Copperleaf PA to gain a deeper understanding of potential future degradation patterns. This information was used to develop an appropriate, balanced asset renewal investment plan for 2026-2030. Based on these findings and the need for grid resilience (related to the increase in extreme weather events), Hydro Ottawa has proposed an increase in overhead asset renewal spending from the 2021-2025 period. This increase aims to manage asset performance while maintaining affordability for customers. More details regarding Hydro Ottawa's system renewal plan for overhead distribution assets are outlined in Section 3 of Schedule 2-5-7 - System Renewal Investments.

7.1.2.1. Distribution Poles

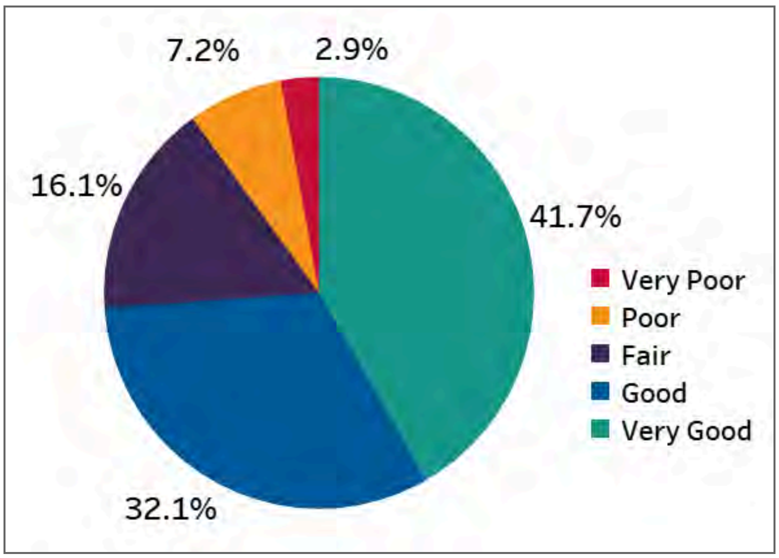
Hydro Ottawa owns approximately 46,636 wood poles in its service territory. The average age of this asset class is 35 years and the TUL is 53 years, with the age demographics shown in Figure 45.

Figure 45 - Distribution Wood Pole Age Demographics



The health index for wood poles is largely based on the estimated remaining mechanical strength in the pole's butt determined using resistograph measurements. Assessment of the pole's condition, and the condition of the ancillary equipment attached to it, are included as part of the process to identify candidate assets for corrective actions. A summary of known Hydro Ottawa's distribution pole conditions is shown in Figure 46.

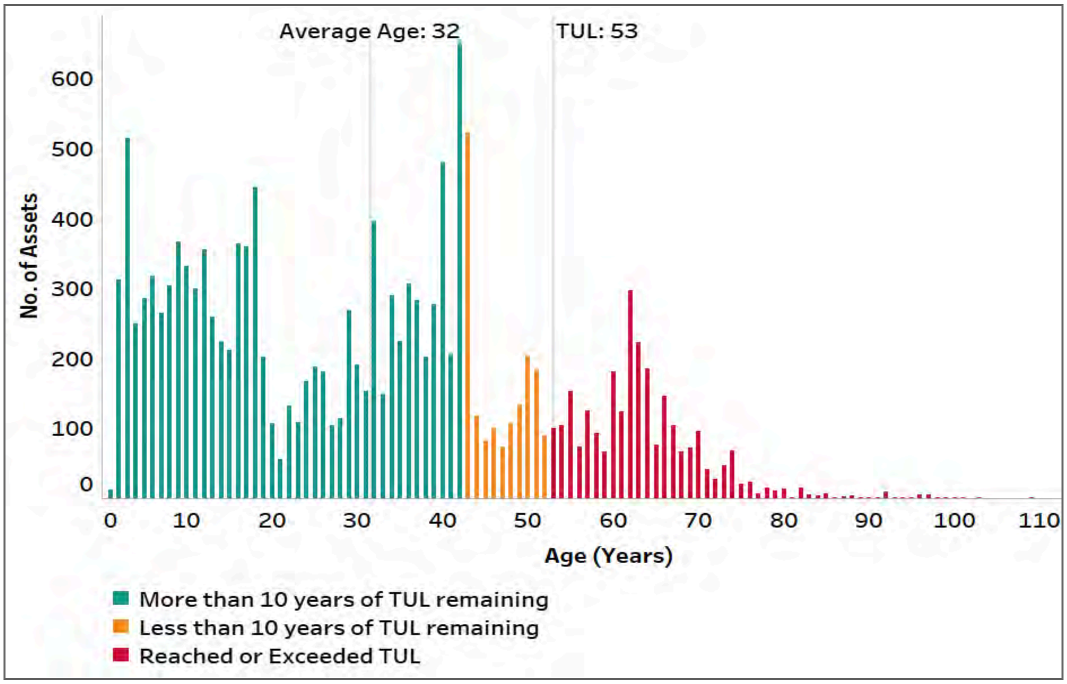
Figure 46 - Distribution Wood Pole Condition Demographics



7.1.2.2. Overhead Transformers

Hydro Ottawa owns and operates 15,218 overhead transformers. These are installed in both the front and rear lot to service Hydro Ottawa customers. The average age of this asset class is 32 years. Figure 47 illustrates the population age demographics. The TUL of overhead transformers is 53 years.

1 **Figure 47 - Overhead Transformers Age Demographics**

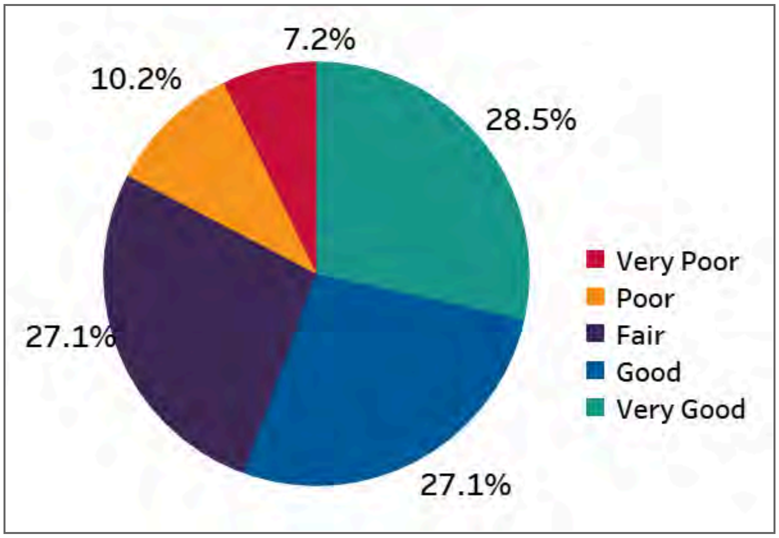


2

3

4 The health index for overhead transformers is based on age and asset condition data collected from
5 planned programs of inspection that use both visual and IR inspection techniques. A summary of
6 known Hydro Ottawa's overhead transformer conditions is shown in Figure 48.

Figure 48 - Overhead Transformer Condition Demographics



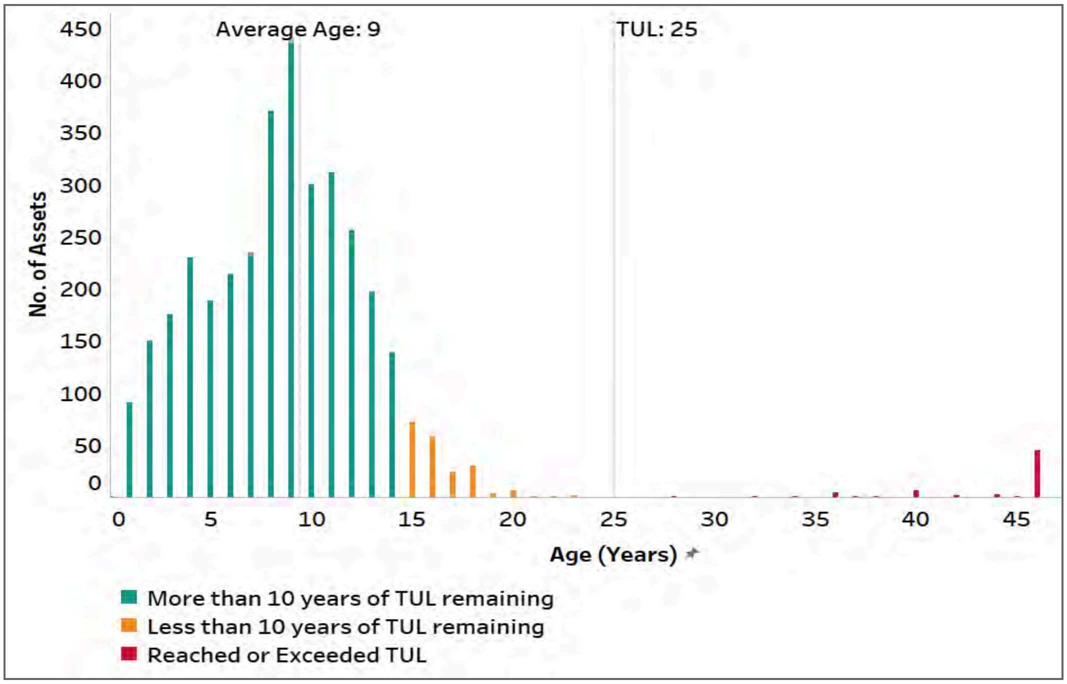
7.1.2.3. Overhead Distribution Switches and Reclosers

Hydro Ottawa's distribution overhead switch and recloser asset class consists of all overhead load break switches, reclosers, fuse cut-outs and inline switches, with a primary voltage rating up to and including 44kV. In general, the purpose of this asset class is to isolate faulted sections of Hydro Ottawa's distribution system, minimize the impact to customers, isolate sections of Hydro Ottawa's distribution system to enable work to proceed while affecting the smallest part of the distribution system possible, isolate customers through requests, and provides backup supply from other feeder(s).

Hydro Ottawa has numerous types of overhead switches with different functionality dependent on the required application. Hydro Ottawa owns 3,583 distribution overhead switches throughout the service territory.

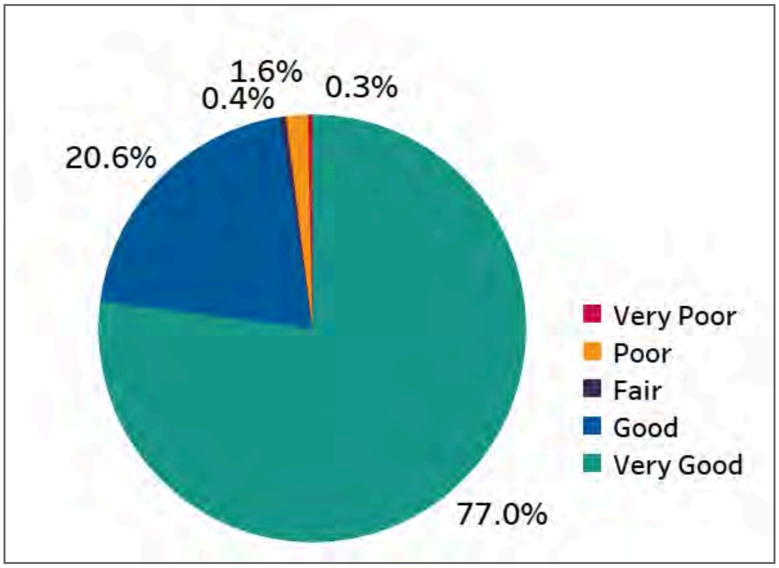
The average age of Hydro Ottawa's overhead load break/gang operated switches with a known age is 9 years; Figure 49 illustrates the population demographics for this asset class. The TUL of overhead load break/gang operated switches is 25 years.

Figure 49 - Overhead Switch Age Demographics



The health index for overhead complex switches is largely based on age and the results from thermographic scans. A complex switch is typically a 3-phase gang-operated device that is capable of interrupting load. Other criteria include the condition of insulators, solid blades, and operating mechanism. A summary of known Hydro Ottawa's overhead switch conditions is shown in Figure 50.

Figure 50 - Overhead Switch Condition Demographics



7.1.3. Underground Assets

Hydro Ottawa underground assets are integral for the distribution of electricity. The underground system consists of distribution assets and their respective supporting civil structures that enable delivery of energy to areas where the feasibility of the overhead system is reduced or where it is preferential to have improved aesthetics. Underground assets are broken into the following categories:

- Distribution cables (PILC, polymer)
- Underground transformers
- Underground switchgear
- Vault transformers
- Underground civil structures

Figure 51 and Figure 52 show the age and condition demographic projections of underground distribution assets into 2040, without any intervention, as obtained through Copperleaf PA. It can be seen that approximately 37% of the underground assets will reach the TUL by 2030, with the proportion increasing to slightly more than half (52%) by 2040. On the condition front, approximately 14% of the asset population will reach a Very Poor/Poor condition by 2035 and increase to slightly more than one-fourth (27%) by 2040.

Figure 51 - Underground Asset Age Demographic Projections

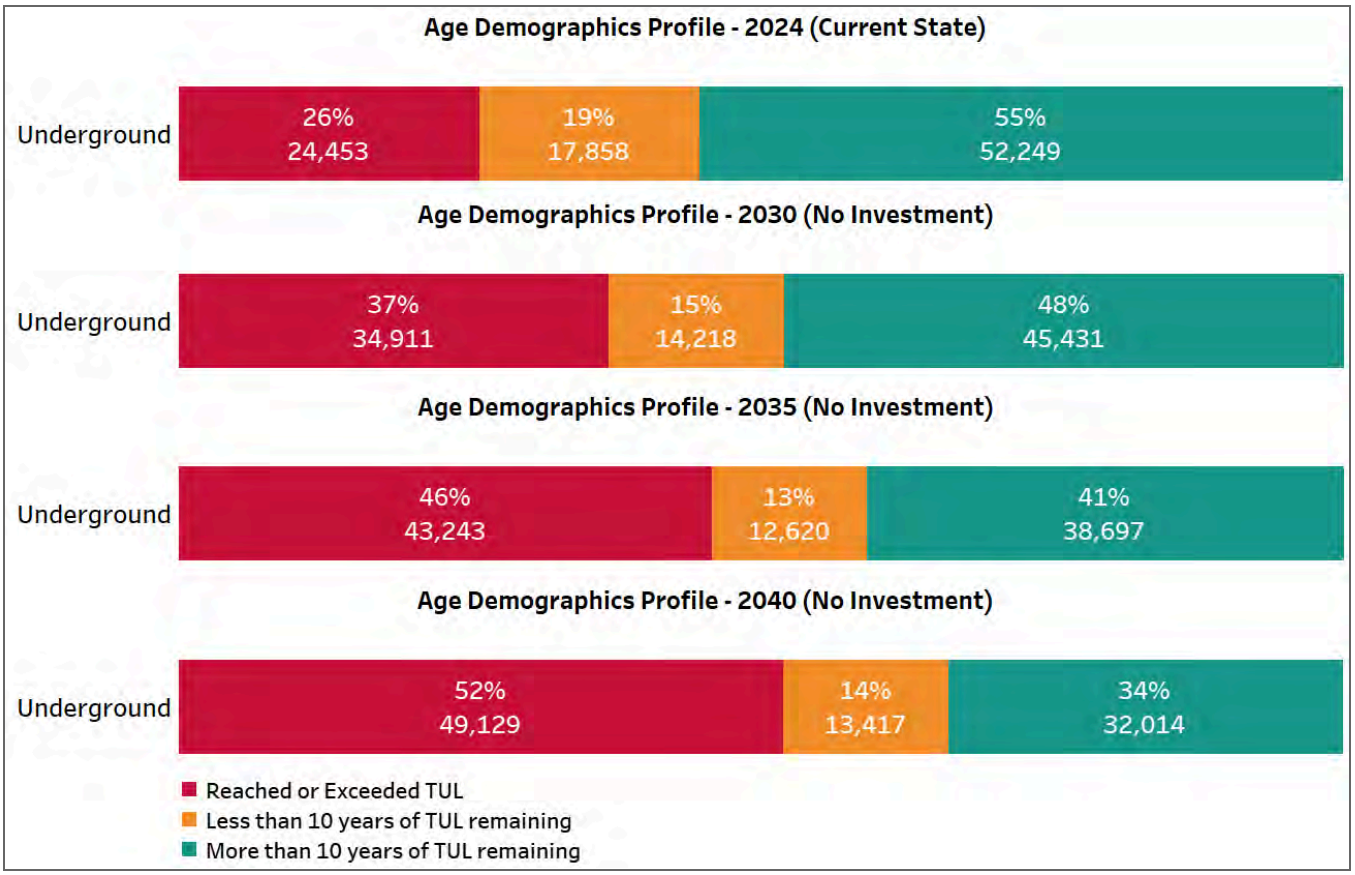
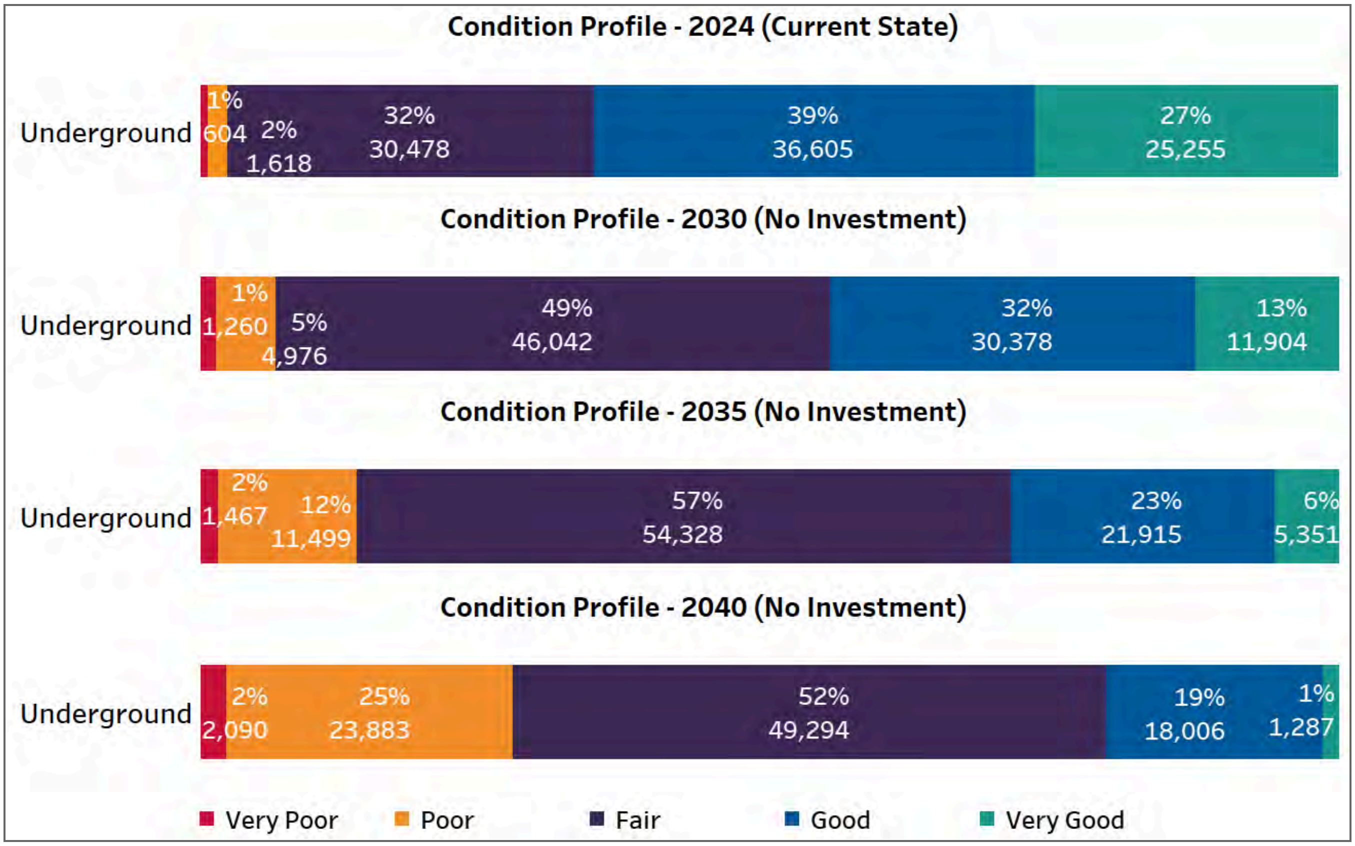


Figure 52 - Underground Asset Condition Demographic Projections



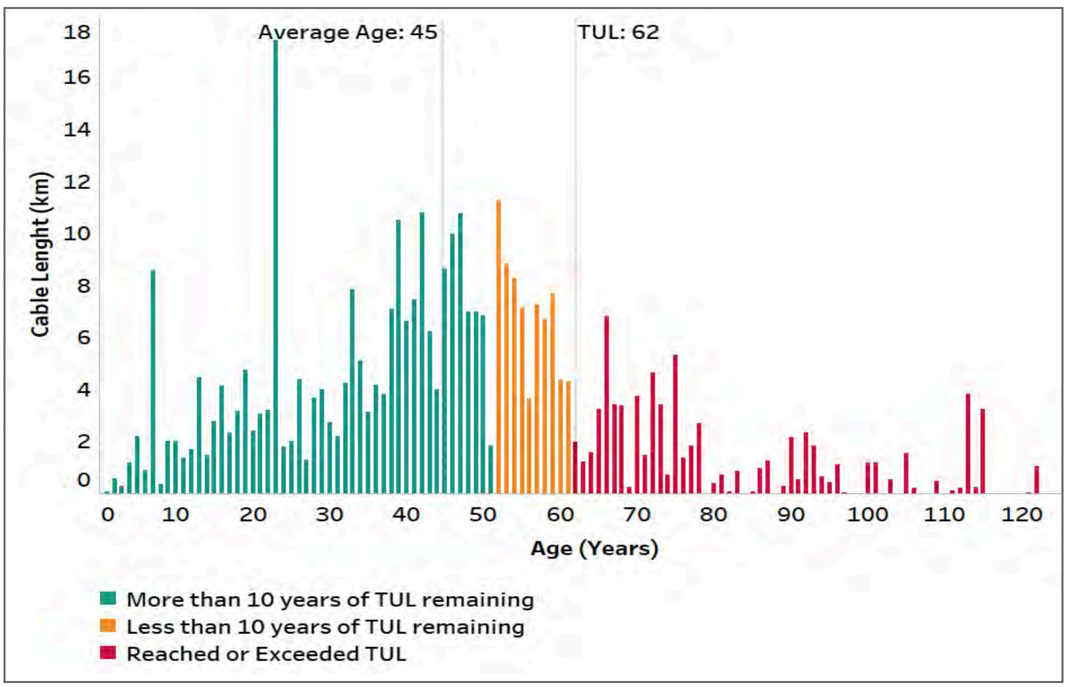
Hydro Ottawa utilized Copperleaf PA to gain a deeper understanding of potential future degradation patterns. This information was used to develop an appropriate, balanced asset renewal investment plan for 2026-2030. Based on these findings, Hydro Ottawa has proposed an increase in underground asset renewal spending from the 2021-2025 period. This increase aims to manage asset performance while maintaining affordability for customers. More details regarding Hydro Ottawa's system renewal plan for underground distribution assets are outlined in Section 4 of Schedule 2-5-7 - System Renewal Investments.

7.1.3.1. Distribution Cables (PILC)

Hydro Ottawa owns and operates 7,419 segments of triple conductor Paper Insulated Lead Cable (PILC). It was primarily installed in the Core of Ottawa on the 13kV system and is some of the oldest cables in the service territory. Due to higher material costs, increasing procurement lead times, and the need for specialized trades, Hydro Ottawa is moving to phase out this type of cable with polymer insulated cable.

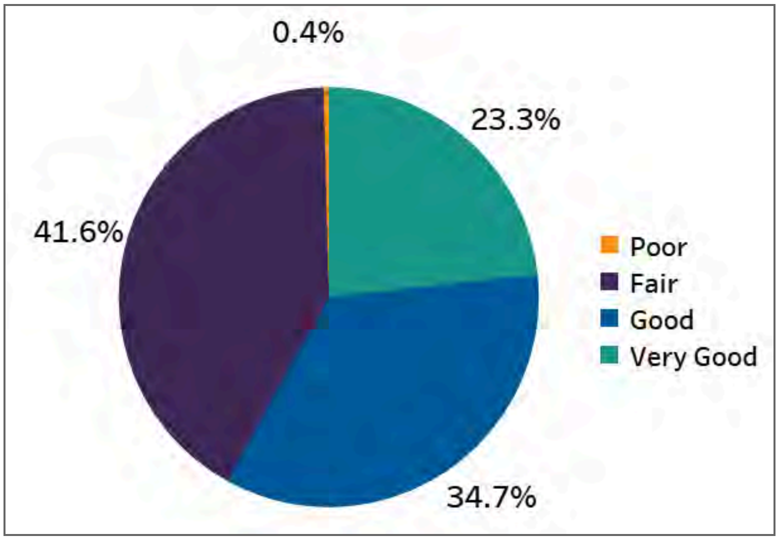
The average age of Hydro Ottawa's PILC cable is 45 years; Figure 53 illustrates the population demographics. The TUL of PILC cables is 62 years.

Figure 53 - PILC Cable Age Demographics



The health index for PILC cables is based on a combination of age, loading history and failure rate. A summary of Hydro Ottawa's distribution PILC cable conditions is shown in Figure 54.

Figure 54 - Distribution Cable (PILC) Condition Demographics



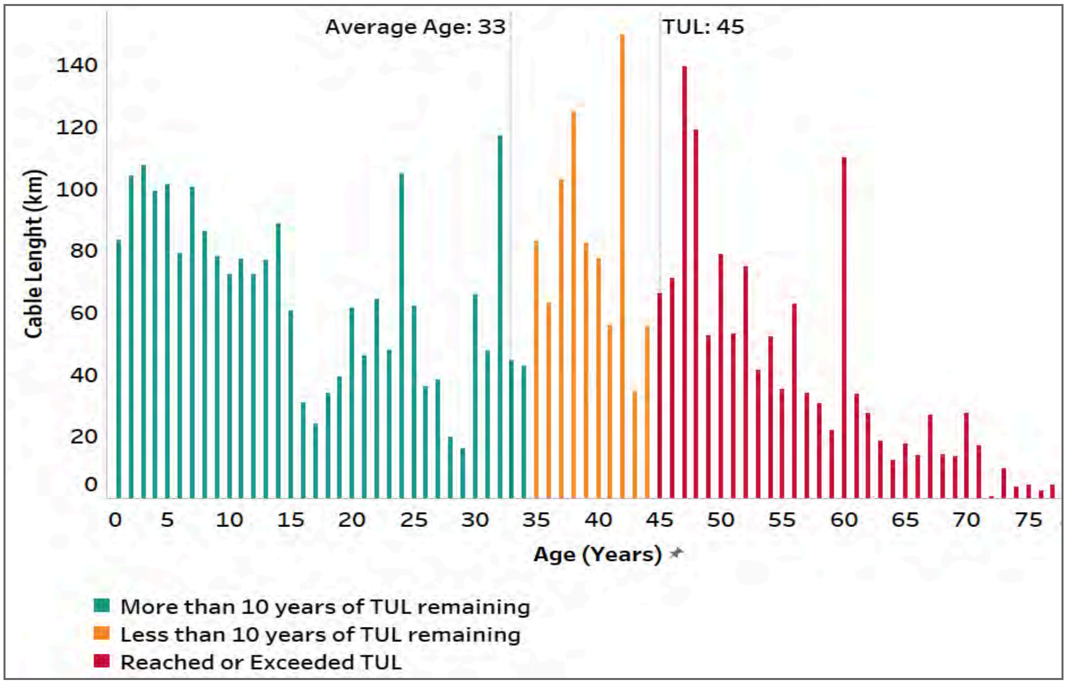
7.1.3.2. Distribution Cables (Polymer)

Hydro Ottawa owns and operates 59,101 segments of single conductor polymer cable (Cross-Linked Polyethylene (XLPE), Ethylene Propylene Rubber (EPR) and Butyl Rubber). The installation of this cable uses a mix of concrete-encased duct, direct-buried duct, and direct-buried cable that can add to the cost and labour requirements when replacing under planned and unplanned events.

The vast majority of the underground polymer cable is XLPE. EPR makes up a small portion of underground cables and has only recently been introduced as a replacement for PILC as it is phased out. For this reason, the condition assessment of underground polymer cable is focused on testing of XLPE cable.

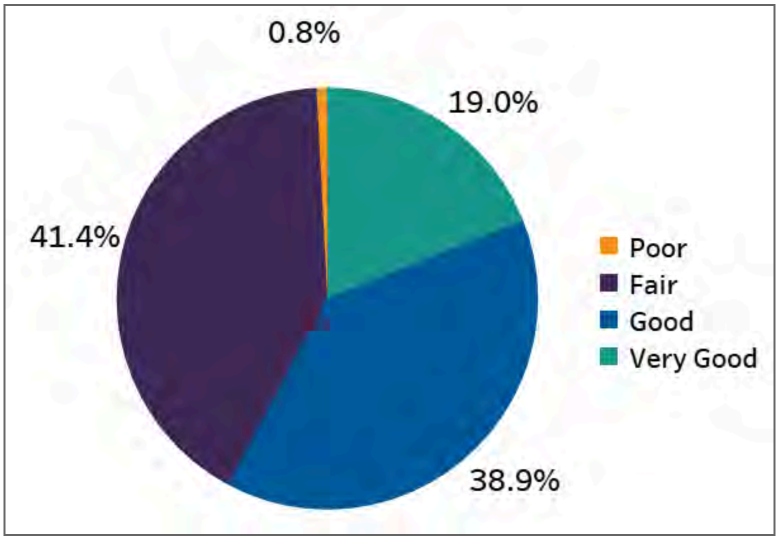
The average age of this asset class is 33 years; Figure 55 illustrates the population demographics. The TUL of XLPE cables is 45 years.

Figure 55 - Distribution Cable (XLPE) Age Demographics



The health index for XLPE cables is based on a combination of age, loading history and failure rate. A summary of Hydro Ottawa's distribution XLPE cable condition is shown in Figure 56.

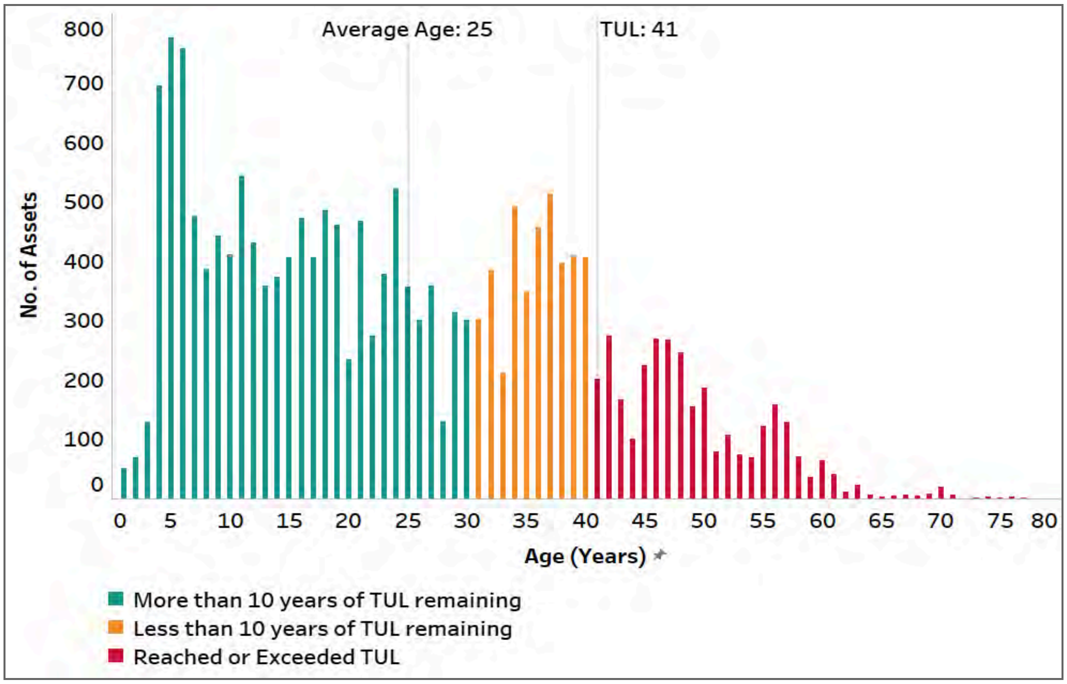
Figure 56 - Distribution XLPE Cable Condition Demographics



7.1.3.3. Underground Transformers

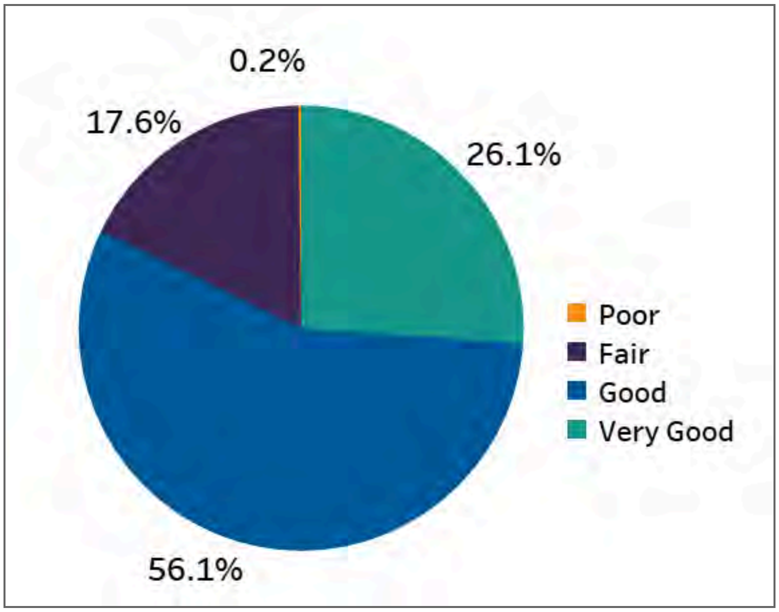
Hydro Ottawa owns and operates 18,875 underground transformers. These are installed in both the front and rear lot to service Hydro Ottawa customers. The average age of this asset class is 25 years. Figure 57 illustrates the population demographics. The TUL of underground transformers is 41 years.

Figure 57 - Distribution Underground Transformers Age Demographics



The health index for underground transformers is largely based on the visual and thermographic inspections. Other factors that influence the health index are the age, loading, and condition of the civil structure. A summary of known Hydro Ottawa's underground transformer conditions is shown in Figure 58.

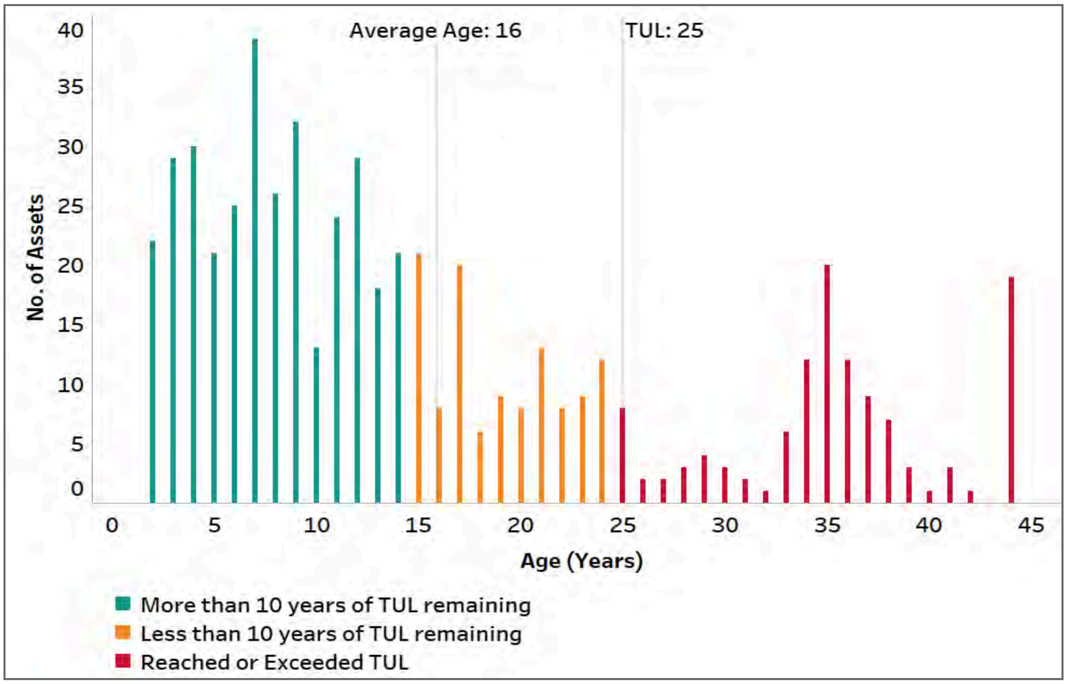
Figure 58 - Underground Transformer Condition Demographics



7.1.3.4. Underground Switchgear

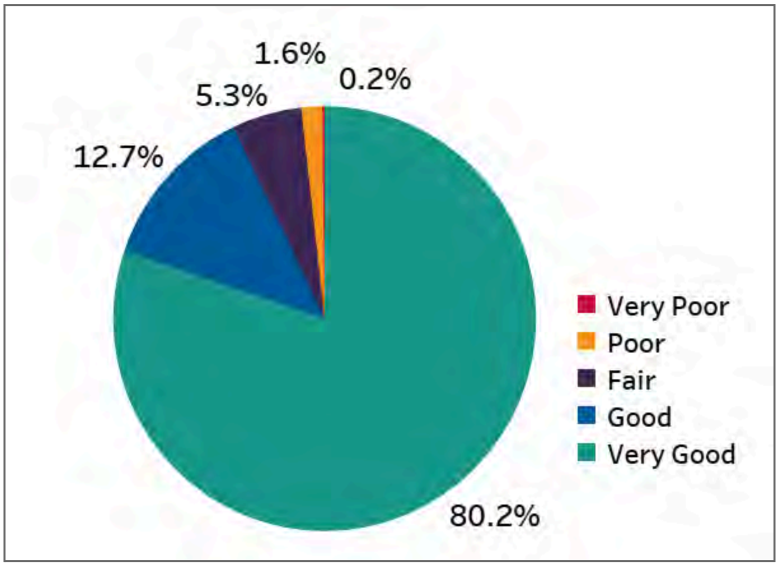
Hydro Ottawa owns and operates 561 underground switchgear units. There are many different configurations and types of switchgear in service due to the amalgamation of the former utilities and their varying policies for servicing customers. The average age of this asset class is 16 years. Figure 59 illustrates the population demographics. The TUL of underground switchgear is 25 years.

Figure 59 - Underground Switchgear Age Demographics



The health index for underground switchgear is largely based on age and the results from visual and thermographic inspections. A summary of known Hydro Ottawa's underground switchgear conditions is shown in Figure 60.

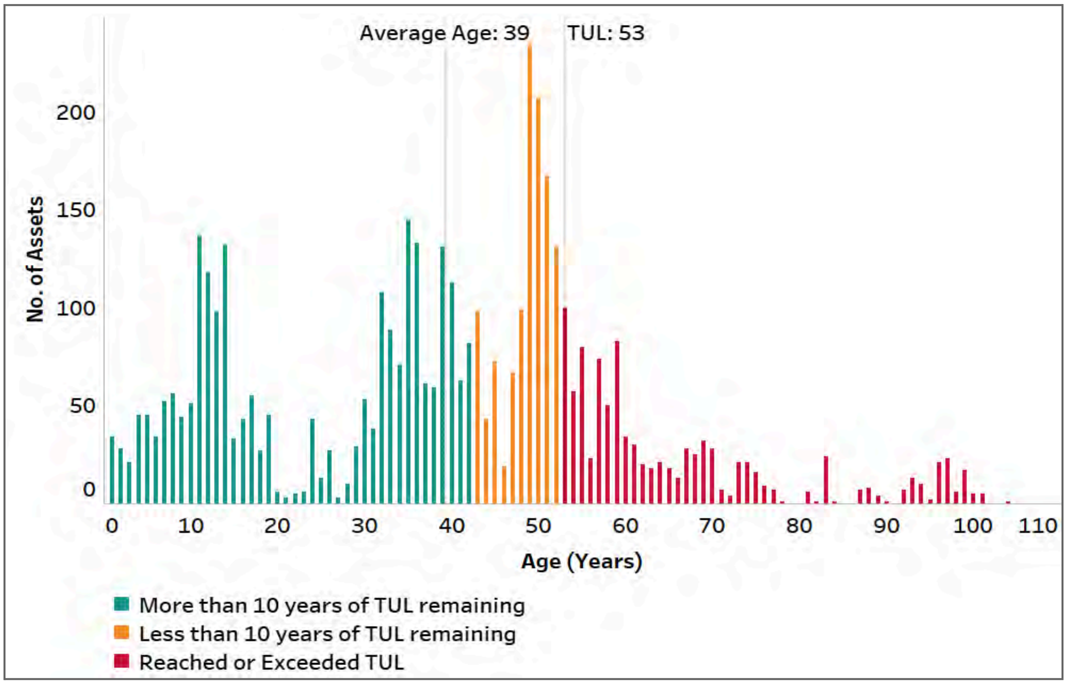
Figure 60 - Underground Switchgear Condition Demographics



7.1.3.5. Vault Transformers

Hydro Ottawa's vault transformers are located in building vaults and typically service a single large customer. Currently Hydro Ottawa owns 4,511 vault transformers. The average age of this asset class is 39 years. Figure 61 illustrates the population demographics. The TUL of vault transformers is 53 years.

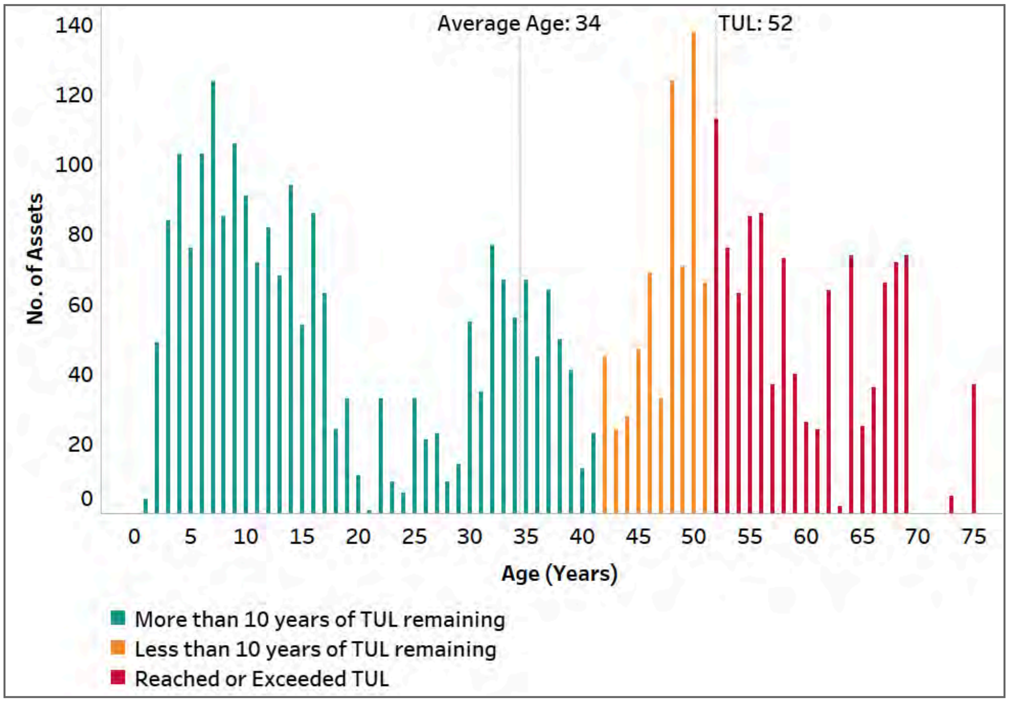
Figure 61 - Vault Transformer Age Demographics



7.1.3.6. Underground Civil Structures

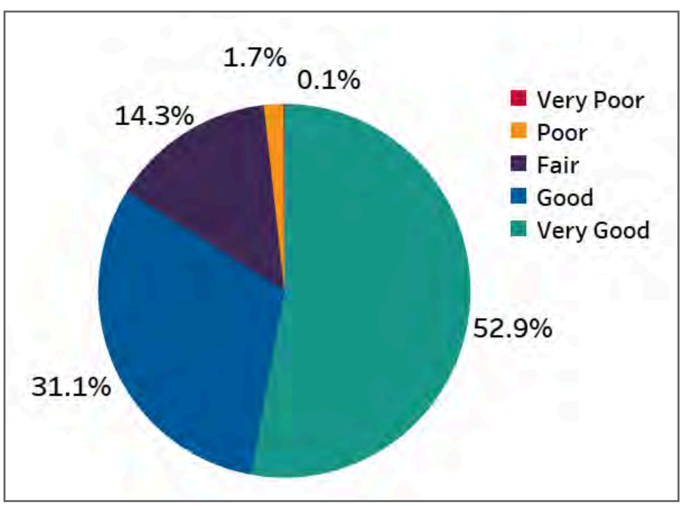
Hydro Ottawa's Underground Civil Structure asset class consists of duct banks, hand holes, and cable chambers forming a network through which cables may be installed. Distribution underground civil structures are used in areas where underground wiring is required, which allows for ease of access and protection of electrical equipment. Currently, Hydro Ottawa owns 3,904 cable chambers. The average age of this asset class is 34 years. Figure 62 illustrates the population demographics. The TUL of cable chambers is 52 years.

Figure 62 - Cable Chamber Age Demographics



The health index for cable chambers is primarily based on visual inspections. A summary of known Hydro Ottawa's cable chamber conditions is shown in Figure 63.

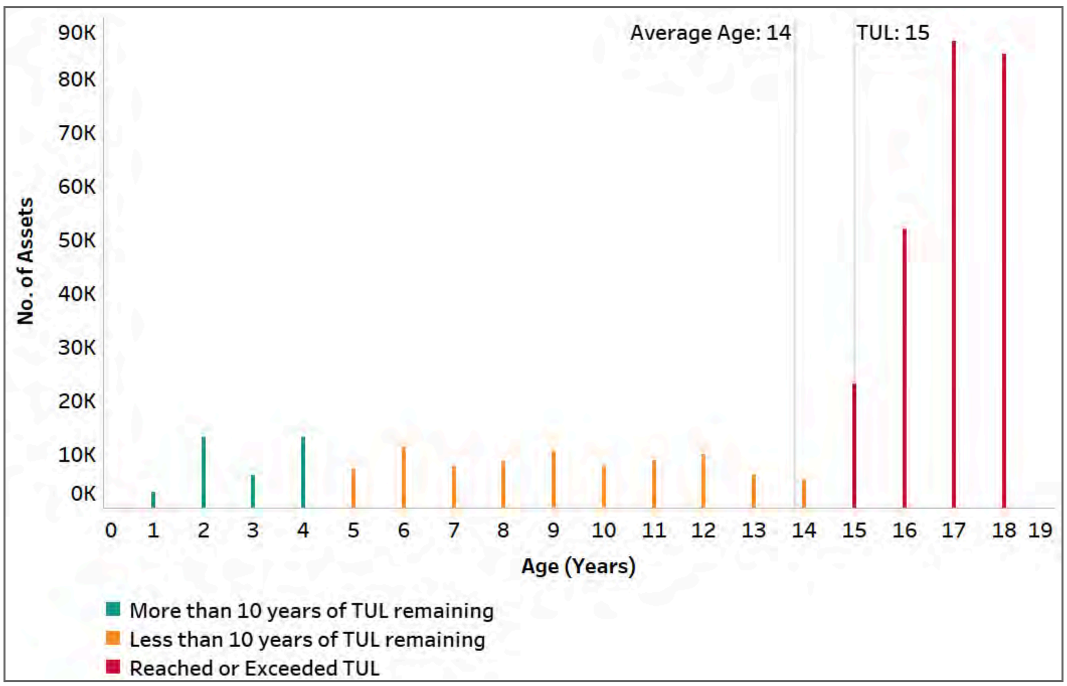
Figure 63 - Cable Chamber Condition Demographics



7.1.4. Metering Assets

Hydro Ottawa's metering asset class consists of residential meters, small commercial meters, and interval meters, all of which are essential for accurate customer billing, settlement with the IESO, and effective grid operations. Currently, Hydro Ottawa owns 366,212 meters. The average age of this asset class is 14 years; Figure 64 illustrates the population demographics. The TUL of a meter is 15 years.

Figure 64 - Current Age Demographics Profile of Residential and Small Commercial Meters



7.2. ASSET FAILURES AND PERFORMANCE

Asset performance metrics can be found in Section 3.3 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Schedule 2-5-3 also contains a summary of asset failures that caused customer interruptions as outlined in Section 4.5.6 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement.

7.3. ASSET RISK PROFILES

Hydro Ottawa utilized the PA module as the primary means for establishing risk at an individual asset level, rolled up to the asset class/system level. Key risk measures tied to reliability impact, safety implications, environmental considerations, financial aspect, and compliance have been considered in determining individual asset risk profiles. While all risk measures have been weighted equally in the PA model, reliability risk was found to be the major contributor, given its wide applicability across all asset types and data availability around asset failure modes and the related customer impact. More information regarding Hydro Ottawa's risk assessment process is outlined in Section 5.1.4 - Asset Risk Assessment.

Figure 65 shows the overall baseline reliability risk profile carried by Hydro Ottawa's asset systems in 2024, with the breakdown of the reliability risks associated with individual assets considered in the PA model shown in Figure 66.

Figure 65 - 2024 Baseline Reliability Risk Profile by Asset System

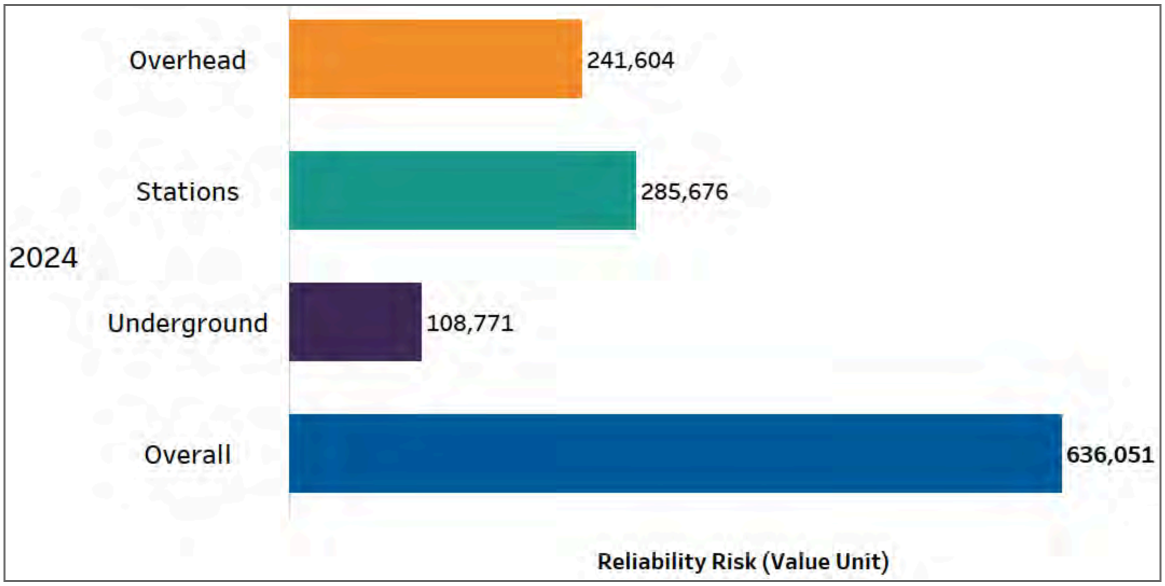
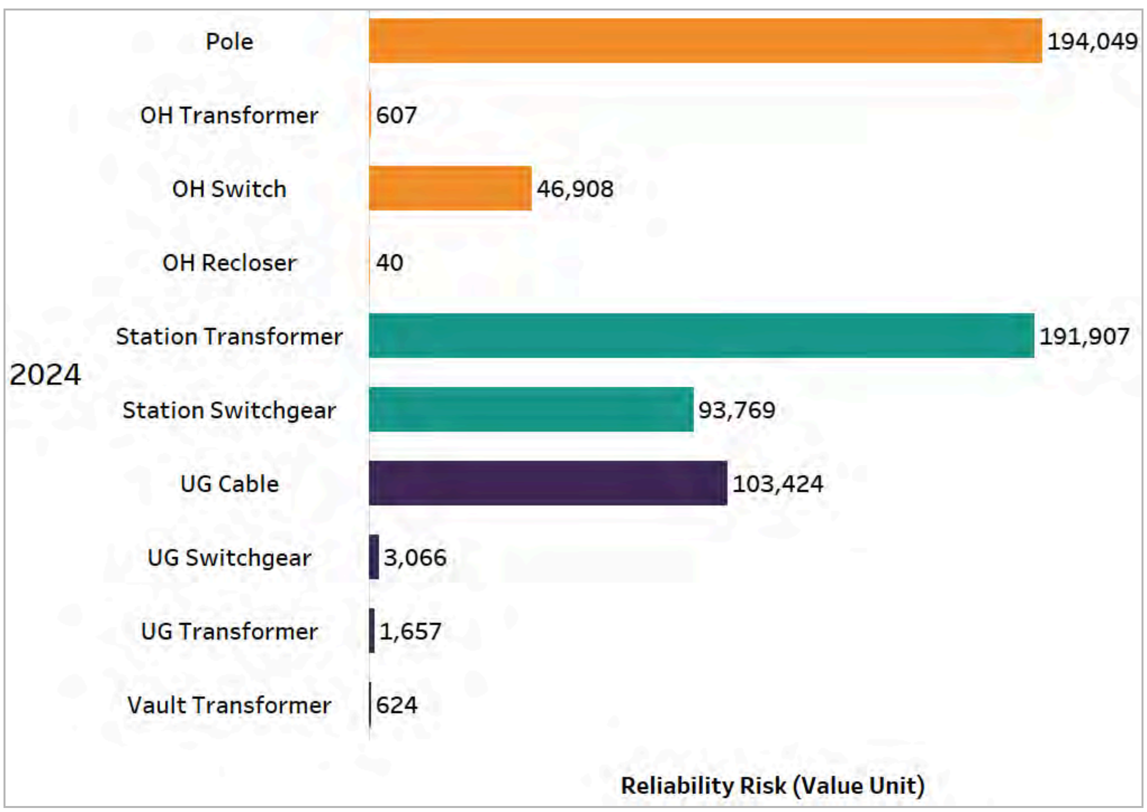


Figure 66 - 2024 Baseline Reliability Risk Profile by Individual Assets



7.4. SYSTEM UTILIZATION

Hydro Ottawa is facing a challenge in maintaining reliable power distribution while accommodating future load growth in some supply regions in its service territory. The current infrastructure is under strain, with eight stations already operating beyond their planned capacity limits (100%+ category in Figure 67) and an additional three stations approaching those thresholds (95%-100% category), as illustrated in Figure 67 and listed by planning region in Table 24. This situation highlights critical capacity constraints within the power distribution system.

Figure 67 - Stations by Planning Rating Thresholds

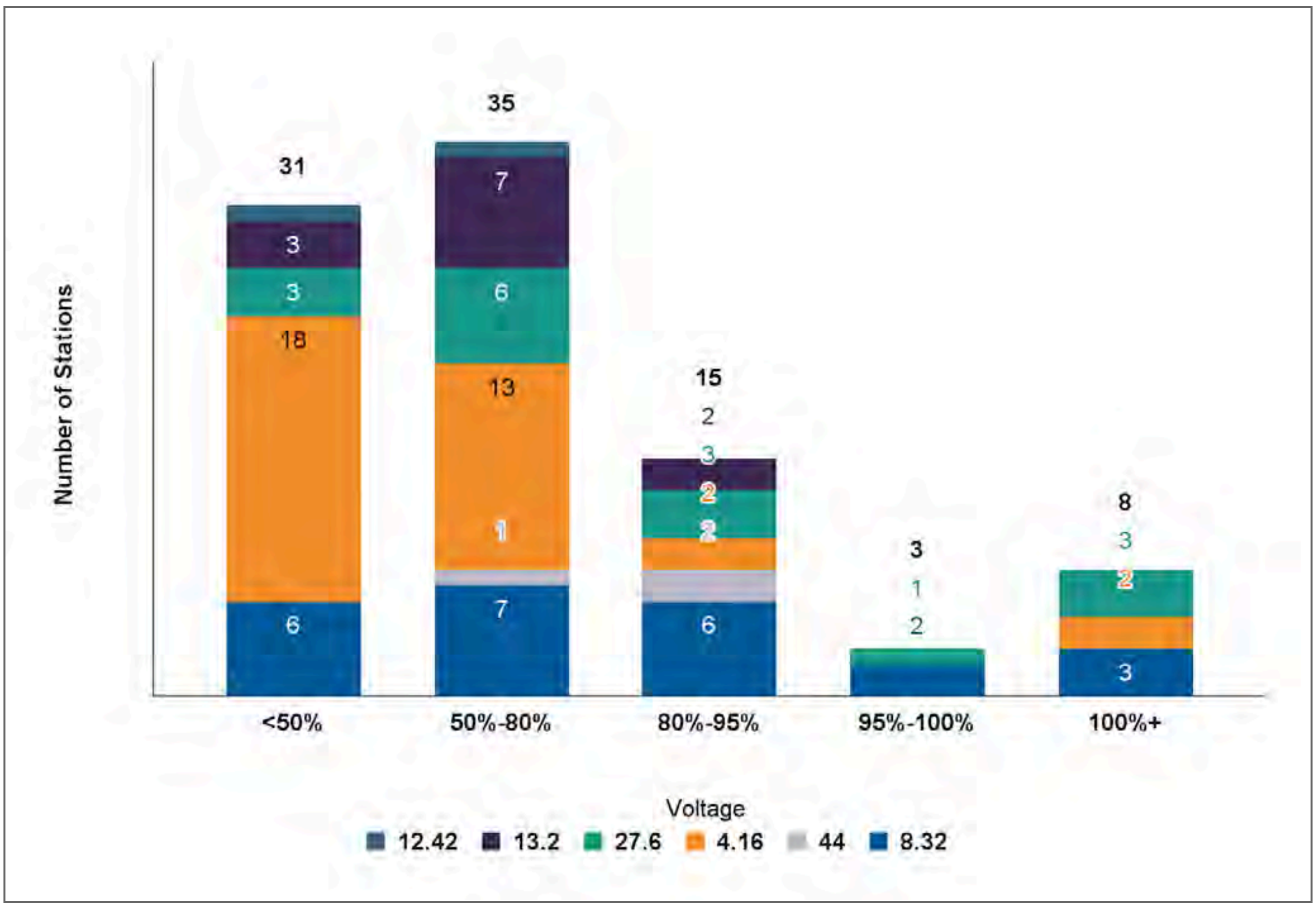


Table 24 - Stations Approaching or Above Planning Thresholds

Planning Threshold	Station	Planning Region
95%-100%	Stafford Road DS	Bells Corners/Bayshore 8 kV
95%-100%	Jockvale DS	Barrhaven 8 kV
95%-100%	Kanata MTS	West 28 kV (North)
100%+	Centrepointe MTS	Nepean 8 kV
100%+	Manordale MTS	Nepean 8 kV
100%+	Leitrim DS	South East 28 kV
100%+	Church DS	East 4 kV
100%+	Richmond North DS	West 8 kV
100%+	Vaughan DS	East 4 kV
100%+	Fallowfield MTS	South 28 kV
100%+	Marchwood MTS	West 28 kV (North)

Operating stations above their planning rating capacity has several detrimental effects on the overall system. Primarily, it significantly reduces the system's flexibility to effectively manage both planned maintenance and operational activities, as well as respond to unforeseen disruptions or abnormal system states, such as equipment failures, power surges, or extreme weather events.

This lack of flexibility can lead to cascading failures, where a problem at one station can quickly propagate to others due to the limited capacity to reroute power or isolate affected areas. This can result in widespread power outages, service disruptions, and potential damage to equipment.

Furthermore, operating stations beyond their intended capacity can accelerate equipment wear and tear, leading to more frequent maintenance requirements and a shorter overall lifespan. This can increase operational costs and further strain the system's ability to meet future load demands.

Hydro Ottawa must take proactive measures to address these capacity issues and ensure the long-term reliability and resilience of the power distribution system. This may involve a combination of strategies, such as upgrading existing stations, building new infrastructure, implementing demand-side management programs, and exploring innovative technologies to optimize system performance and accommodate future load growth.

Hydro Ottawa monitors utilization of assets through KPIs such as SLI and FLI detailed in Section 8.4 - Asset Utilization Policies and Practices.

Hydro Ottawa aims to ensure the stability, efficiency, and sustainability of Hydro Ottawa's distribution system by relying on several key strategies focused on system utilization, such as Load Forecasting and Capacity Planning, Renewable Energy Integration, NWSs, Demand Side Management and Energy Efficiency Programs, see more details in Section 9 - System Capacity Assessment and Grid Modernization Technologies as described in Section 3.4.2 - Grid Modernization Strategy.

8. ASSET LIFECYCLE OPTIMIZATION POLICIES AND PRACTICES

Hydro Ottawa is committed to providing a sustainable and dependable electricity service by optimizing asset lifecycles and ensuring reliability and cost-effectiveness through informed asset management practices. This is achieved by balancing maintenance, renewal, and replacement strategies and includes establishing TUL values; implementing asset replacement and refurbishment policies; conducting testing, inspection, and maintenance programs; and monitoring asset utilization.

The TUL of assets is determined through a robust process involving failure curve analyses and industry benchmarking. This ensures informed decisions about asset renewal and replacement, preventing premature retirement or extended use beyond safe operational lifespans. Corrective actions for assets include repair, refurbishment, or replacement, based on a case-by-case analysis considering factors like age, condition, maintenance history, new standards, and spare parts availability. Hydro Ottawa proactively replaces end-of-life assets and those posing immediate risks through the System Renewal program, while also evaluating opportunities for efficiencies during replacements.

Hydro Ottawa also employs various inspection techniques, including non-destructive testing and preventative maintenance, to assess asset performance and condition. The frequency and nature of these activities vary based on the asset type and are important to ensure the continued reliable operation of low-risk assets in a deteriorated condition (through relevant corrective maintenance). Corrective maintenance addresses minor issues and unforeseen failures to ensure grid reliability.

KPIs such as the SLI and FLI, are monitored to ensure efficient asset utilization and identify areas for improvement. This involves tracking station capacity and feeder capacity to prevent overloads, minimize downtime, and optimize resource allocation.

The following sub-sections highlight Hydro Ottawa’s asset lifecycle optimization policies and practices in detail.

8.1. ASSET TYPICAL USEFUL LIFE

Hydro Ottawa partnered with Hatch to enhance asset failure curve knowledge and insights, aiming to refine the utility's risk- and value-based asset management framework. In addition to the primary goal of enhancing Hydro Ottawa's understanding of asset failure and degradation patterns (failure curve intelligence), this project also yielded crucial insights into the typical lifespans of various asset types. These recommended TUL values were not determined arbitrarily, but rather through a rigorous process that involved aligning the results from the failure curve simulation model with the maturity and reliability of the input data used, as well as drawing upon extensive industry experience and established benchmarks. Refer to Section 4.4.4 - Failure Curves and Update for details on this process.

The ability to establish these updated and empirically-grounded TUL values for the diverse range of asset types within Hydro Ottawa's infrastructure represents a significant achievement. These values provide a solid and defensible basis for making informed asset renewal and replacement decisions, ensuring that assets are not prematurely retired, leading to unnecessary capital expenditure, nor kept in service beyond their safe and reliable operational lifespan, which could increase the risk of failures and service disruptions.

Hydro Ottawa has categorized its assets into three groups based on their remaining TUL to facilitate asset renewal planning:

- **Assets with over 10 years of TUL remaining:** These assets are stable and don't need immediate action. They are routinely monitored through maintenance and inspections.
- **Assets with less than 10 years of TUL remaining:** These assets are not at the end of their lifespan but will need attention and possible replacement or refurbishment within 10 years.
- **Assets that have reached or exceeded their TUL:** These assets pose the highest risk of failure and are prioritized for immediate or short-term replacement or refurbishment.

A detailed report on the asset failure curve analysis and TUL determination is available in Attachment 2-5-4(D) - Failure Curves Review.

Table 25 shows a summary between the old and new TUL values for the various asset types considered as a part of the study. The suitability of the new TUL values were confirmed through a workshop between Hydro Ottawa and Hatch Subject Matter Experts. Factors such as the convergence of the failure curve simulation model, maturity of input data and industry experience were considered in finalizing the new TUL values, thereby making the new proposed changes more robust.

Table 25 - Summary of Typical Useful Life Values

Asset Type	Old Typical Useful Life (in years)	New Typical Useful Life (in years)
Station Transformers	55	55
Station Switchgear	42 (Air), 55 (Oil), 46 (Vacuum) and 51 (SF_6)	42 (Air), 55 (Oil), 46 (Vacuum) and 51 (SF6), 45 (HV SF_6)[27]
UG Switchgear	25 (Air) and 25 (SF_6)	25 (Air) and 25 (SF_6)
UG Transformers	53	41
OH Transformers	53	53
Vault Transformers	53	53
Vault Switchgear	25 (Air) and 25 (SF_6)	25 (Air) and 25 (SF_6)
OH Switches	25 (Manual) and 25 (SCADAmate)	25 (Manual) and 25 (SCADAmate)
Poles, Towers, Fixtures (Wood)	53	53
UG Polymer Cable	45 (XLPE and EPR)	45 (XLPE and EPR)
UG PILC Cable	62	62
Cable Chambers	52	54
Station Batteries	15 (VRLA batteries) and 25 (VLA batteries)	15 (VRLA batteries),17 (VLA batteries)
SCADA RTU, Relays and Communication Equipment	40 (Electromechanical relays), 15 (Electronic relays) and 25 (Microprocessor relays)	40 (Electromechanical relays), 30 (Electronic relays), 25 (Microprocessor relays)

8.2. ASSET REPLACEMENT & REFURBISHMENT POLICIES

Assets identified as needing corrective action (through periodic maintenance, field inspections, patrols, etc.) are evaluated to determine whether the asset should be repaired, refurbished, or replaced. Factors such as the age, condition, maintenance history, new standards, and availability of spare parts all influence the decision of whether or not to refurbish, repair, or replace the asset.

[27] Historically, HV SF6 was grouped within “SF6” with a TUL of 51.

Specific to asset replacements, Hydro Ottawa proactively replaces end-of-life assets in a deteriorated condition, as a part of the system renewal program outlined in Schedule 2-5-7 - System Renewal Investments. To determine the asset renewal needs, Hydro Ottawa uses PA to calculate the risk posed by individual assets. PA is also capable of predicting the degradation pattern, probability of failure, and progression of risk over time for each individual asset in Hydro Ottawa's service territory. This allows Hydro Ottawa to follow a risk-based asset replacement/intervention strategy. More details on Hydro Ottawa's asset risk assessment framework that drives system renewal investment planning can be found in Section 5.1.4 - Asset Risk Assessment.

Apart from this, assets which pose an immediate or imminent risk to the asset management objectives are repaired under maintenance or replaced under corrective renewal. These assets are identified immediately based on visual inspections or periodic maintenance and also based on recommendations by PA on low-risk assets in a deteriorated condition. Hydro Ottawa has a budget allocated for corrective renewal, outlined in Section 6 of Schedule 2-5-7 - System Renewal Investments. Repair and refurbishment activities are covered under the reactive maintenance budget and typically undertaken on asset sub-components, which if unaddressed may lead to a catastrophic failure.

Hydro Ottawa has also defined the criteria which determine corrective renewal for each individual asset class in order to determine the relevant budget program and timeline. An example for station transformers is provided in Table 26. Specifics on the emergency and critical renewal criteria for all asset classes are provided in Section 6 of Schedule 2-5-7 - System Renewal Investments.

Table 26 - Station Transformer Corrective Renewal Criteria

Emergency Renewal (Immediate Risk)	Critical Renewal (Imminent Risk)
Internal fault	Tap-changer failure
Bushing failure	Heavy gassing
Tank rupture (loss of oil)	Overheated bushing (found with IR scan)
Major issue found during maintenance	High furan level
Health index of 0%	Significant issues found in testing
	Insufficient health index (very poor / < 30%)

In addition to individual intervention assessments, each asset identified for replacement is evaluated for opportunities for efficiencies by assessing the condition of the other assets in proximity that may need to be replaced concurrently, evaluating future growth and demand, and determining if decommissioning is an option.

Repair actions are corrective interventions that involve the replacement of a minor component which can be obtained from stock materials or through manufacturer sourcing.

Refurbishment is expected to renew the asset and extend the TUL. These actions are also used to defer the need for replacement to a time where efficiencies can be found by replacing other assets at the same time. Typically, station assets, such as transformers and breakers, have been more economical to refurbish than overhead and underground assets. The refurbishment/repair actions are undertaken through targeted maintenance programs as detailed in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

To maintain overall system reliability and mitigate the related risks (safety, reliability, environmental, financial, and compliance), Hydro Ottawa uses a strategic, forward-looking approach that includes levelized spending and data-driven system renewal investment planning. The asset renewal strategy is designed to manage and mitigate asset risks by strategically replacing deteriorating infrastructure, not simply replacing all aged or deteriorated assets. Hydro Ottawa's proposed 2026-2030 System

Renewal investment plan does not aim to replace all degraded assets. Instead, it prioritizes replacement based on PA assessments, while balancing cost, resourcing and material availability, and short- and long-term risk. This comprehensive assessment emphasizes that Hydro Ottawa is making strategic choices about which assets to replace and at what rate, rather than simply replacing everything that is degraded. Specific details of each renewal program are outlined in Schedule 2-5-7 - System Renewal Investments.

8.3. TESTING, INSPECTION & MAINTENANCE PROGRAMS

To optimize the asset lifecycle and manage risk, Hydro Ottawa uses various programs and activities to evaluate the performance and condition of its assets. The practices used to assess risk include non-destructive testing and predictive and preventative maintenance, which help to drive corrective maintenance and capital investments.

Most of Hydro Ottawa's asset maintenance activities are performed on a predetermined periodic schedule. The cycle period is selected based on various factors such as asset age, equipment usage, equipment type, and typical operating life, to address manufacturers' recommendations, regulatory requirements in the DSC, and/or internal experience and standards. Table 27 outlines the inspection and maintenance cycles of each program.

Table 27 - Hydro Ottawa's Maintenance Programs

Asset	Activity Type	Cycle	Type
Stations	Station Inspections	Monthly	Predictive
	Thermographic Scans	Annually	Predictive
	Transformer Inspection	Annually	Predictive
	Transformer Oil Analysis	Annually	Predictive
	Transformer Maintenance	Every 3-5 Years	Preventative
	Transformer Tap Changer Maintenance	Every 1-8 Years	Preventative
	Switchgear and Breaker Inspection	Annually	Predictive
	Switchgear and Breaker Maintenance	Every 4-6 Years	Preventative
	Battery Testing	Annually	Predictive
	Relay Maintenance	Every 4-6 Years	Preventative
Underground	Underground Switchgear Thermographic and Visual	Every 3 Years	Predictive
	Underground Distribution Transformer Thermographic and Visual	Every 3 Years	Predictive
	Vault Inspections	Every 3 to 6 Years	Predictive
	Underground Switchgear CO2 Washing	Every 3 Years	Preventative
	XLPE/TRXLPE Cable Testing	200 Segments Annually	Predictive
	Cable Chamber Inspections	Every 10 Years	Predictive
Overhead	Overhead Visual and Thermographic Inspection	Every 3 Years	Predictive
	Vegetation Management	Every 2 to 3 Years	Preventative
	Pole Inspection	Every 10 Years	Predictive
	Critical Switch Inspection	Every 8 Years	Preventative
	Insulator Washing	Bi-Annual	Preventative

Aside from the preventative and predictive maintenance programs, Hydro Ottawa also tackles any repairs to the asset population through corrective maintenance. The repairs are performed to address minor issues that do not indicate that an asset has reached its TUL. This determination is made through a thorough inspection process, which includes both visual and detailed assessments/electrical testing, as shown in Table 27. The corrective maintenance activities might include tasks such as repairing, replacing, or refurbishing underlying asset components. Hydro Ottawa also carries out corrective maintenance to address unforeseen issues and failures in electrical assets, ensuring the continued reliability of the electrical grid.

Hydro Ottawa's electrical assets (especially in stations) require significant capital investments through 2026-2030 in renewals to maintain reliability (from a condition and risk perspective), based on the risk assessment process outlined in Section 5.1.4 - Asset Risk Assessment using Copperleaf PA. A significant level of investment is necessary to intervene on all deteriorated station and distribution assets, as outlined in Section 2.3.2 of Schedule 2-5-1 - Distribution System Plan Overview, Table 3. Hydro Ottawa selected the proposed alternatives to ensure that resourcing, material availability, customer affordability, and risk mitigation were properly considered and balanced in the decision, however in some cases, Hydro Ottawa is only able to balance short-term risk as a result of the selected alternative.

In response, Hydro Ottawa has planned increases in the frequency of testing, inspection, and maintenance activities for some asset classes where the planned replacement rate is not high enough to keep up with the pace that assets reach their TUL. Hydro Ottawa has also expanded the data collected through the inspection and maintenance programs to collect more comprehensive condition information. This approach allows Hydro Ottawa to gather additional condition information on deteriorating asset infrastructure and manage it accordingly. To this end, Hydro Ottawa proposes to increase investments in maintenance programs through 2026-2030 to mitigate failure risk of assets not immediately slated for replacement. Further details are outlined in Schedule 4-1-2 - Operation, Maintenance and Administration Program Costs. This strategic investment in maintenance programs supports a balanced approach to long-term asset performance.

Updates to the station maintenance program will include support for voltage conversion of 4kV station assets, and improved transformer maintenance (through targeted insulator washing, advanced diagnostic testing and ensuring the operational performance of online dissolved gas analysis (DGA) monitors). In addition, Hydro Ottawa will introduce advanced inspection technologies, such as drones, to gather more precise data on OH distribution assets. This will enable targeted maintenance and improve asset health assessments. Finally, Hydro Ottawa will focus on spending in its UG distribution asset maintenance programs. This includes leveraging advanced techniques to identify vulnerabilities and optimize capital investments.

By increasing the investment in maintenance activities, Hydro Ottawa can sustain asset performance while minimizing customer interruptions. These updates are intended to ensure that Hydro Ottawa's asset population remains functional and safe through 2026-2030. More information regarding the proposed O&M costs can be found in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

The following sections detail the testing, inspection, and maintenance practices for each asset type.

8.3.1. Station Assets

8.3.1.1. Station Transformers

Hydro Ottawa performs monthly station inspections where a visual inspection checks for any deficiencies and initiates corrective actions. Annually, Hydro Ottawa performs predictive maintenance on every station transformer, which includes a detailed visual inspection, oil analysis, and infrared scans. The oil analysis includes a dissolved gas and oil quality analysis. Every five years, a furan analysis is performed to assess the degradation of the transformer's paper insulation.

Several major station transformers are also continuously monitored through the SCADA system to provide operational and asset condition-related information. Various monitoring technologies have been added to station transformers due to the consequences associated with a failure. These include online DGA monitors, winding and oil temperature monitors and monitors to track tap changer status, cooling fan status, and loading information. Warnings and alarms from these monitoring units allow Hydro Ottawa to identify the need for corrective actions with real-time data. It also ensures that the transformers are not overloaded or overheating, which causes the insulation to degrade and reduces transformer lifespans. Figure 68 shows an example of the visual inspection of a station transformer.

Figure 68 - Visual Inspection of a Station Transformer

Every three to five years, station transformers are isolated for preventative maintenance, which includes electrical testing and mechanical maintenance. Transformer tap changer maintenance intervals vary with the type: oil-filled tap changers with no oil filter are maintained every one to two years, oil-filled tap changers with an oil filter are maintained every two to four years, and vacuum tap changers are maintained every six to eight years.

8.3.1.2. Station Switchgear

Hydro Ottawa performs monthly station inspections where a visual inspection is performed to check for any deficiencies and initiate corrective actions. Predictive maintenance is undertaken annually on station switchgear, which includes a detailed visual inspection and infrared scan. Every five years, preventative maintenance is performed on individual breakers. The breaker maintenance includes electrical, mechanical, and type-specific maintenance tasks to ensure the proper functioning of the breaker.

Every 10 years, detailed preventative maintenance is performed on the entire switchgear assembly. Switchgear maintenance includes detailed internal visual inspections; insulation resistance tests; and ensuring that there are no structural deficiencies, such as cracks, leaks or warped metal, in the switchgear.

8.3.1.3. Station Batteries

Batteries are visually inspected as part of the monthly station inspections to check for any deficiencies and initiate corrective actions. Annually, detailed predictive maintenance is performed on station battery banks; this includes a detailed visual inspection, infrared scan, and electrical and mechanical tests. Battery charger predictive maintenance consists of an annual visual inspection, electrical tests, and functional and alarm tests.

8.3.2. Overhead Assets

8.3.2.1. Distribution Poles

Hydro Ottawa inspects all of its distribution poles as part of multiple planned programs of inspection for overhead assets. This planned program of inspection subjects all of its distribution poles and associated attachments to both a visual and thermographic inspection on a rotating three-year cycle, identifying candidate assets for corrective actions.

Hydro Ottawa also conducts a predictive maintenance program of detailed inspection of all poles on a 10-year cycle. The data collected from this program is used to assess the pole’s condition and estimate remaining strength using the results of non-destructive resistograph drill tests. Hydro Ottawa is also working on a drone inspection pilot program to gather more accurate condition information on pole mounted hardware.

8.3.2.2. Overhead Transformers

Hydro Ottawa inspects overhead transformers as part of multiple planned predictive maintenance programs. Transformers are inspected visually as part of the 10-year pole line inspection program and every three years as part of the infrared inspection program. Hydro Ottawa is also working on a drone inspection pilot program to gather more accurate condition information on overhead transformers.

8.3.2.3. Overhead Switches

Hydro Ottawa inspects all of its overhead switches as part of multiple planned programs of inspection for overhead assets. This planned program of inspection subjects all of its overhead switches to both a visual and thermographic inspection on a rotating three-year cycle identifying candidate assets for corrective actions. Hydro Ottawa is also working on a drone inspection pilot program to gather more accurate condition information on overhead switches.

Hydro Ottawa also conducts a separate planned program of detailed inspection and maintenance, based on a rotating eight-year cycle, on overhead load break gang-operated switches. The detailed inspection is to address switches that have a higher reliability consequence. Inspections are performed in the air, in closer proximity to the switch’s components, allowing for a more detailed inspection that could not be performed from the ground. Simultaneously, preventative maintenance is performed on the switch to ensure that it continues to operate as intended.

8.3.3. Underground Assets

8.3.3.1. Distribution Cables

Hydro Ottawa annually tests a portion of its polymer cables using non-destructive test methods to determine the cable’s probability of failure resulting from water tree migration, neutral corrosion, and partial discharge. Hydro Ottawa also combines this information with feedback from utility staff (such as the condition of related UG transformers/UG switchgear, physical condition, operational experience/failure trend based on similar installations, etc.), outage information, and the cable segment's age to determine if the cable would be a candidate for replacement.

PILC are not subjected to a dedicated planned program of inspection or maintenance and are instead included as part of the inspection of underground civil structures. A visual inspection is performed on a 10-year cycle, by qualified outdoor field staff, which includes reviewing the cable condition, racking within the cable chamber, and duct allocation.

8.3.3.2. Underground Transformers

Hydro Ottawa inspects its underground distribution transformers annually on a three-year cycle. The inspection process uses a visual inspection to identify transformers with broken components or leaking oil. A thermographic inspection is also performed to identify defective transformer components including elbows, bushings, and fuses. This process identifies candidate transformers for corrective actions including mechanical repair and component replacement. When repair isn't economical, the transformer is scheduled for replacement.

8.3.3.3. Underground Switchgear

Hydro Ottawa inspects and maintains all of its underground distribution switchgear on a planned basis. This planned program subjects all of its underground distribution switchgear to a visual and thermographic inspection based on a rotating three-year cycle. The maintenance of air-insulated switchgear also includes cleaning of its internal mechanism. The visual inspection records demographic information and the current condition, including the enclosure and civil base.

8.3.3.4. Vault Transformers

Hydro Ottawa inspects all of its vault transformers on a planned three-year cycle. This planned program subjects its vault transformers to a visual and thermographic inspection in addition to minor cleaning. The visual inspection records demographic information and the current condition.

Hydro Ottawa does not own the electrical supply room within customer-owned buildings. Deficiencies found that would affect the ongoing operations or identified safety risks are identified to the building owner to take corrective actions.

8.3.3.5. Underground Civil

Hydro Ottawa performs an inspection of its cable chambers on a 10-year cycle. The cable chamber inspection process involves a visual inspection and sounding test to assess the cable chamber's condition. The inspection includes reviewing the condition of the collar and lid, the roof, and the walls. Cable chamber components that pose an immediate risk to the public, workers, or reliability of the distribution system are identified for immediate corrective actions; if they pose a reduced risk, they are identified for planned corrective actions at a later date.

Through the use of experienced underground field workers, the electrical components installed within the cable chambers can be inspected and minor corrective actions addressed immediately. The visual inspection includes capturing information about the cable demographics, location of splices, and identification of duct allocation.

Other civil assets, including hand holes, ducts, and duct banks, are not subject to a planned program of inspection. Unforeseen failure of these assets poses a reduced risk to the public and workers.

8.4. ASSET UTILIZATION POLICIES AND PRACTICES

Hydro Ottawa monitors the operational performance of the distribution system by tracking annual levels of station capacity, feeder capacity, and system losses. Monitoring and managing the capacity and performance of these distribution systems are critical to prevent overloads, minimize downtime, and optimize resource allocation.

Two key metrics used in this context are the SLI and FLI.
The SLI and FLI are discussed in greater detail in Sections 8.3.1 - Station Assets and 8.3.2 - Overhead Assets. The importance and application of these measures are:

- **Capacity Planning:** Hydro Ottawa monitors these indices to identify which substations or feeders are under stress and require upgrades. This proactive approach ensures that adequate capacity is available during normal system conditions, avoiding unexpected outages and delivering reliable power supply to Hydro Ottawa's customers.
- **Load Management:** Hydro Ottawa uses these indices to identify areas of overloading and take measures such as system reconfiguration to redistribute loads or enhancing infrastructure to manage the load effectively.
- **Investment Decisions:** Hydro Ottawa can utilize SLI and FLI insights to prioritize investments in substations or feeders that are nearing/exceeding capacity limits, ensuring optimal use of resources and budget, and implement the appropriate actions required to maximize the value of the distribution assets throughout its lifecycle.
- **Reliability and Service Quality:** By keeping SLI and FLI within safe limits, Hydro Ottawa can maintain high reliability and service quality. This is crucial for customer satisfaction and compliance with regulatory standards.

8.4.1. Station Capacity

To improve System Accessibility, Station Capacity measures are tracked to provide insight for larger medium- and long-term capacity needs, as well as smaller capacity deficits that may be solved through load transfers.

System Service projects are initiated to address capacity constraints. Projects, in order of increasing complexity and cost, include extending distribution ties to other stations with available capacity, upgrading an existing station's planning capacity, and construction of a new station. The following measure quantifies capacity risks through demand comparisons to a station's planning and equipment ratings and by determining if stranded load is possible during the loss of a station transformer, Section 5.2.2 - Distribution System Assessment.

Station Load Index (SLI)

The SLI is a measure used to assess the load on a substation. It is a critical parameter for determining the current utilization of the substation's capacity and for planning future upgrades or expansions. SLI is typically calculated as the ratio of the peak load to the substation's capacity rating (i.e. planning and/or design rating). The formula can be expressed as:

$$\text{SLI} = (\text{Peak Load}/\text{Capacity Rating}) \times 100$$

The station load indices monitored by Hydro Ottawa are defined in Table 28:

Table 28 - Station Load Index

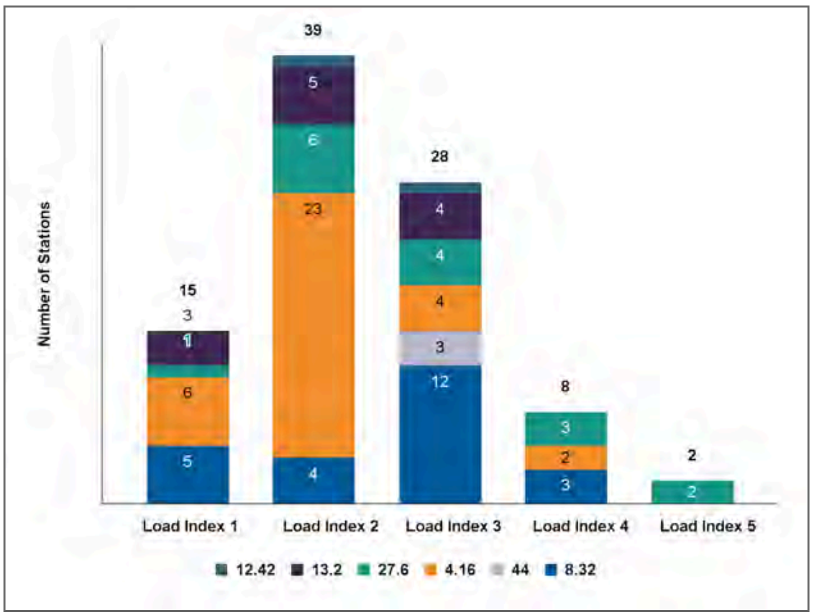
Load Index	Criteria	Explanation
5	x > 70% of Design Rating	Approaching thermal limit
4	x ≥ 100% of Planning Rating	Very heavily loaded, exceeding N-1 contingency
3	70% of Planning Rating ≤ x < 100% of Planning Rating	Heavily loaded, but within contingency
2	40% of Planning Rating ≤ x < 70% of Planning Rating	Moderately loaded
1	x < 40% of Planning Rating	Lightly loaded

- **Planning Rating:** The planning rating is the sum of either the transformers' 10-day LTR or the allowable top load rating if no LTR is published, following the loss of the largest element in the station (N-1 contingency). For stations with a single supply and transformer, feeder ties from adjacent stations provide contingency backup and the planning capacity is based on the single unit's rated capacity (10-day LTR or top load rating if LTR is not available).
- **Design Rating:** A transformer's design rating specifies the maximum electrical power (in kVa or MVA) it can handle under optimal cooling conditions including fan-assisted heat dissipation. This rating ensures the transformer operates reliably within its thermal limits.

Hydro Ottawa monitors the percentage of stations with load indices of 4 and 5 to plan capacity upgrades and has completed significant station expansion projects, improving station performance within planning and design ratings.

In 2023, eight Hydro Ottawa stations had a SLI of 4 and two stations had a SLI of 5, as shown in Figure 69. Stations above 100% of their planning capacity (Load Index 4) limit the flexibility of the system to manage abnormal system states including planned activities. Stations operating at >70% of their design rating (Load Index 5) are approaching their design rating and need intervention to reduce their loading for contingency scenarios.

Figure 69 - Stations by Load Index



The list of stations with a SLI of 4 and 5 have been listed in Table 29.

Table 29 - Stations of Load Index 4 and 5

Region	Station	Voltage	2023 System Peak Day Load (MVA)	Planning Factor (%)	Design Factor (%)	Load Index
West 28kV	Janet King DS 28kV	27.6	26.5	88%	88%	5
West 28kV	Beckwith DS	27.6	3.9	105%	105%	5
West 28kV (North)	Marchwood MTS	27.6	45.7	138%	69%	4
South 28kV	Fallowfield MTS	27.6	32.0	114%	60%	4
East 4kV	Vaughan DS	4.16	7.3	109%	51%	4
West 8kV	Richmond North DS	8.32	6.8	136%	52%	4
East 4kV	Church DS	4.16	5.7	114%	46%	4
South East 28kV	Leitrim DS	27.6	26.6	106%	46%	4
Nepean 8kV	Manordale MTS	8.32	10.9	109%	45%	4
Nepean 8kV	Centrepointe MTS	8.32	14.9	106%	38%	4

Hydro Ottawa is utilizing multiple approaches to address the stations at a Load Index of 4 and 5. For information about Hydro Ottawa's plans to address system capacity, see Section 9.1 - Capacity Needs Assessment.

8.4.2. Feeder Capacity

Hydro Ottawa plans feeder capacity based on coincident peak loading and N-1 contingency. The majority of distribution feeders are paired so that if one feeder fails, its load can be transferred to an adjacent feeder. This arrangement minimizes the number of switching operations and the time required to restore full load. Hydro Ottawa also has feeders with dedicated backups; i.e., an alternative backup feeder that normally carries no load. Feeders with a dedicated backup can carry more load without overheating or sustaining damage. Please refer to Table 30 below.

The following factors are taken into consideration when determining the planning rating for a distribution feeder:

- **Egress Cable:** The conductor size, insulation material, and installation type.
- **Egress Design Rating:** Based on the cable specifications and ampacity calculations, a design rating is identified for the respective cable type.
- **Egress 8-hour Rating:** Based on the cable specification and ampacity calculations, a contingency 8-hour rating is identified for the respective cable type.
- **Overhead Conductor:** The conductor size is identified.
- **Overhead Conductor Rating:** A rating is identified for the respective conductor size based on manufacturer specifications.
- **Other Limitations:** Assets on the distribution system that could cause an ampacity limitation, such as jumpers or switches, are identified for the respective feeders.

Table 30 - Typical Egress & Conductor Ratings

Voltage	Typical Egress Cable	Egress Design Rating (A)	Egress 8hr Rating (A)	Typical Overhead Conductor	Overhead Conductor Rating (A)
4 kV	5 kV 350 Cu PILC	340	405	15 kV, 4/0 Cu	510
8 kV	15 kV, 500 MCM Cu XLPE	455	605	15 kV, 336 Al	500
12 kV	15 kV, 2/0 Al XLPE	210	280	15 kV, 336 Al	500
13 kV	15 kV, 500 MCM Cu PILC	425	510	15 kV, 477 Al	600
28 kV	29 kV, 750 MCM Al XLPE	455	620	29 kV, 556 Al	700
28 kV	29 kV, 1000 MCM Al XLPE	505	685	29 kV, 556 Al	700
44 kV	46 kV, 750 MCM Cu XLPE	545	720	46 kV, 556 Al	700

The planning rating for feeders **without** a dedicated backup is calculated as 50% of the egress 8-hour rating or 50% of the overhead conductor rating, whichever is lesser. This approach ensures that feeders always have capacity to backup adjacent circuits during N-1 contingency conditions.

The planning rating for feeders **with** a dedicated backup is calculated as the egress design rating or the overhead conductor rating, whichever is lesser. These feeders have a higher planning rating as they can rely on the dedicated backup for capacity in N-1 contingency scenarios.

The planning rating is calculated on an individual feeder basis to account for feeder specific limitations. This approach ensures that assets on the feeder never exceed their respective thermal limits while also identifying constrained areas on the network, such as undersized conductors, that could be upgraded to increase capacity on the entire feeder. The FLI is used to assess capacity risks through demand comparisons to a feeder's planning ratings and by determining if stranded load is possible during an N-1 contingency.

Feeder Load Index (FLI)

The FLI measures the load on individual feeders that distribute electricity from substations to consumers. It helps in assessing the performance and capacity utilization of these feeders, which helps in planning for feeder extensions to make station capacity available or create feeder ties between stations to improve reliability.

FLI is calculated as the ratio of the actual load on the feeder to its rated capacity (planning/design rating). The formula is:

$$\textbf{FLI} = (\textbf{Peak Load}/\textbf{Capacity Rating}) \times 100$$

The feeder load indices monitored by Hydro Ottawa are defined in Table 31.

Table 31 - Feeder Load Index

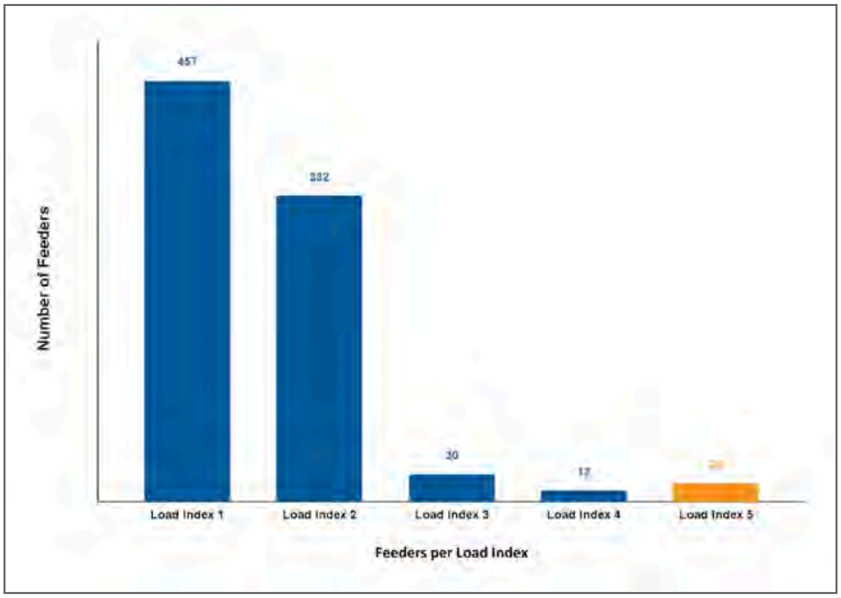
Load Index	Criteria	Explanation
5	x > 70% of Design Rating	Approaching thermal limit
4	x ≥ 100% of Planning Rating	Very heavily loaded, exceeding N-1 contingency
3	85% of Planning Rating ≤ x < 100% of Planning Rating	Heavily loaded, but within contingency
2	40% of Planning Rating ≤ x < 85% of Planning Rating	Moderately loaded
1	x < 40% of Planning Rating	Lightly loaded

Hydro Ottawa monitors the percentage of feeders with a load index of 4 and 5 to plan for feeder capacity upgrades and reliability improvement investments.

In 2023, 12 Hydro Ottawa feeders had a FLI of 4 and 19 feeders at a FLI of 5, as shown in Figure 70. Feeders must be maintained within the planning capacity to allow for efficient load transfer during N-1 contingency situations while respecting equipment ratings.

Feeders equal to or above 100% of their planning capacity (Load Index 4) limit the flexibility of the system to manage abnormal system states, including planned activities. Feeders operating at >70% of their design rating (Load Index 5) signal at approaching rated capacity and need some intervention to reduce the loading to be able to manage contingency scenarios.

Figure 70 - 2023 Feeder Load Index



The list of feeders with a FLI of 4 and 5 have been listed in Table 32 below.

1 **Table 32 - Feeders with Load Index 4 or 5**

Station	Voltage	Feeder	Planning Factor (%)	Design Factor (%)	Load Index
South March TS	44	A9M3	159%	79%	5
Jockvale DS	8.32	145F1	147%	73%	5
Parkwood Hills DS	8.32	190F5	146%	83%	5
Russell TS	13.2	5304	122%	73%	5
Nepean TS	44	22M27	117%	75%	5
Fallowfield MTS	27.6	FAL01	110%	75%	5
Cambrian MTS	27.6	CBNF5	108%	73%	5
Gladstone DS	4.16	UX03	80%	80%	5
Carling TS	13.2	TC4TM	79%	79%	5
Russell TS	13.2	TB2JP	79%	79%	5
Henderson DS	4.16	UN04	77%	77%	5
Carling TS	13.2	TC2TM	76%	76%	5
Florence DS	4.16	UF07	75%	75%	5
Carling TS	13.2	TC1TM	75%	75%	5
Carling TS	13.2	TC3TM	74%	74%	5
Bayswater DS	4.16	UJ07	72%	72%	5
Nepean DS	4.16	AB03	71%	71%	5
Bronson DS	4.16	SB02	71%	71%	5
Carling DS	4.16	SM12	70%	70%	5
Beckwith DS	27.6	BECKF2	105%	35%	5
Casselman DS	8.32	CAS-F2	168%	55%	4
Barrhaven DS	8.32	140F3	122%	67%	4
Startop DS	8.32	6F10	111%	61%	4
Parkwood Hills DS	8.32	190F2	109%	54%	4
Rideau Heights DS	8.32	180F4	109%	70%	4
Beaconhill DS	8.32	BCHF5	109%	60%	4
Casselman DS	8.32	CAS-F1	108%	36%	4
Richmond North DS	8.32	RHNF3	104%	31%	4
Centrepointe MTS	8.32	87F3	104%	51%	4
Hawthorne TS	44	48M2	103%	66%	4
Bridlewood MTS 8kV	8.32	BRDF6	102%	56%	4
Richmond North DS	8.32	RHNF2	102%	30%	4

9. SYSTEM CAPACITY ASSESSMENT

Hydro Ottawa's capacity planning process ensures that the distribution system is sufficiently sized to deliver reliable electricity to its expanding customer base. With growing energy demand and existing system constraints, Hydro Ottawa is focusing on powering the growing community by addressing the immediate and short-term needs over the 2026-2030 rate period. This requires immediate infrastructure investments aligned with long-term potential outcomes, promoting efficiency in capital deployment.

Hydro Ottawa's planning process takes into account existing and short-term system constraints, new developments, a rise in DERs, and a shift towards electrification informed by known large load requests. Other important drivers considered in the planning process are the need to build a more resilient grid to tackle climate change and its impacts to the distribution system, as detailed in Section 6.4.2 - Future Climate, and customer preferences evident through the engagement survey that supports making investments to further growth and electrification, for further details on the Customer Engagement Survey, see Schedule 1-4-1 - Customer Engagement Ongoing.

Transmission and distribution line availability is another key factor impacting system capacity. Transmission lines carry electricity from generating stations to substations, while distribution lines deliver power from substations to individual customers. If these lines are not adequate in number or capacity, they can limit the amount of electricity that can be delivered to customers. As described in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties, transmission assessment is led by the IESO through the IRRP Process. The current investment plan submitted through this application is in consultation with the IRRP working group and based on the needs assessment completed through the regional planning process. Plans will be revised, if necessary, based on the final IRRP report that is yet to be published.

Hydro Ottawa's System Capacity Assessment is a complex and technical process that analyzes large quantities of data from various sources to enable well-informed decisions about system upgrades and expansions, leveraging the planning forecast as its foundation. By investing in its electrical infrastructure, Hydro Ottawa can ensure that it has the capacity to meet the current needs of its customers by making prudent decisions to support the long term trajectory of the community.

This section describes Hydro Ottawa's capacity planning approach and is organized as follows:

- **Section 9.1:** Capacity Needs Assessment
- **Section 9.2:** Non-Wires Solutions to Address System Needs
- **Section 9.3:** System Capability Assessment for Renewable Energy Generation (REG) & DERs
- **Section 9.4:** Planning Load Forecasting

9.1. CAPACITY NEEDS ASSESSMENT

Hydro Ottawa utilizes the Planning Forecast, as detailed in Section 9.4 - Planning Load Forecasting, to assess and anticipate the immediate needs of the system. This forecast is then compared against established system limits and constraints to pinpoint areas requiring intervention. Identified issues are consolidated to develop a comprehensive and cohesive set of solutions. This section outlines the overall requirements to meet system capacity forecasts and the needs identification process, starting with determination of the immediate needs (by utilizing the Planning Forecast) and an evaluation of the medium to long-term requirements for efficient capital deployment (by utilizing the IRRP Forecast-as detailed in Section 9.4 - Planning Load Forecasting) followed by detailed assessment by planning region.

9.1.1. Overview

Table 33 summarizes the Wires and Non-Wires investment needs by planning region determined through the immediate and medium to long-term needs assessments.

1 **Table 33 - Investment Needs per Planning Region**

Planning Regions	Wire Solutions	Non-Wires Solutions (NWSs)	Capacity Addition (LTR-MVA)
44 kV	• A new 44 kV station (Hydro Road MTS) to cater to a specific need for the OC Transpo's Zero Emission Buses • Hydro One has plans to upgrade South March TS transformers due to end of life. Installing higher capacity transformers would aid in adding capacity to the region		171
South 28 kV	• Construction of a new 28 kV station (Greenbank MTS) to accommodate overloads in the 8 kV system and large load requests including the Regulatory and Science Main Project • Feeder integration plans for new station		120
South-East 28 kV	• Construction of a new station in the region along the 230 kV transmission corridor (Piperville MTS) to accommodate overloads and support future growth • Feeder integration plans for new station		120
East 28 kV	• With plans to decommission Bilberry TS and an Orleans feeder, a new 28 kV station is underway (Mer Bleue MTS) to manage existing load from Orleans TS and Bilberry TS • Cyrville MTS is proposed to be upgraded to support overload in the East 13 kV and East 8 kV regions and support large load requests including TerraCanada National Capital Area project • Feeder integration plans for new station		190
West 28 kV	• Additional transformer upgrade at Richmond South MTS to meet load requirements of the Department of National Defence Dwyer Hill Training Center • Upgrade and maintain transformer-level redundancy	Utility Owned Battery Storage	3
West 28 kV (North)	• Construction of a new 28 kV station to accommodate overloads and support future growth. • Feeder integration plans for new station	Non-Wires Customer Solutions Program	120 (plus NWCS: 10-15 MW)
West 13 kV	• Cable upgrades and remove equipment limitations at Hydro One stations - Carling TS • Slater TS upgrade completed • Conversion of Bronson[28] from 4 kV to 13 kV will help with capacity constraints and support Carling, Lisgar and Riverdale		150

[28] Conversion of Bronson is initiated in this 2026-2030 Rate Period but will only be energized in 2031.

Planning Regions	Wire Solutions	Non-Wires Solutions (NWSs)	Capacity Addition (LTR-MVA)
Core 13 kV	• Riverdale switchgear upgrade underway • Cable upgrades and remove equipment limitations at Hydro One stations - King Edward TS, Lisgar TS • Slater TS upgrade completed • Conversion of Bronson DS from 4 kV to 13 kV will help with capacity constraints and support Lisgar TS and Riverdale TS	Utility Owned Battery Storage Non-Wires Customer Solutions Program	63 (plus NWCS: 10-15 MW)
East 13 kV	• Hydro One has plans to upgrade Russell TS and Albion TS station transformers due to end of life • Installing higher capacity transformers would aid adding capacity to the region		68[29]
West 12 kV	• Strategic and phased voltage conversion		
Nepean 8 kV	• Voltage conversion of 8 kV to 28 kV in the long term supported by the new Greenbank station in the South 28 kV region		
Bells Corner/ Bayshore 8 kV	• None required	Utility Owned Battery Storage	8
Barrhaven 8 kV	• Voltage conversion of 8 kV to 28 kV in the long term supported by Cambrian MTS and the new Greenbank station in the South 28 kV region		
West 8 kV	• Voltage conversion of 8 kV to 28 kV in the long term		
Casselman 8 kV	• None required	Utility Owned Battery Storage	6
East 8 kV	• Voltage conversion of 8 kV to 28 kV in the long term supported by the station upgrades in the East 28 kV stations		
Central 4 kV	• Strategic and phased voltage conversion. Fisher DS is underway and Henderson DS will be initiated. • Strategic 4 kV-to-13 kV voltage conversion of Bronson DS		
East 4 kV	• Strategic and phased voltage conversion. Dagmar DS is underway. Church DS and Vaughan DS will be initiated		

In summary, to balance the need for increased capacity with affordability, Hydro Ottawa has identified areas for upgrades, including enhancing distribution infrastructure, building new stations, upgrading existing stations, utilizing NWSs, and implementing grid modernization initiatives. For new station

[29] Capacity added to the distribution system is driven by Hydro One investments.

capacity projects, please see further details in Section 2.3.2 of Schedule 2-5-8 - System Service Investments, Hydro Ottawa prioritized investments in areas with immediate, confirmed, and committed load requirements. Hydro Ottawa will continuously monitor the impact of electrification to minimize disruptions and ensure the ability to connect new customers.

9.1.2. Immediate Needs Assessment

This section details the assessment of currently overloaded stations and utilizes the Planning Forecast to outline planned investments critical for maintaining system reliability and accessibility required for initiation or completion within the 2026-2030 rate period.

As detailed in Section 8.4.1 - Station Capacity, the 2023 system peak demand assessment reveals ten[30] stations currently operating above planning capacity. To alleviate these constraints and accommodate existing committed loads, Hydro Ottawa is implementing the actions outlined in Table 34. Without these interventions, Hydro Ottawa would be unable to connect new customers and maintain station loading at or below planning levels.

These immediate needs are addressed through the MIPs, specifically Section 2 of Schedule 2-5-8 - System Service Investments and for the new stations, and feeder integration plans for those stations. Some distribution transfer projects may also be undertaken as part of Distribution Enhancements.

[30] Nine stations are operating above planning capacity and one is approaching design capacity.

Table 34 - Immediate System Needs

Planning Region	Need Criteria	Station	Planned Actions
44 kV	Existing Committed Load	Hydro Road MTS	• A new 44 kV station (Hydro Road MTS) to cater to a specific need for OC Transpo's Zero Emission Buses • Provides increased reliability to Hawthorne TS through feeder ties
East 28kV	Existing Committed Load	Cyrville MTS	• With plans to decommission Bilberry TS, a new 28 kV station is underway (Mer Bleue MTS) to manage existing load from Orleans TS and Bilberry TS • Cyrville MTS is proposed to be upgraded to support growth and large loads requests including the TerraCanada National Capital Area project • Distribution transfers to build redundancy and support growth in the East 8 kV system
West 28 kV	Existing Capacity Constraint + Committed Load	Janet King DS	• Utility Owned Battery Storage in the West 28 kV to support minor overloads • To support committed large load request from the Department of National Defence Dwyer Hill Training Center Upgrade, an additional transformer upgrade at the existing station to meet customer need and maintain transformer-level redundancy
		Beckwith DS	
West 28 kV (North)	Existing Capacity Constraint	Marchwood DS	• Construction of a new 28 kV station (Kanata North Station) to accommodate overloads and Kanata North Business developments
West 8 kV	Existing Capacity Constraint	Richmond North DS	• Managed through distribution transfers to build redundancy in the near term • Voltage conversion of 8 kV to 28 kV in the long term
South 28 kV	Existing Capacity Constraint + Committed Load	Fallowfield DS	• Construction of a new 28 kV station (Greenbank MTS) to accommodate overloads in the 8 kV system and large load requests such as the Regulatory and Security Science Main Project • Voltage conversion of 8 kV to 28 kV in the long term
Nepean 8 kV	Existing Capacity Constraint	Manordale DS	
		Centrepointe DS	
South-East 28 kV	Existing Capacity Constraint	Leitrim DS	• Construction of a new station (Piperville MTS) in the region along the 230 kV transmission corridor to accommodate overloads, residential growth and improved area reliability
East 4 kV	Existing Capacity Constraint	Church DS	• Strategic and phased voltage conversion removing limitations for connecting larger loads in the area. Dagmar DS is underway. Church DS and Vaughan DS will be initiated • Distribution transfers to build redundancy improving reliability
	Existing Capacity Constraint	Vaughan DS	

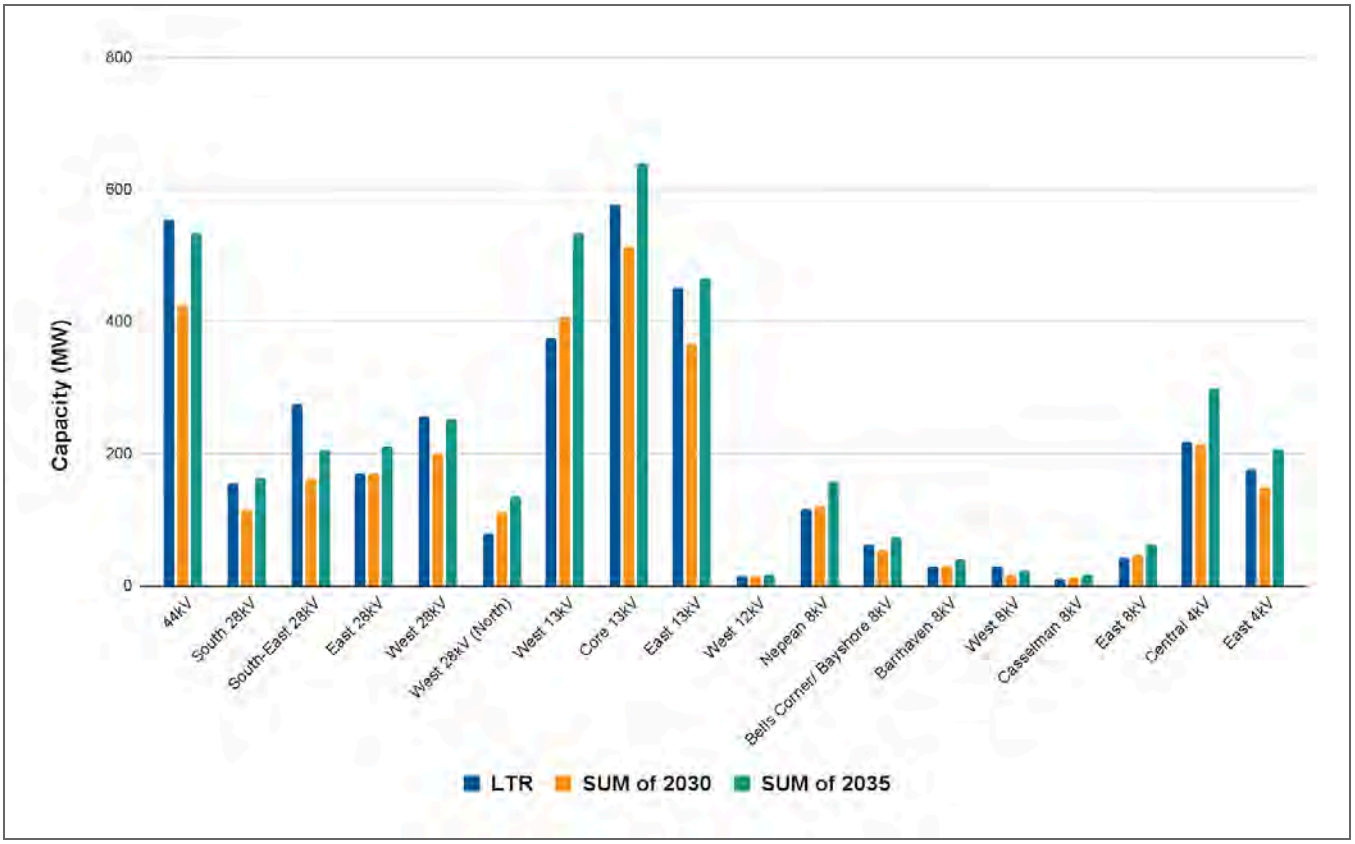
9.1.3. Medium and Long Term Needs Assessment

To proactively identify stations at risk of overload by 2030 and 2035 Hydro Ottawa analyzed the IRRP forecast in all regions, refer to Section 9.1.4 - Investments by Planning Region for the detailed region specific analysis. Given the four- to six-year lead time required for station upgrades and even longer lead times for transmission upgrades, focus on the medium to long-term outlook (beyond 2030) allows Hydro Ottawa to validate that capacity investments for immediate needs (informed through Hydro Ottawa's planning forecast) strategically align with indications of long-term needs, ensuring efficient capital deployment and optimizing asset utilization.

To meet projected capacity needs by 2030, Hydro Ottawa will implement several measures, including distribution infrastructure enhancements, new station construction, existing station upgrades, NWSs, and grid modernization. New station projects are prioritized based on immediate, confirmed, and committed load requirements.

Hydro Ottawa's IRRP forecast shows that, even with the immediate planned actions undertaken, the system will not have enough capacity to meet the growing demand by 2035 in all planning regions. Figure 71 compares the megawatt (MW) forecast for 2030 and 2035 with current available capacity (including Piperville and Hydro Road Station) for the 18 planning regions considering both transmission and the downstream distribution-connected stations.

Figure 71 - 2030 & 2035 Forecast vs. Capacity



Out of the 18 planning regions, 7 will exceed the available capacity and 4 will be over 90% of available capacity by 2030. By 2035, 14 planning regions will exceed available capacity and 2 operating over 90% of available capacity when considering the IRRP forecast. Table 35 details the needs assessment for capacity increases required by 2030 and 2035, beyond the immediate needs outlined in Table 34.

1 **Table 35 - Needs Assessment 2030 and 2035**

Planning Region	Overload Capacity %:		Capacity Upgrade Needs
	2030	2035	
Barrhaven 8 kV	101%	137%	• Voltage conversion from 8 to 28kV to supply from the new Greenbank MTS
Bells Corner / Bayshore 8 kV	89%	118%	• Utility owned battery storage solutions for peak load management
Casselman 8 kV	113%	146%	• Utility owned battery storage solutions for peak load management
Central 4 kV	98%	137%	• Strategic and phased voltage conversion. Fisher AK is underway and Henderson UN will be initiated • Distribution transfers to build redundancy • Bronson SB is proposed to be upgraded to 13 kV to support growth in the West 13 kV region including projects like the Ottawa Hospital's New Campus
Core 13 kV	89%	111%	• Riverdale switchgear upgrade underway • Cable upgrades and remove equipment limitations at Hydro One stations- King Edward TS, Lisgar TS to support growth related to the transit oriented developments and electrification growth • Slater TS upgrade completed • Conversion of Bronson DS from 4 kV to 13 kV will help with capacity constraints and support Carling TS, Lisgar TS and Riverdale TS. Although energization is beyond 2030, construction needs to start in this Rate App to meet forecasted demand • Utility Owned Battery Storage for peak load management
East 8 kV	114%	152%	• Voltage conversion from 8 to 28kV to supply from the new upgraded Cyrville MTS or new Mer Bleue MTS
East 13 kV	81%	103%	• Hydro One has plans to upgrade Russell TS and Albion TS station transformers due to end of life which will add additional capacity to the region • Distribution transfers to build redundancy
West 12 kV	95%	120%	• Strategic and phased voltage conversion
West 13 kV	109%	142%	• Cable upgrades and remove equipment limitations at Hydro One stations- Carling TS to support the Ottawa Hospital New Campus • Slater TS upgrade completed • Conversion of Bronson DS from 4 kV to 13 kV will help with capacity constraints and support Carling TS, Lisgar TS and Riverdale TS including projects like the Ottawa Hospital's New Campus

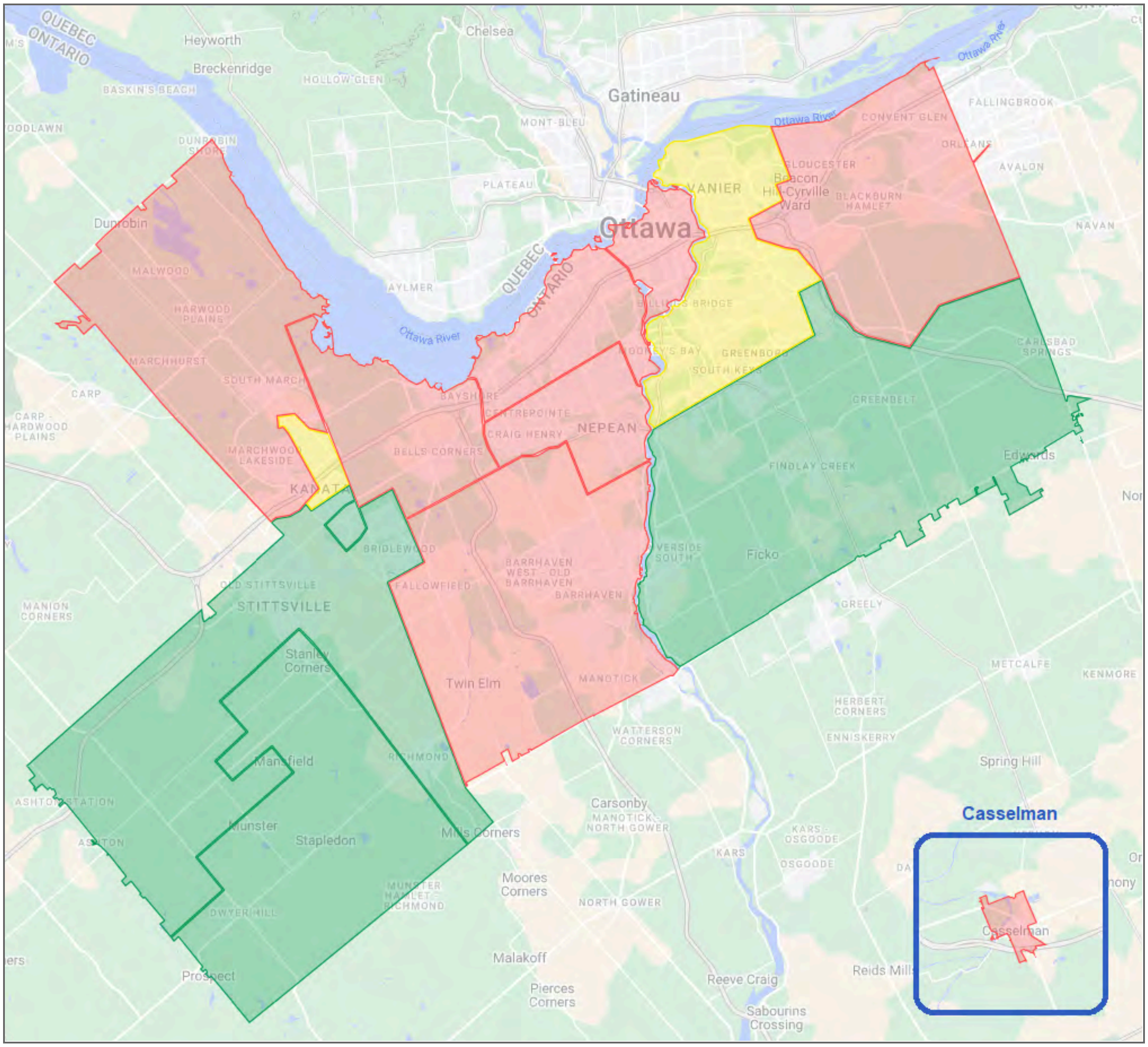
In conclusion, capacity investments identified through the immediate needs assessment as in Section 9.1.2 - Immediate Needs Assessment are efficiently sized to meet projected needs through 2035, maximizing long-term efficiency, as each new station is expected to remain in service for at least 50 years. The incremental cost of appropriately sizing infrastructure for the long term ensures efficient capital deployment and avoids premature rebuilding.

9.1.4. Investments by Planning Region

Hydro Ottawa's distribution system comprises several subsystems, or planning regions, segmented by operating voltage and geographic boundaries, typically aligned with pre-amalgamation utility demarcations as described in Section 6.2.3 - Planning Regions. Detailed summaries of each planning region follow.

Figure 72 visually represents capacity constraints in each of the planning regions based on the IRRP forecast. Red-highlighted regions indicate the highest concern, with projected loads exceeding planning limits within five years (by 2030). Yellow-highlighted regions represent moderate concern, with limits expected to be exceeded within five to ten years (2035). Green-highlighted regions are of least concern, not projected to exceed limits within ten years.

Figure 72 - Heatmap of Capacity Needs



In each of the planning region sub-sections below, there is first a figure of the region and then a second figure to assess the regional needs, which charts the historical weather normalized actuals (trend highlighted in green), Hydro Ottawa planning forecast (trend highlighted in blue), and the

IRRP forecast (trend highlighted in orange) and load inquiries received to date (trend highlighted in purple) over the Rate Application period.

9.1.4.1. 44 kV System

The 44kV system covers Hydro Ottawa's entire service area (excluding Casselman), fed by three stations: Hawthorne TS, Nepean TS, and South March TS.

This system serves numerous large commercial and industrial customers, as well as downstream 8kV, 12kV and 28kV distribution stations. Figure 73 shows the locations and supply areas of the 44kV stations. South March TS supplies the west, Nepean TS supplies the south, and Hawthorne TS supplies the east. There are distribution ties between South March TS and Nepean TS feeders, as well as between Nepean TS and Hawthorne TS feeders.

Figure 73 - 44kV Supply Region

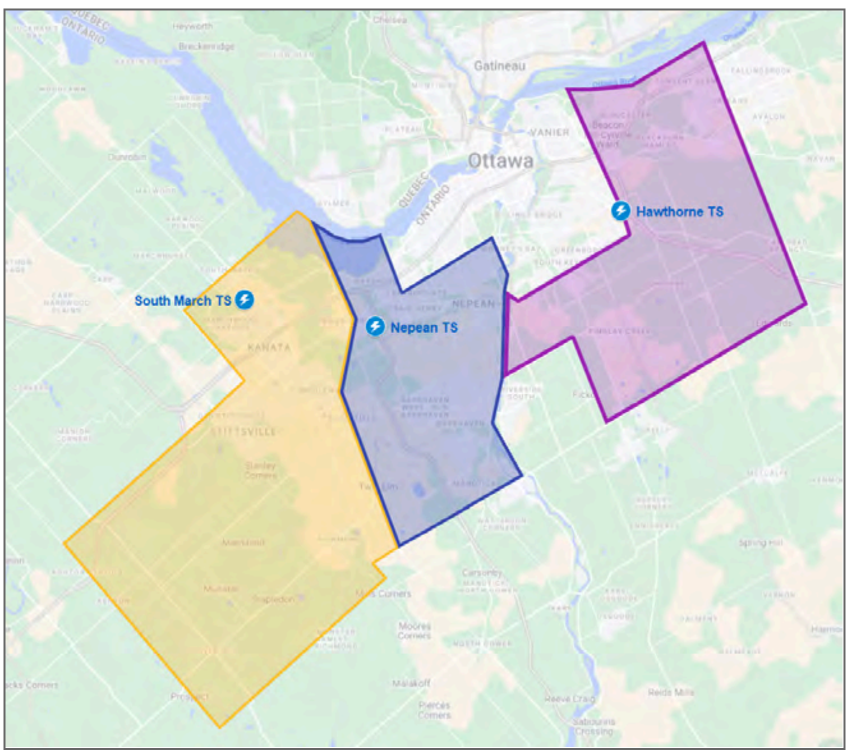


Figure 74 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the 44kV region out to 2035. There are some factors that will reduce this region's load in the coming years mainly due to voltage conversions from the 8kV and 12kV system to the 28kV system and with the planned energization of Piperville TS in 2026, some load will be transferred from Leitrim TS, reducing Hawthorne's total load. However, with natural load growth on the remaining connected 8kV stations and forecasted growth and electrification in the region, the overall region load is expected to increase.

Figure 74 - 44kV Planning Forecast and IRRP Forecast

Investments that will increase the capacity of the 44kV region are listed below:

- **South March TS Upgrade (Hydro One Investment)**
  The South March TS's two 230kV/44kV transformers, commissioned in 1971, need to be replaced due to their asset condition. Given the forecasted developments on the connected stations and overall system electrification that is expected, increasing the transformer capacity is required to meet the long-term demand forecast.
- **New Hydro Road Station (System Access - System Expansion)**
  To support a large load request (OC Transpo's Zero Emission Buses[31]), Hydro Ottawa is constructing a 100 MVA, 230kV to 44kV substation with six feeders, scheduled to be energized in 2027. For more details on the need and justification of this investment please refer to Section 4 of Schedule 2-5-6 - System Access Investments.

These investments align with the Needs Assessments conducted by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

[31] Ottawa-Carleton Transportation, "Zero-Emission Bus," https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/

9.1.4.2. 28 kV System

Hydro Ottawa’s 28kV supply system is comprised of five main areas:

1. South 28kV System
2. South-East 28kV System
3. East 28kV System
4. West 28kV System
5. West 28kV (North) System

9.1.4.2.1. South 28kV

The South 28kV supply region, as shown in Figure 75, covers the areas of Nepean south of the Greenbelt. It is supplied by Fallowfield MTS, Longfields DS, Limebank MTS, and Cambrian MTS. Despite the physical barrier of the river between Nepean and Gloucester, Limebank station plays an essential role in supplying both sides of the river, making it one integrated supply region.

Figure 75 - South 28kV Supply Region

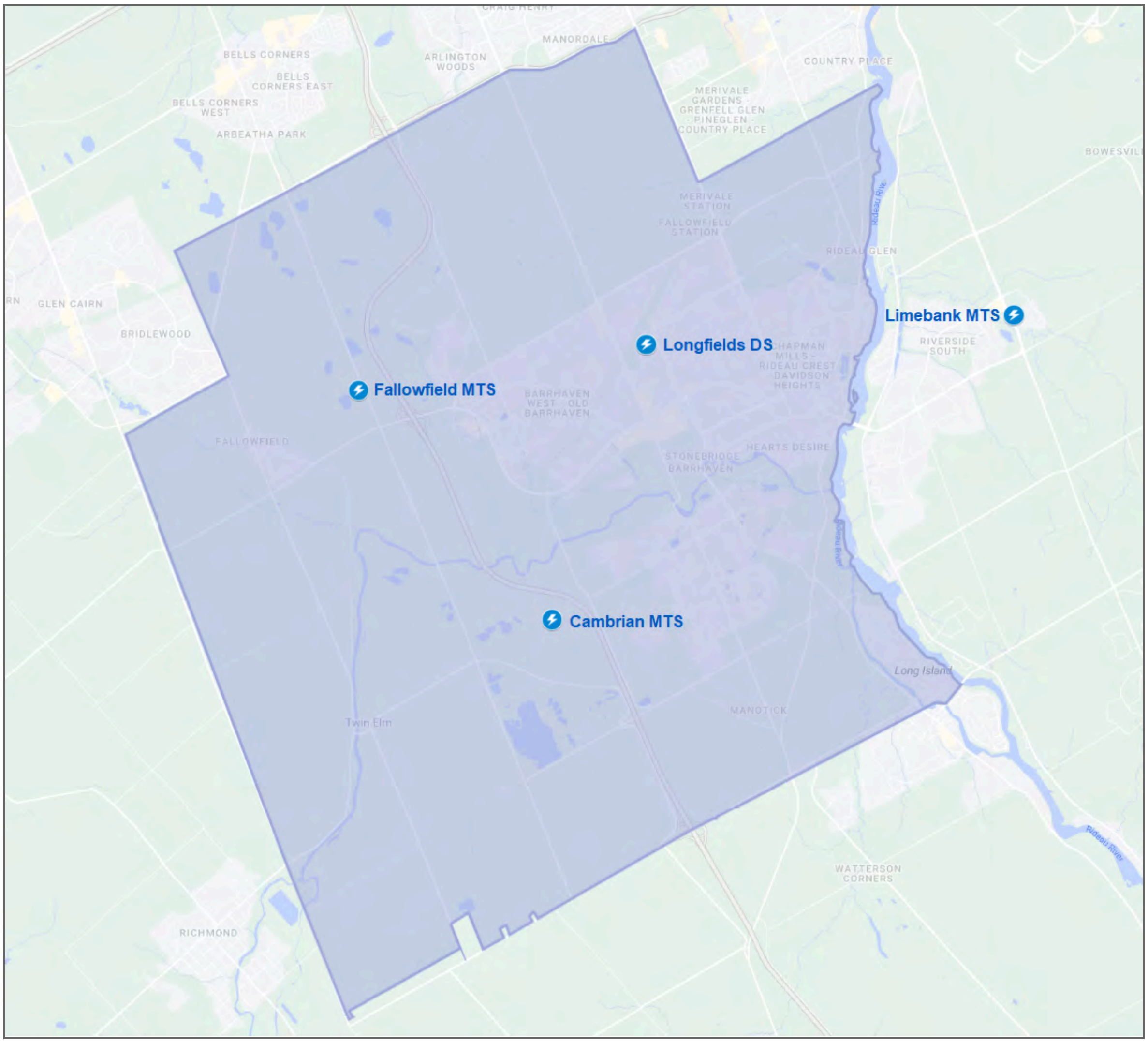
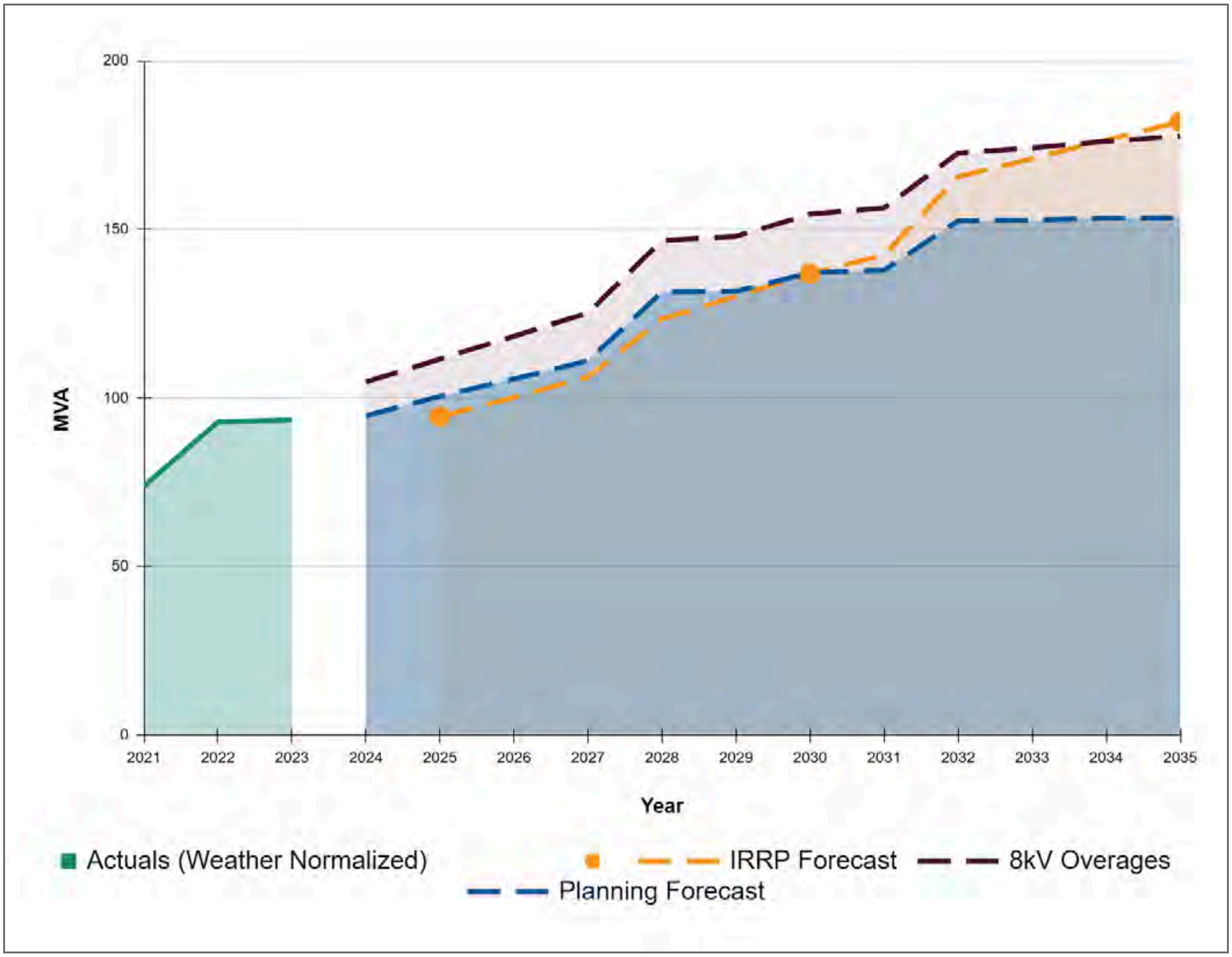


Figure 76 shows the weather normalized actuals, the planning forecast, the IRRP forecast and the new loads to be transferred from 8 kV overloaded stations, which represent the 28 kV Planning Forecast plus the additional capacity needed to address the overloaded 8 kV system for the region out to 2035.

Figure 76 - South 28kV Planning Forecast and IRRP Forecast



Energizing Cambrian MTS in 2022 has relieved the immediate capacity constraints just in time for Fallowfield MTS to reach its rated capacity in 2021. The increase in the South 28kV region's load between 2021 and 2023 can be explained by the transfer of load from Limebank MTS. Limebank MTS forms part of the South-East 28kV region and supported the South 28kV region while Cambrian MTS was being built; as such, post-energization, this load was transferred back to Cambrian MTS. The region is anticipating a large load request,[32] a laboratory facility staging major energizations in 2028 and 2032.

New Greenbank MTS (System Service-Capacity Upgrade)

A new 230 kV-connected 28 kV station with 100 MVA capacity and eight new feeders is proposed in the South 28kV region. This station is scheduled to be energized in 2028. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 System Service Investments.

This capacity upgrade aligns with the Needs Assessments completed by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties. A comprehensive transmission supply evaluation, conducted with Hydro One and the IESO through the regional planning process, will determine the most feasible and reliable power delivery option for the new substation.

[32] Government of Canada, "Government of Canada invests in laboratories to support science in Canada." https://www.canada.ca/en/public-services-procurement/news/2024/03/

9.1.4.2.2. South-East 28kV System

The South-East 28kV supply region, encompassing southern Gloucester, is supplied by Limebank MTS, Uplands MTS, and Leitrim DS, as shown in Figure 77. Although geographically separated from Nepean by the river, Limebank MTS is crucial for supplying both areas, creating interdependence between the South 28kV and the South-East 28kV systems.

Figure 77 - South East 28kV Supply Region

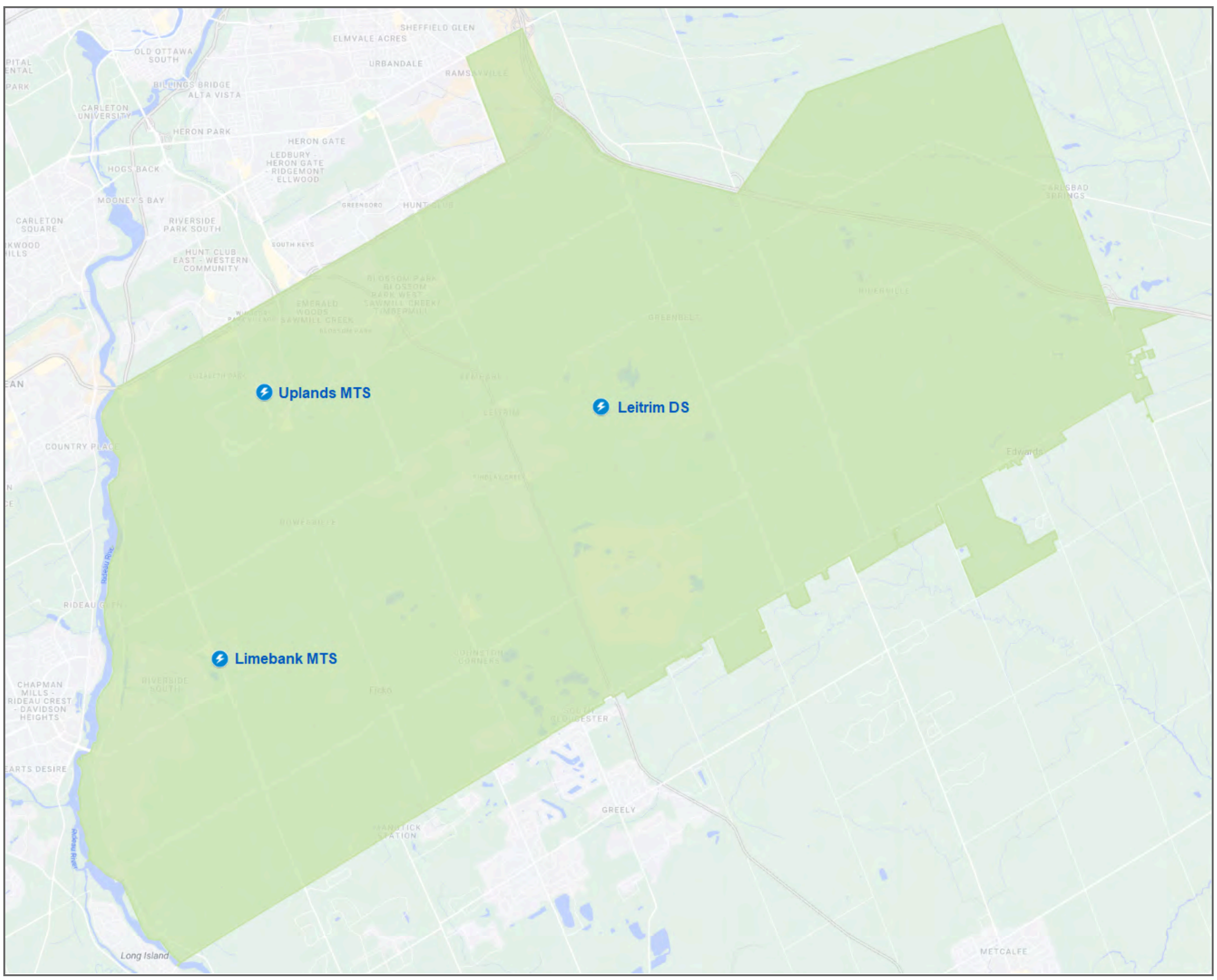
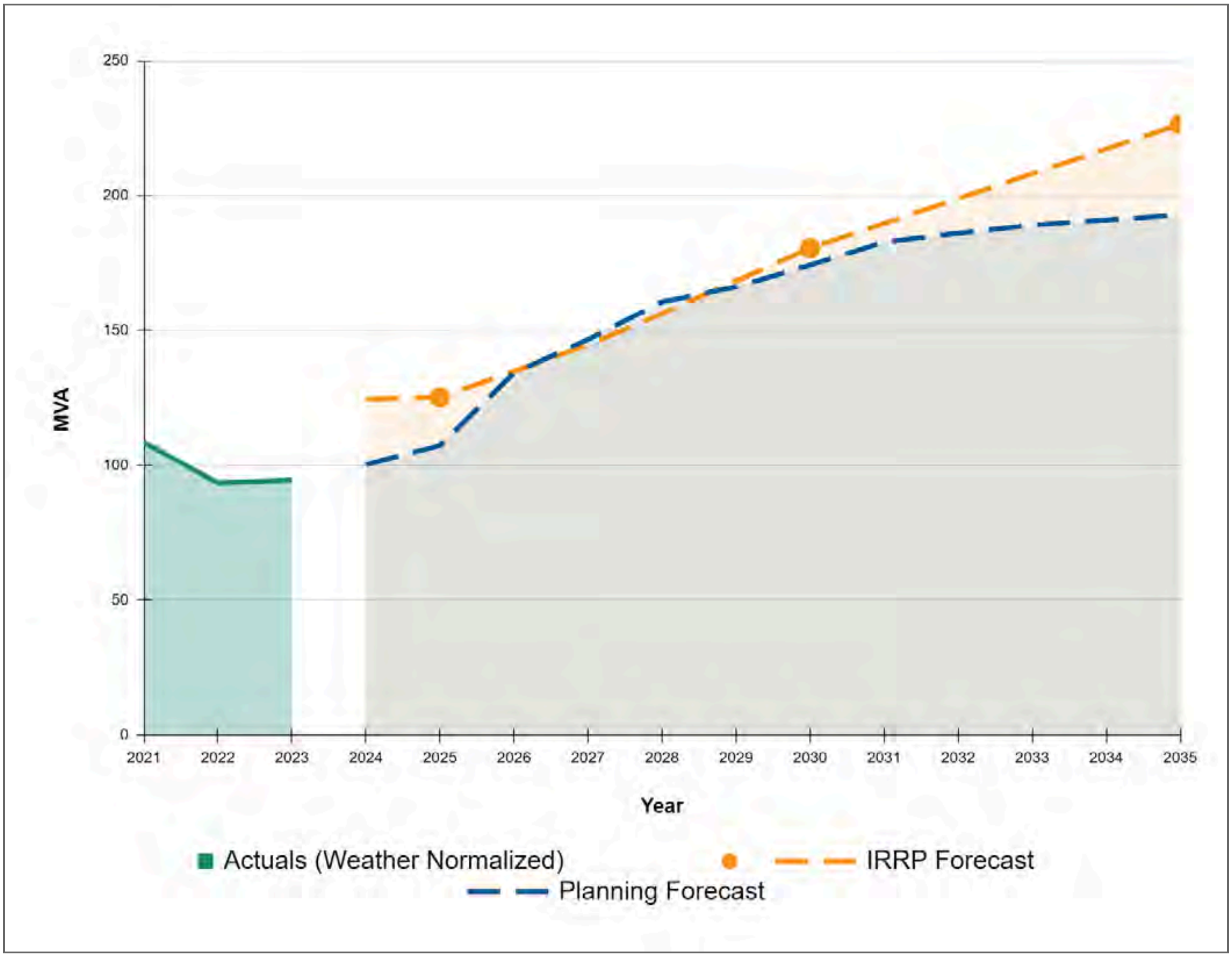


Figure 78 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 78 - South East 28kV Planning Forecast and IRRP Forecast



New Piperville MTS (System Service-Capacity Upgrade)

To accommodate growing load forecast in the South-East region, shown in Figure 78, the new Piperville MTS is under construction, with planned energization in 2026. This project, approved as part of the 2021-2025 Rate Application, will be a 230kV-connected station with two 100 MVA transformers and capacity for eight new feeders. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This capacity upgrade investment is consistent with the Needs Assessments conducted by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties. A comprehensive transmission supply evaluation, in collaboration with Hydro One and the IESO, was completed to determine the most feasible and reliable power delivery solution for Piperville MTS, ensuring its optimal operation.

9.1.4.2.3. East 28kV System

The East 28kV supply region is defined by the former Gloucester and Ottawa municipal boundary and Highway 417 to the south. The region is supplied by transmission-connected 28kV stations Cyrville MTS, Bilberry TS, Orleans TS, and Moulton MTS, as shown in Figure 79. Hydro Ottawa also owns a single 28kV circuit from Hydro One's Orleans TS station, which supports the region.

Figure 79 - East 28kV Supply Region

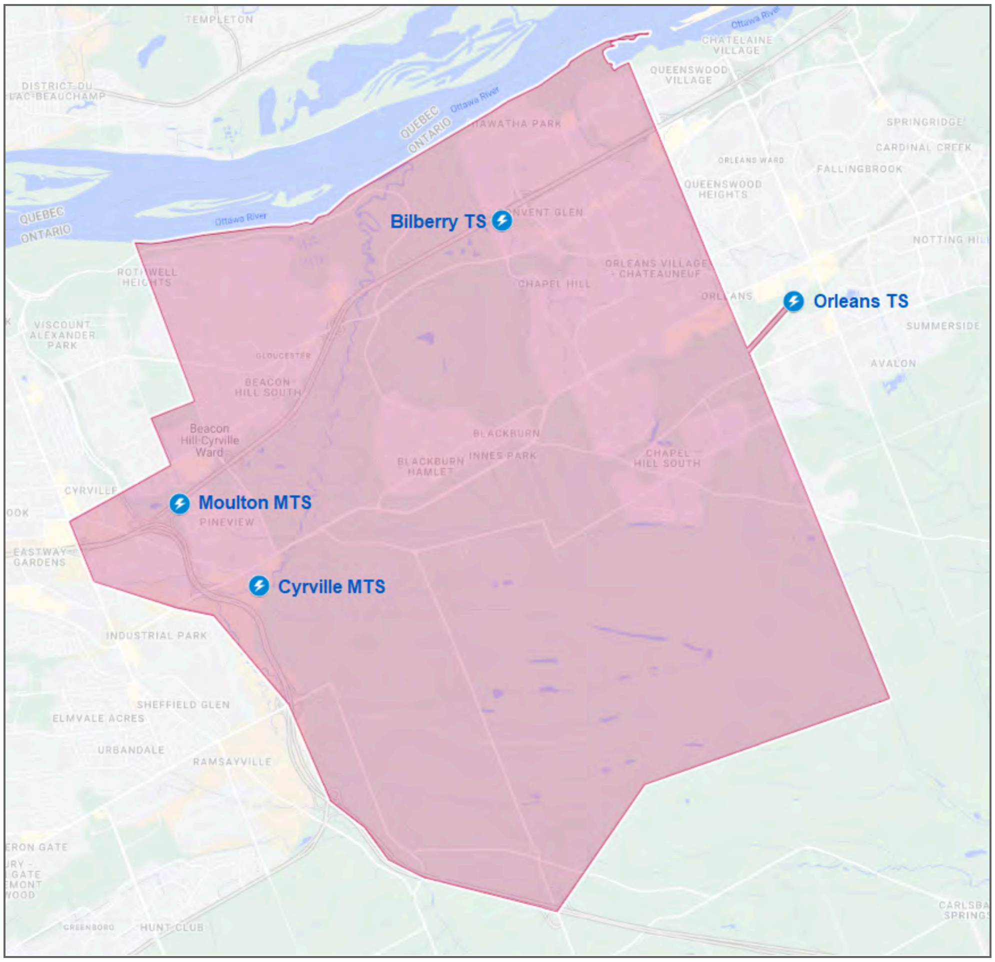
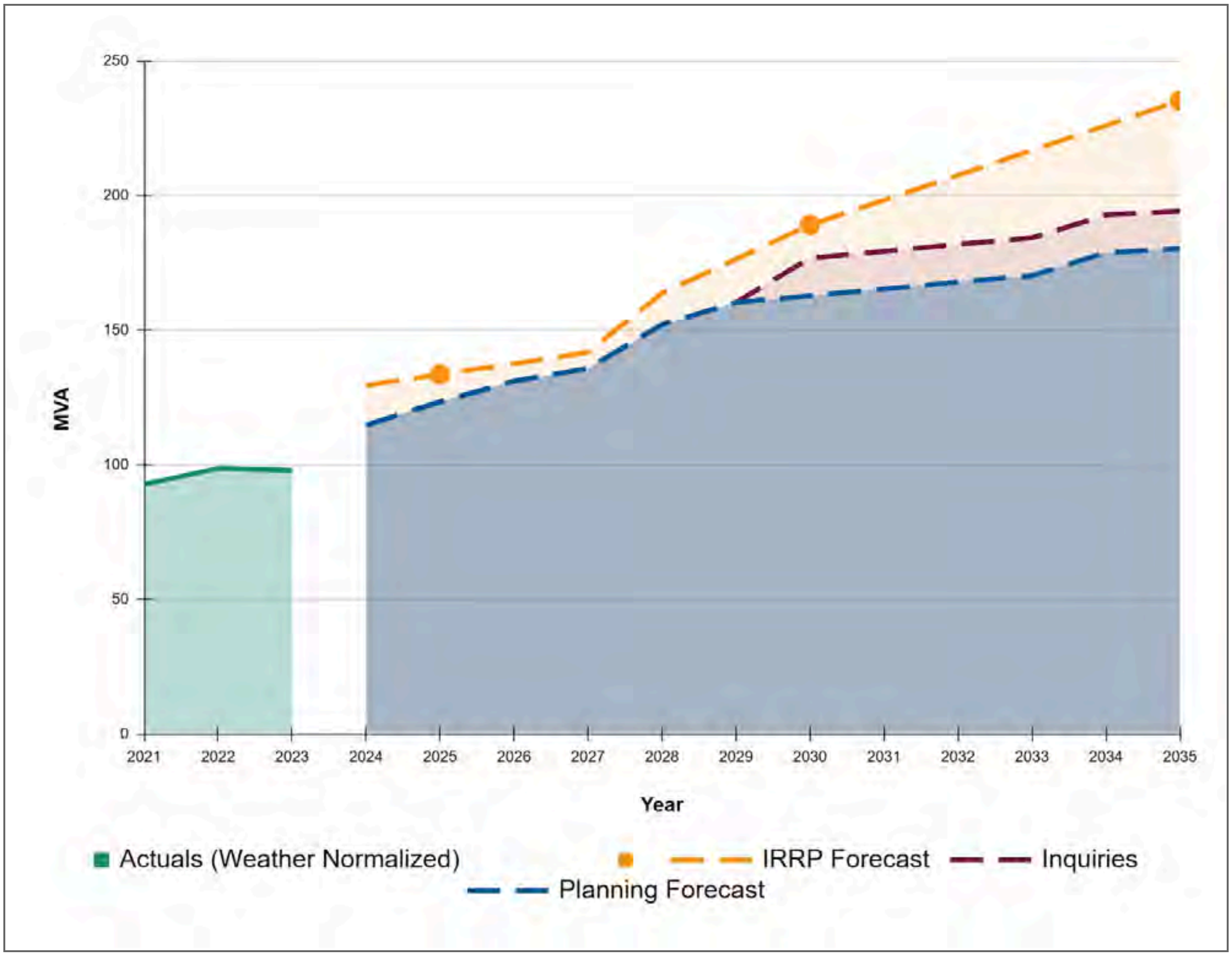


Figure 80 illustrates the weather normalized actuals, the planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

Figure 80 - East 28kV Planning Forecast and IRRP Forecast



New Mer Bleue MTS (System Service-Capacity Upgrade)

Hydro Ottawa will energize a new station in 2028, Mer Bleue MTS. The station will include two 100 MVA transformers and eight feeders. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This capacity upgrade investment is consistent with the Needs Assessments by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 -

Coordinated Planning with Third Parties. A joint transmission supply evaluation with Hydro One and the IESO through the regional planning process is underway to determine the most feasible and reliable power delivery option for Mer Bleue MTS.

Cyrville MTS Upgrade (System Service-Capacity Upgrade)

The existing Cyrville MTS is proposed to be upgraded by replacing two existing 50 MVA transformers with 100 MVA by 2028 to cater to a large load request.[33] For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This capacity upgrade aligns with the IRRP working group Needs Assessments as part of the regional planning process. A comprehensive transmission supply evaluation, conducted with Hydro One and the IESO, will determine the most feasible and reliable power delivery solution for the upgraded Cyrville MTS.

9.1.4.2.4. West 28kV System

The West 28kV supply region encompasses the majority of Kanata South, most of the township of Stittsville, and the western region of Goulbourn. These areas are supplied by Bridlewood MTS and Terry Fox MTS in Kanata South, Janet King DS in Stittsville, and the BECK-F2 feeder, supplied from Hydro One-owned Beckwith DS, in Goulbourn, as shown in Figure 81. Upon completion, the upgraded Richmond South MTS will provide 28kV supply to the Richmond area, which is currently supplied at 8kV.

[33] Government of Canada,"Government of Canada announces milestones for new science facilities in National Capital Area" https://www.canada.ca/en/public-services-procurement/news/2024/07/government-of-canada-announces-milestones-for-new-science-facilities-in-national-capital-area.html

Figure 81 - West 28kV Supply Region

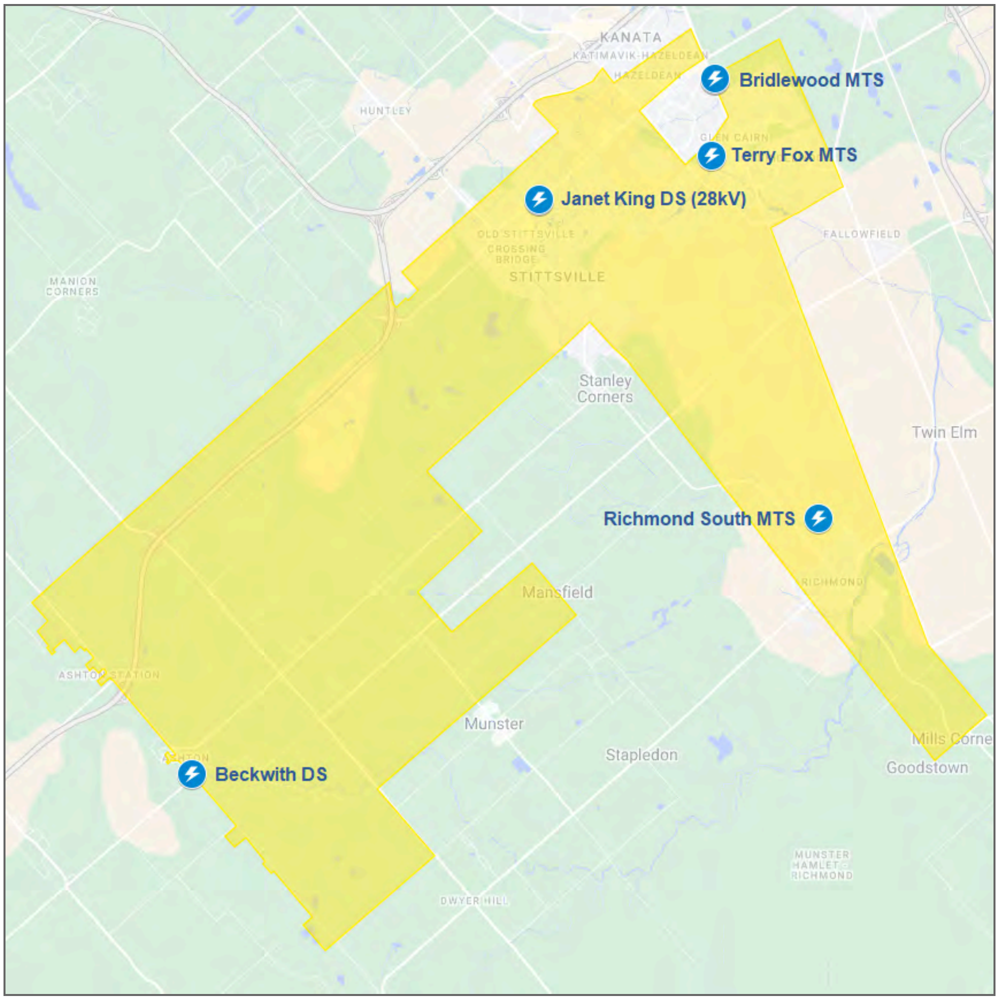
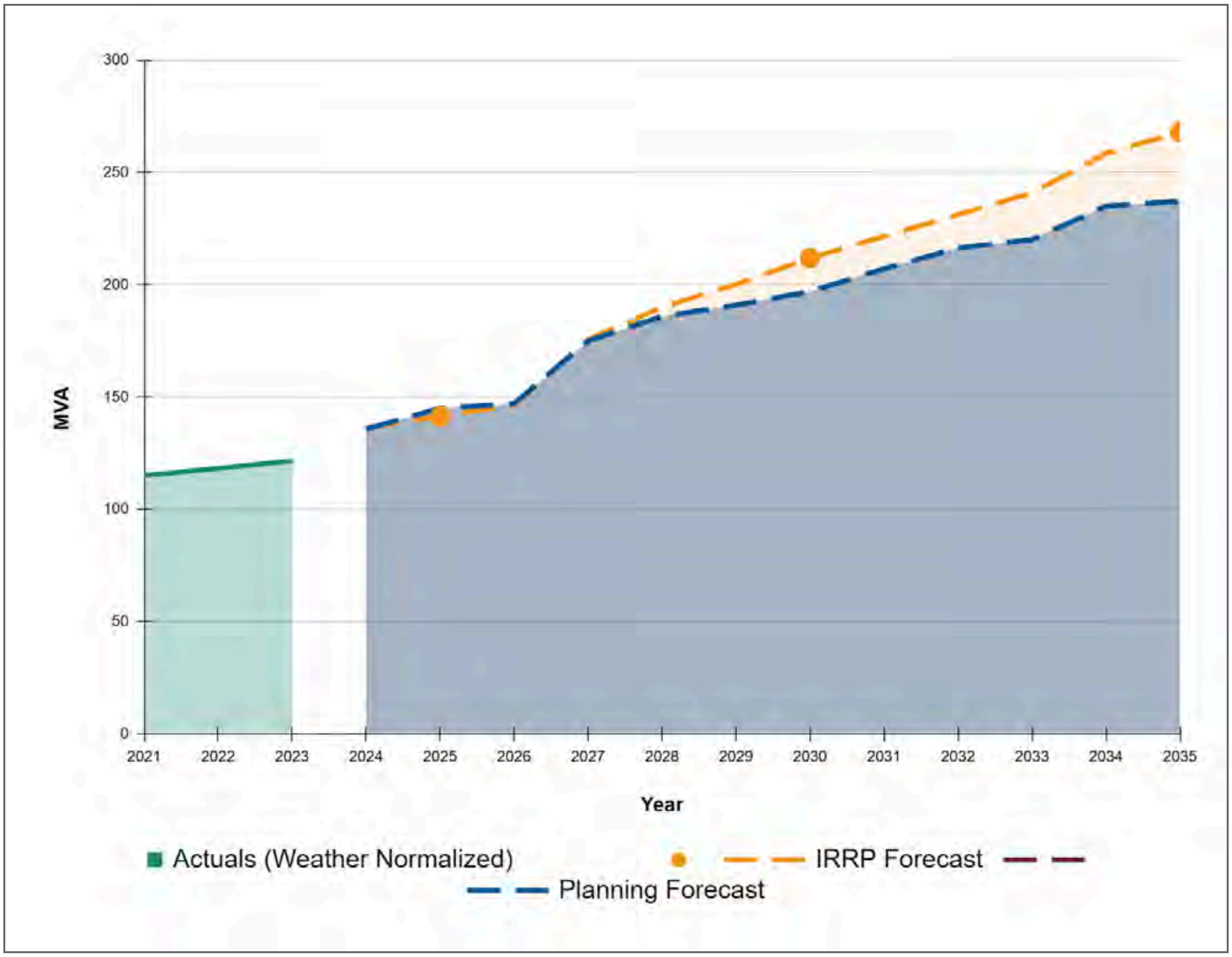


Figure 82 the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. primarily due to the large load from the Department of National Defence in this area, coupled with ongoing electrification and development projects.

Figure 82 - West 28kV Planning Forecast and IRRP Forecast



Richmond South MTS Station Upgrade (System Access - System Expansion)

The Richmond South MTS station upgrade and feeders expansion addresses a large load request from the Department of National Defence.[34] For more details on the need and justification of this investment please refer to Section 4.3.2 of Schedule 2-5-6 - System Access Investments.

[34] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/

Non-Wires Solutions

A 2.5MW utility owned BESS is being proposed for this region. For more details on the need and justification of these solutions refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.2.5. West 28kV (North) System

The West 28kV (North) region encompasses the areas supplied by Kanata MTS and Marchwood MTS, both located at the Station Road site in Kanata North, as shown in Figure 83.

Figure 83 - West 28kV (North) Supply Region

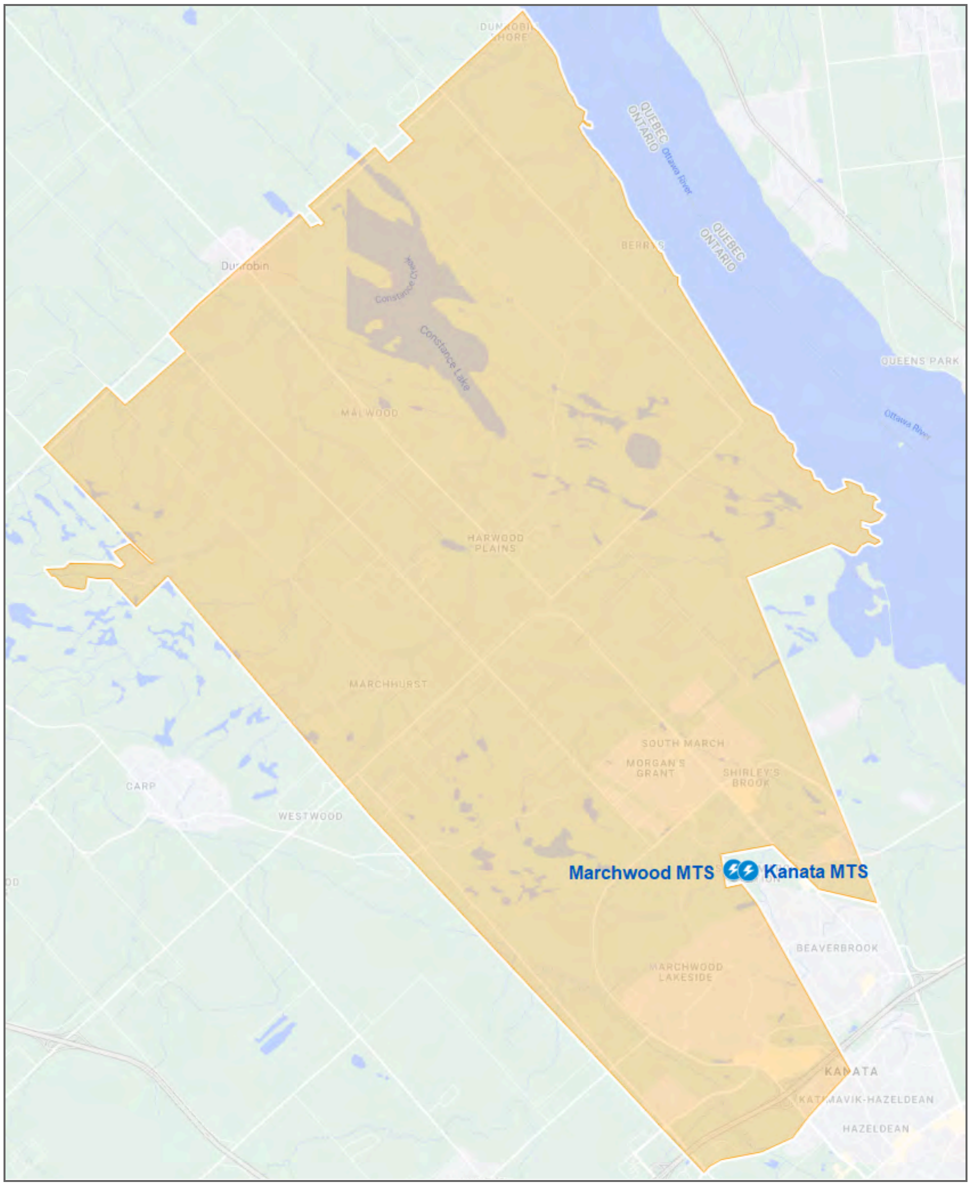
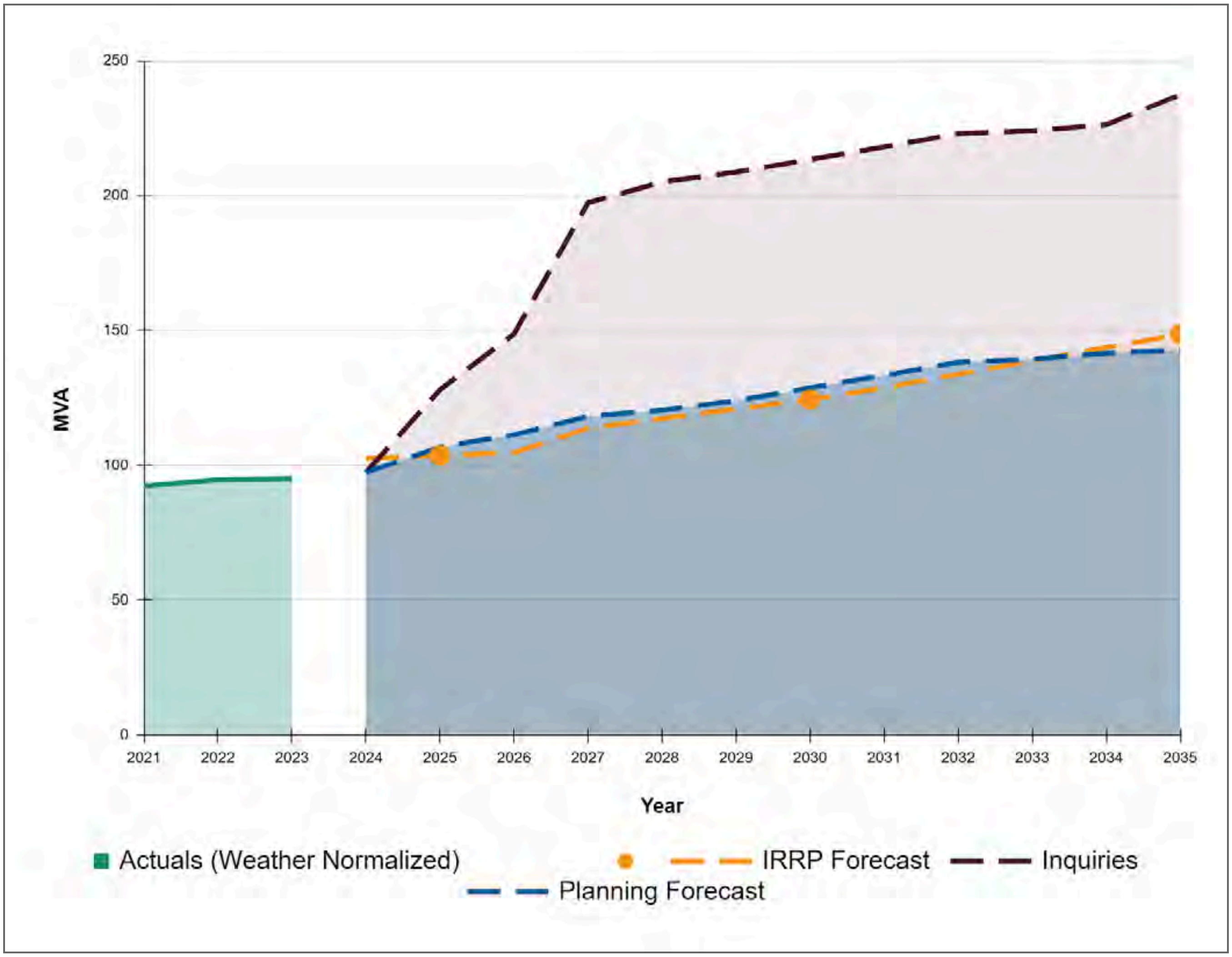


Figure 84 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

Figure 84 - West 28kV (North) Planning Forecast and IRRP Forecast



Since completing the planning forecast, Hydro Ottawa has seen increased data center connection requests in the region. While increased data center load is expected, market uncertainty exists regarding grid connectivity versus on-site generation and load growth within the service territory. Given these uncertainties, Hydro Ottawa will continue to monitor and assess the need as the market evolves.

New Kanata North MTS (System Service-Capacity Upgrade)

A new 230 kV-connected 28 kV station with 100 MVA capacity and eight new feeders is proposed in the West 28kV (North) region. This station is scheduled to be energized in 2028. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This investment aligns with the Needs Assessments completed by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties. A joint transmission supply evaluation with Hydro One and the IESO through the regional planning process is underway to determine the optimal power delivery solution.

Non-Wires Solutions

Non-Wires Customer Solutions are being evaluated to provide peak demand support as an interim measure to manage capacity constraints. For more details on the need and justification of these solutions refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.3. 8 kV System

Hydro Ottawa 8kV supply system is comprised of five main regions:

1. Nepean 8kV
2. Bells Corners/Bayshore 8kV
3. Barrhaven 8kV
4. West 8kV
5. Casselman 8kV
6. East 8kV

Of the twenty-three 8kV stations, five are supplied by the 115kV transmission system, one is supplied by both 44kV and 115kV sources, and the remaining seventeen are supplied from 44kV.

9.1.4.3.1. Nepean 8kV System

The Nepean 8kV supply region includes the northern portions of Nepean. This region is supplied by the Manordale MTS, Centrepointe MTS, Woodroffe DS, Epworth MTS, Merivale MTS, Parkwood Hills DS, Borden Farms DS, and Rideau Heights DS. Figure 85 shows the supply region of the Nepean Core 8kV System.

Figure 85 - Nepean 8kV Supply Region

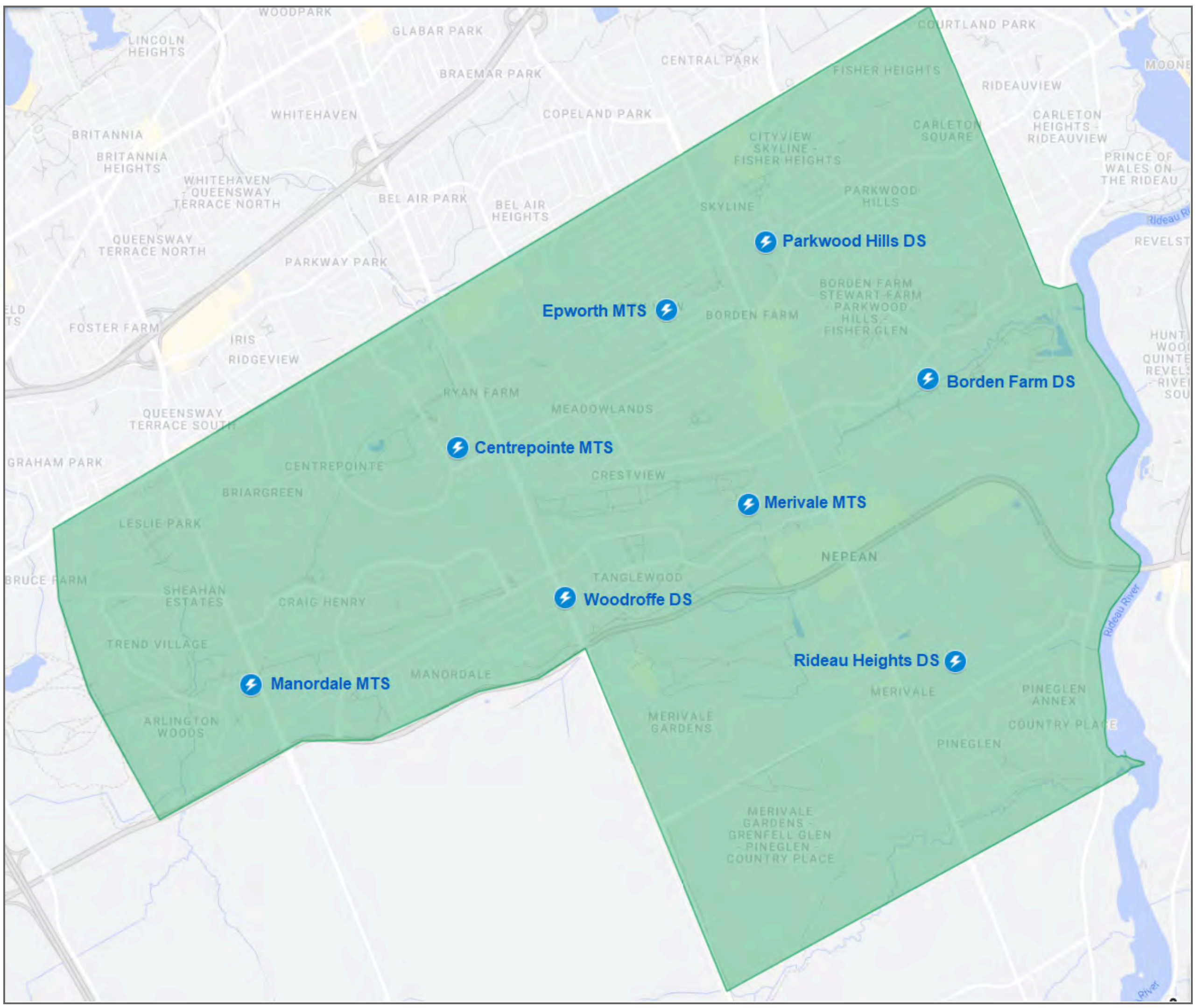
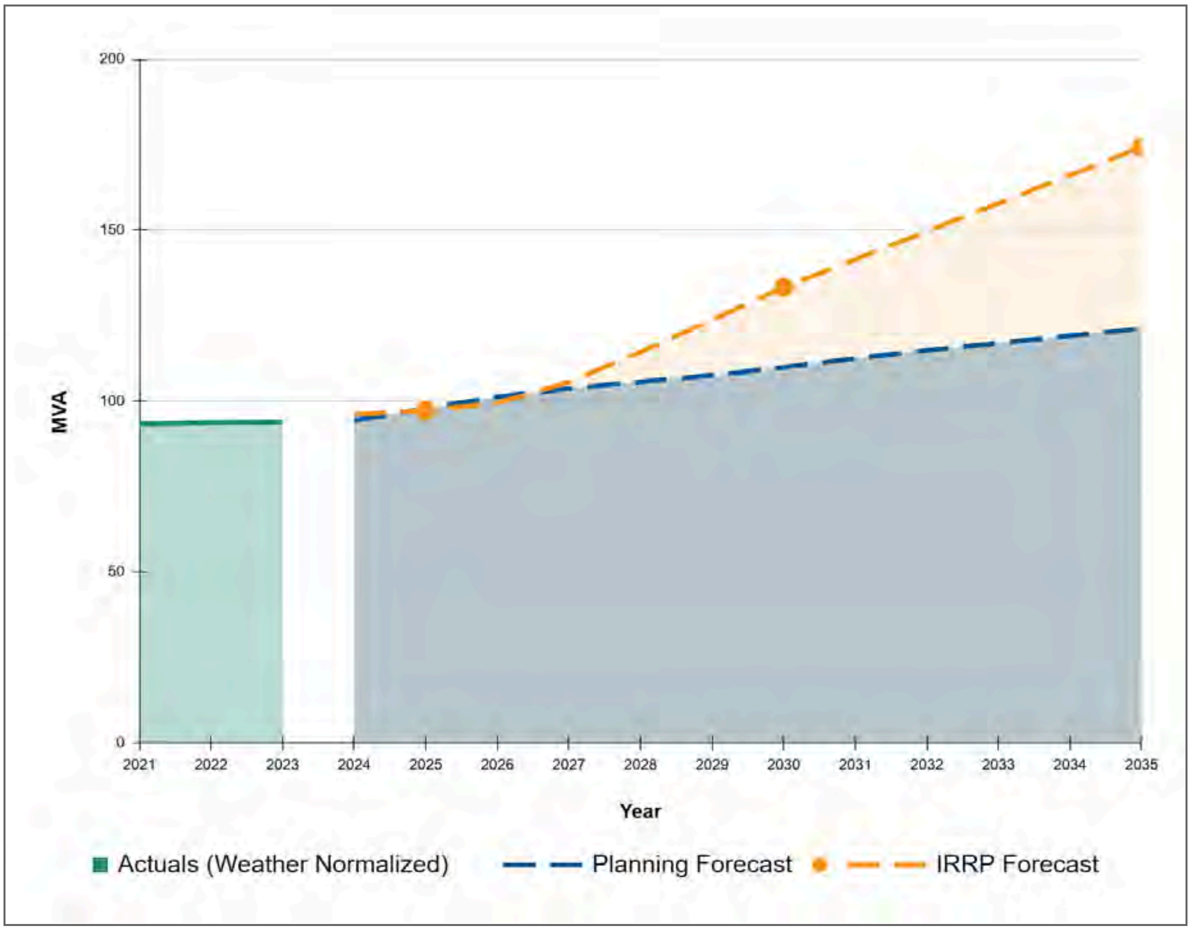


Figure 86 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. Centrepointe MTS and Manordale MTS in this region are exceeding their planning capacity ratings, as noted in Table 29 above. Growth is concentrated in the Nepean employment area, where trunk feeders are at or nearing their capacity limits and existing feeder interconnections are limited. Several feeders in this region have exceeded their planning capacity, as noted in Table 32 above.

Figure 86 - Nepean 8kV Planning Forecast and IRRP Forecast



Switching operations were performed on Parkwood Hills DS feeders in 2024 to reduce overloaded feeders below planning capacity. Similar switching operations are planned for the Borden Farm DS feeder. Rideau Heights DS has limited ties options, making load transfers difficult.

- The 8 kV system presents several challenges:
  - Compared to 28 kV, 8 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 28 kV remains effective up to 15km.
  - The maximum capacity of an 8 kV feeder is 3.6MVA, versus 16.4MVA for a 28 kV feeder, significantly limiting the ability to accommodate the large load requests.
  - Heavy loading on the 8 kV stations in the Nepean and Barrhaven regions is hindering new customer connections.

The new Greenbank MTS expected to energize in 2028 will support the growth in this region, please see further details in Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

9.1.4.3.2. Bells Corners/Bayshore 8kV System

The Bells Corners/Bayshore 8kV supply region covers the northwest portion of Nepean. This region is supplied by Bayshore DS, Queensway-Carleton Hospital (Q.C.H) DS, Stafford Road DS, and Bells Corners DS, as shown in Figure 87.

Figure 87 - Bells Corners/Bayshore 8kV Supply Region

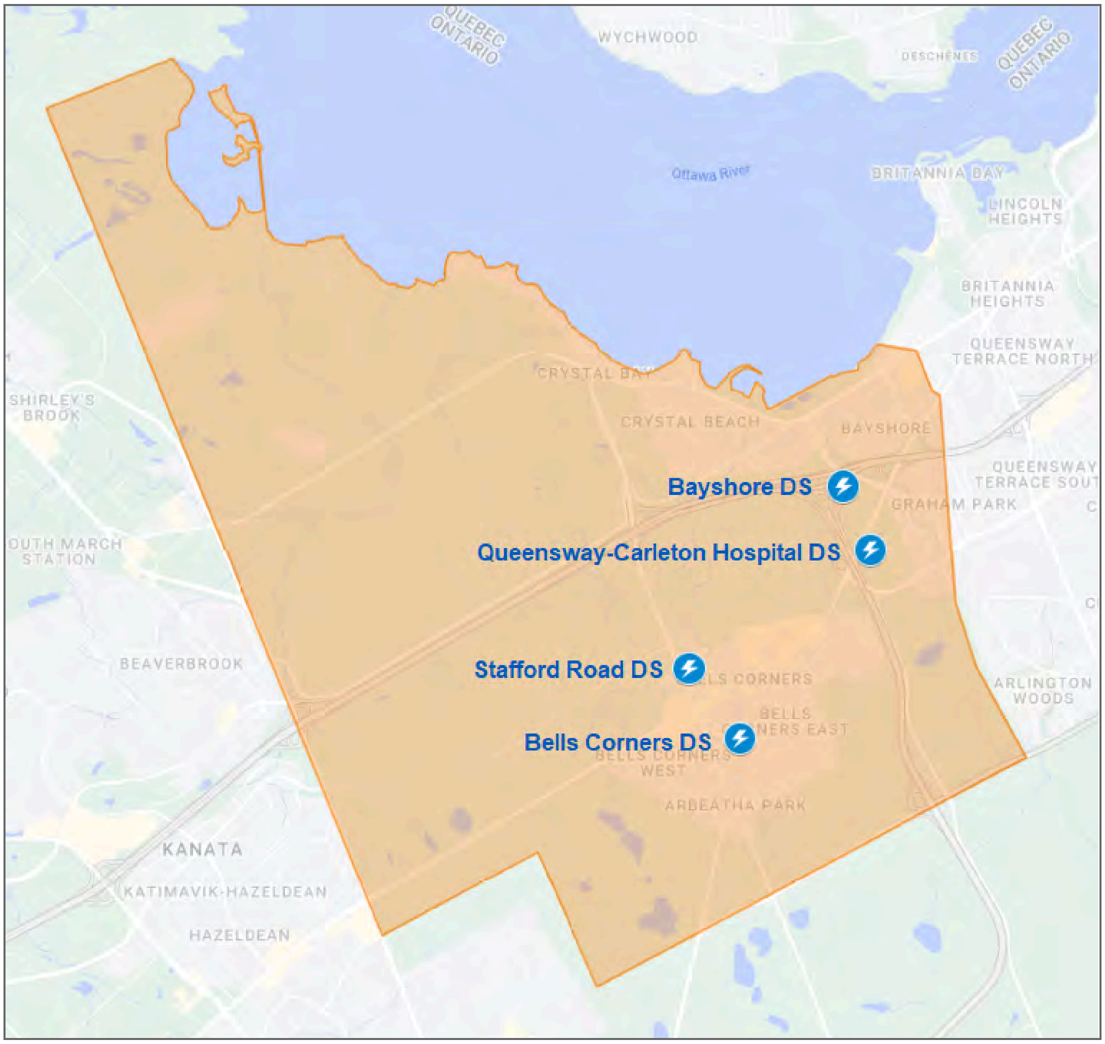
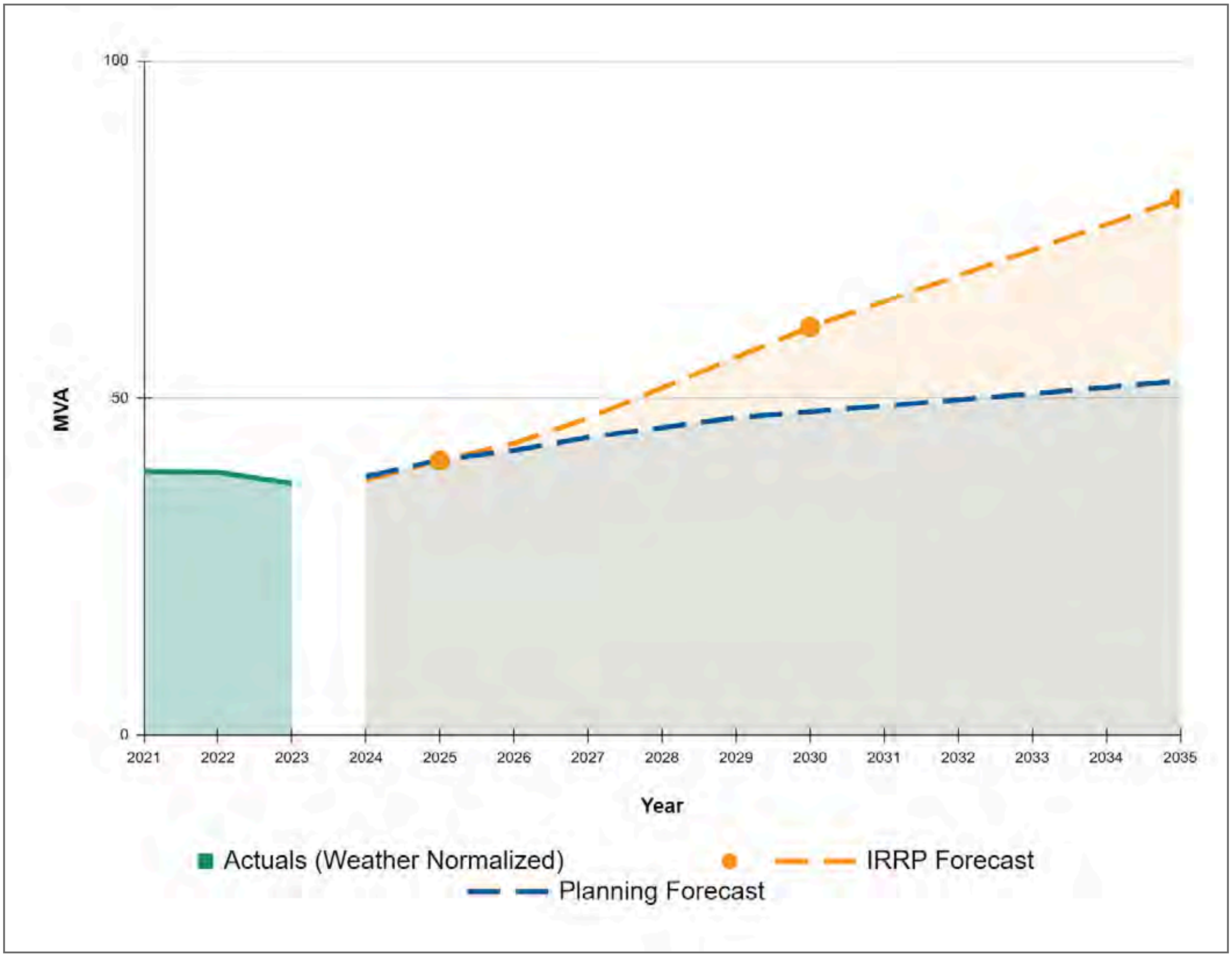


Figure 88 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. While no stations are exceeding their planning capacity, Bayshore DS and Stafford DS are approaching their limits.

Figure 88 - Bells Corners/Bayshore 8kV Planning Forecast and IRRP Forecast



Bells Corners DS underwent a full rebuild in 2023, replacing two transformers with three 12.5MVA units to facilitate the decommissioning of Stafford DS by 2026. Load from Stafford DS T2 has already been transferred to Bells Corners DS, and the T1 is scheduled for transfer in 2025 after feeder extensions from Bells Corners are completed.

Non-Wires Solutions

Hydro Ottawa proposes 7 MW of utility owned BESS to manage peak load in this region. For more details on the need and justification of this solution refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.3.3. Barrhaven 8kV System

Hydro Ottawa operates two 8kV substations in the Barrhaven 8kV region: Barrhaven DS and Jockvale DS, as shown in Figure 89.

Figure 89 - Barrhaven 8kV Supply Region

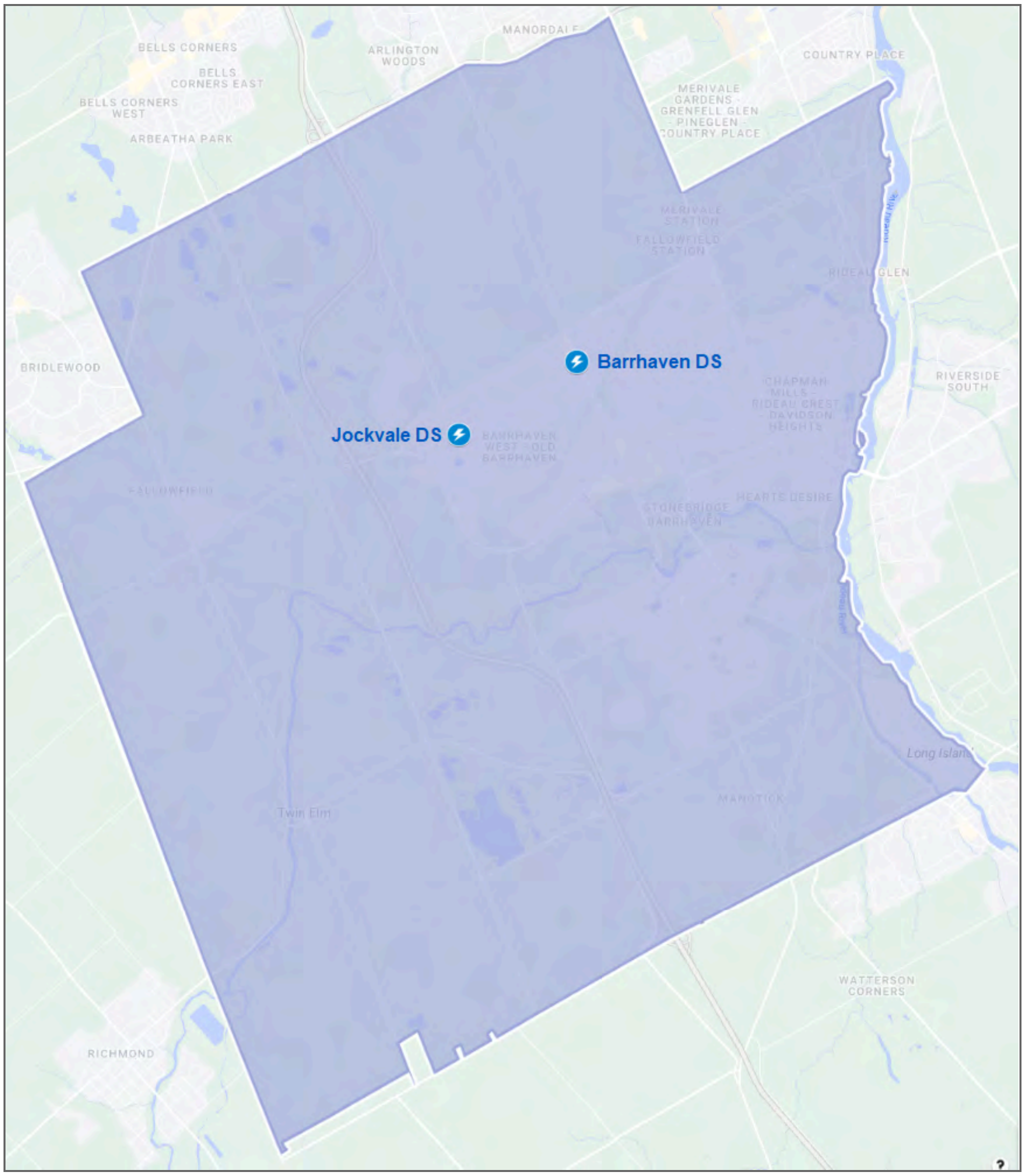
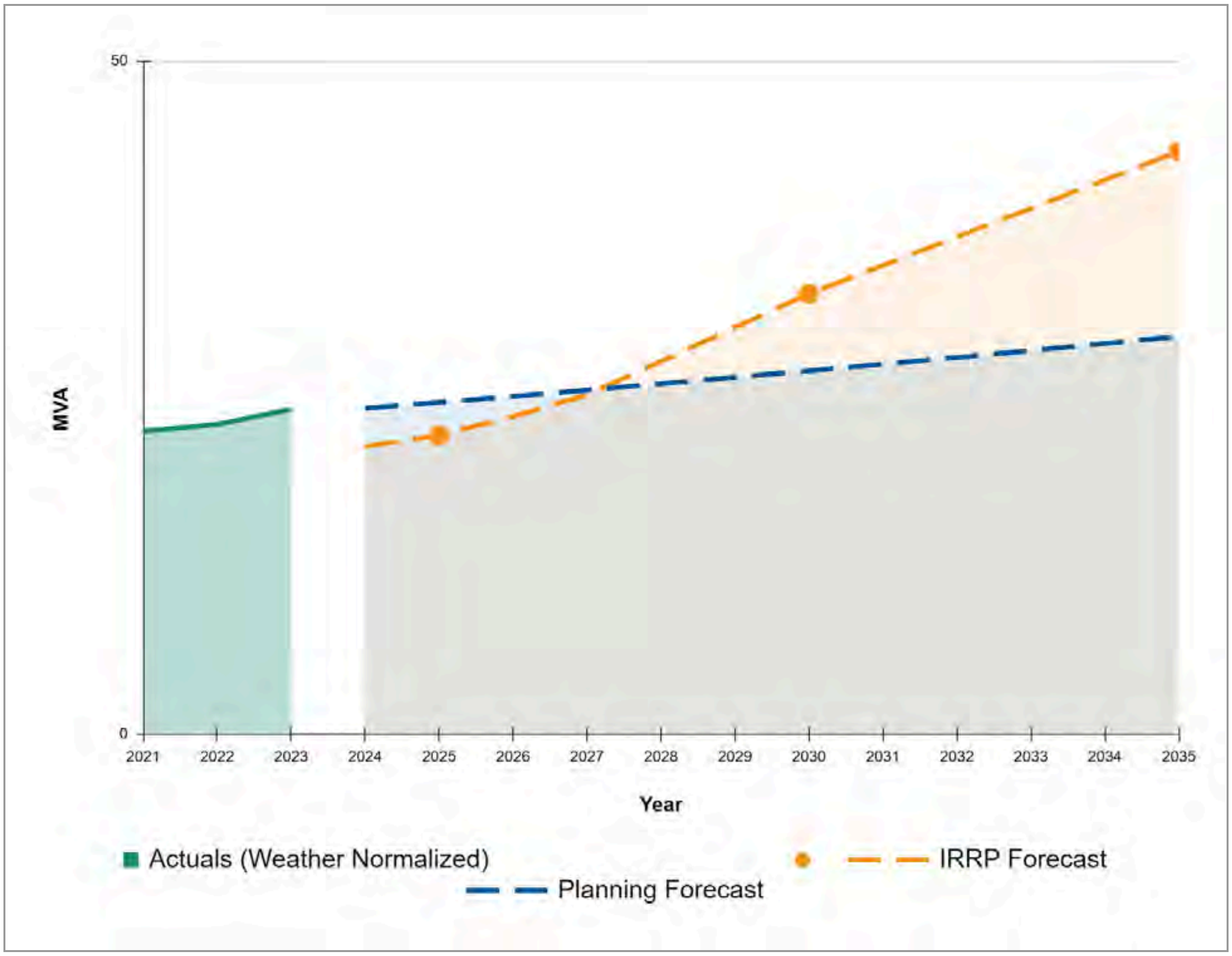


Figure 90 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. Since the Barrhaven 8kV region falls within the South 28kV supply region, most new developments will connect to the 28kV system. To address the overloaded feeders, switching operations are planned to balance the loading and customer count, ensuring all feeders operate within the established limits. Long-term plans include gradually decommissioning the Barrhaven 8kV system through voltage conversion to 28kV.

Figure 90 - Barrhaven 8kV Planning Forecast and IRRP Forecast



- The 8 kV system presents several challenges:
  - Compared to 28 kV, 8 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 28 kV remains effective up to 15km.

- The maximum capacity of an 8 kV feeder is 3.6MVA, versus 16.4MVA for a 28 kV feeder, significantly limiting the ability to accommodate the large load requests.
- Heavy loading on the 8 kV stations in the Nepean and Barrhaven regions is hindering new customer connections.

The new Greenbank MTS expected to energize in 2028 will support the growth in this region, please see further details in Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

9.1.4.3.4. West 8kV System

The West 8kV supply region covers Glen Cairn, parts of Stittsville, Richmond Village, Munster and rural Goulbourn. These areas are supplied by Bridlewood MTS in Kanata, Janet King DS in Stittsville, Richmond North DS and Richmond South MTS in Richmond Village and Goulbourn, and Munster DS in Munster. Figure 91 shows the supply region of the West 8kV System.

Figure 91 - West 8kV Supply Region

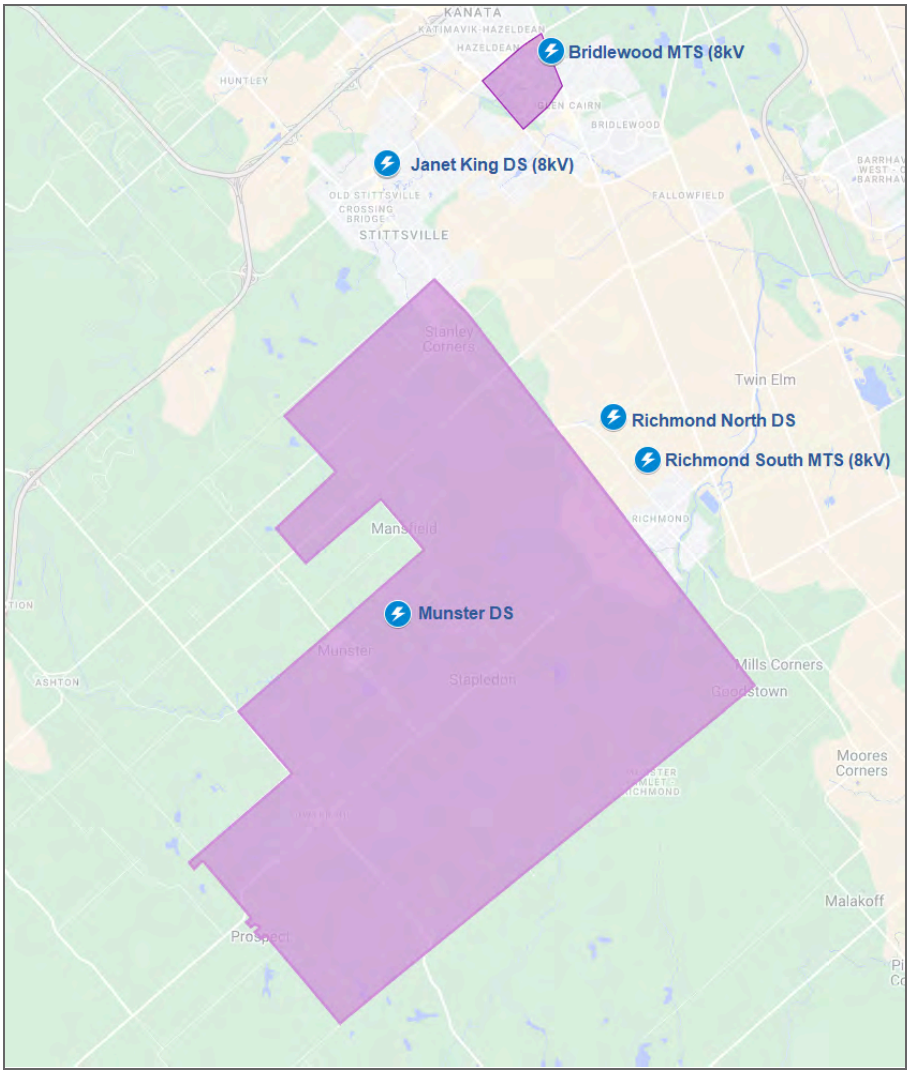
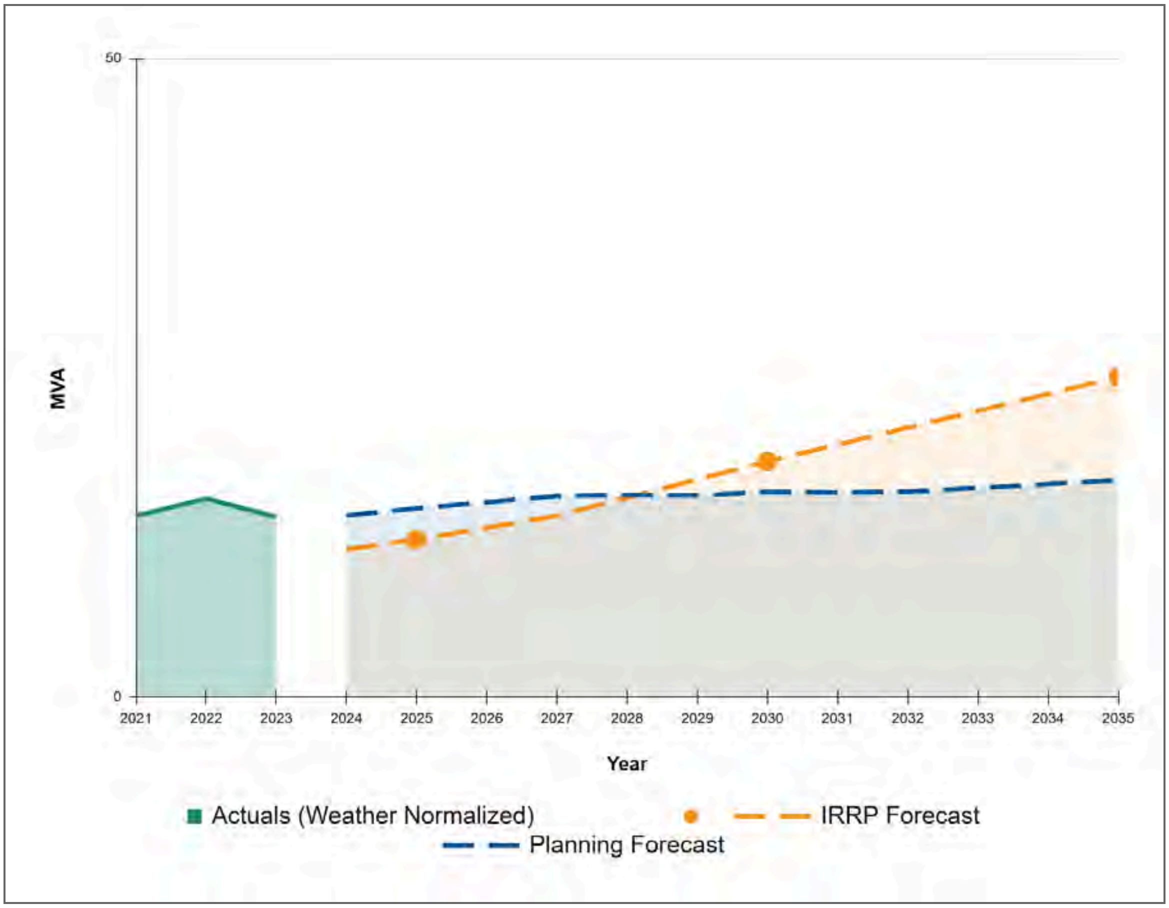


Figure 92 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 92 - West 8kV Planning Forecast and IRRP Forecast



The West 8kV area covers a large geographical region with limited backup feeder options between stations, except for Richmond North DS and the 8kV feeders from Richmond South MTS. Completed in 2019, upgrades to Richmond South MTS introduced the 28kV system in this region. The station has two 3MVA step-down transformers to supply the remaining 8kV load until the phased voltage conversion to 28kV is complete. Voltage conversion projects in this region will be done through System Renewal as assets reach end of useful life and are identified for replacement due to limitations on the 8kV system elaborated in Section 9.1.4.3.1 - Nepean 8kV system.

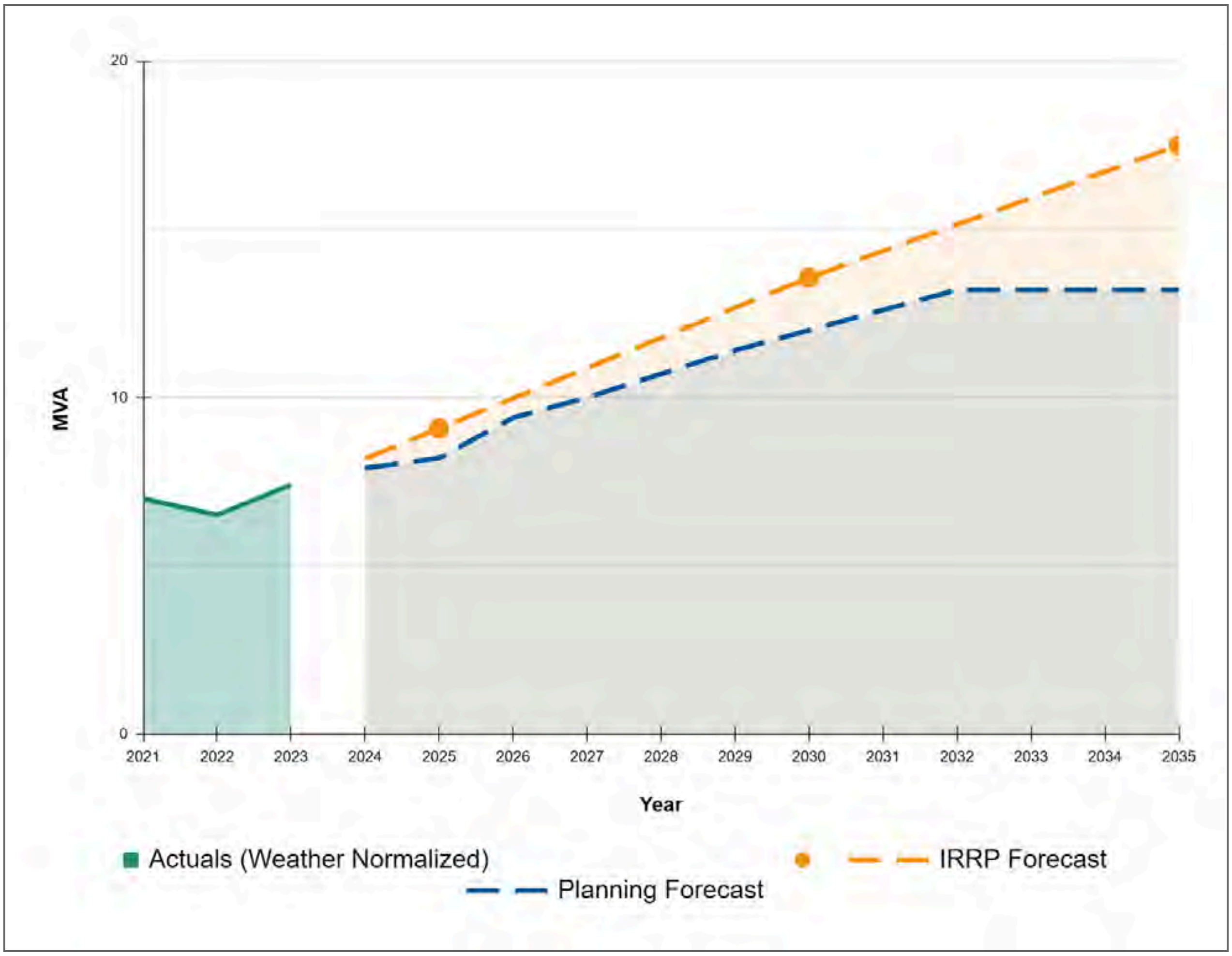
9.1.4.3.5. Casselman 8kV System

The Municipality of Casselman is supplied from a single Hydro Ottawa station, Casselman DS, via four 8kV feeders. One of these feeders serves as a dedicated backup for the others. The Casselman supply area is shown in Figure 93.

Figure 93 - Casselman 8kV Supply Region

Figure 94 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035. Two feeders, CAS-F2 and CAS-F1, are overloaded, see Table 32 above. To address these issues, switching operations and new switches will balance the load among the feeders, ensuring they operate within the established limits.

Figure 94 - Casselman 8kV Planning Forecast and IRRP Forecast



Non-Wires Solutions:

Hydro Ottawa proposes a 5 MW battery to manage peak load in this region. For more details on the need and justification of this solution refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.3.6. East 8kV System

The East 8kV supply region, bounded by the former Gloucester and Ottawa municipal boundary and Highway 417 to the south, as shown in Figure 95, is served by Startop DS, Blackburn DS, and Beacon Hill DS. These stations are supplied from Hawthorne TS.

Figure 95 - East 8kV Supply Region

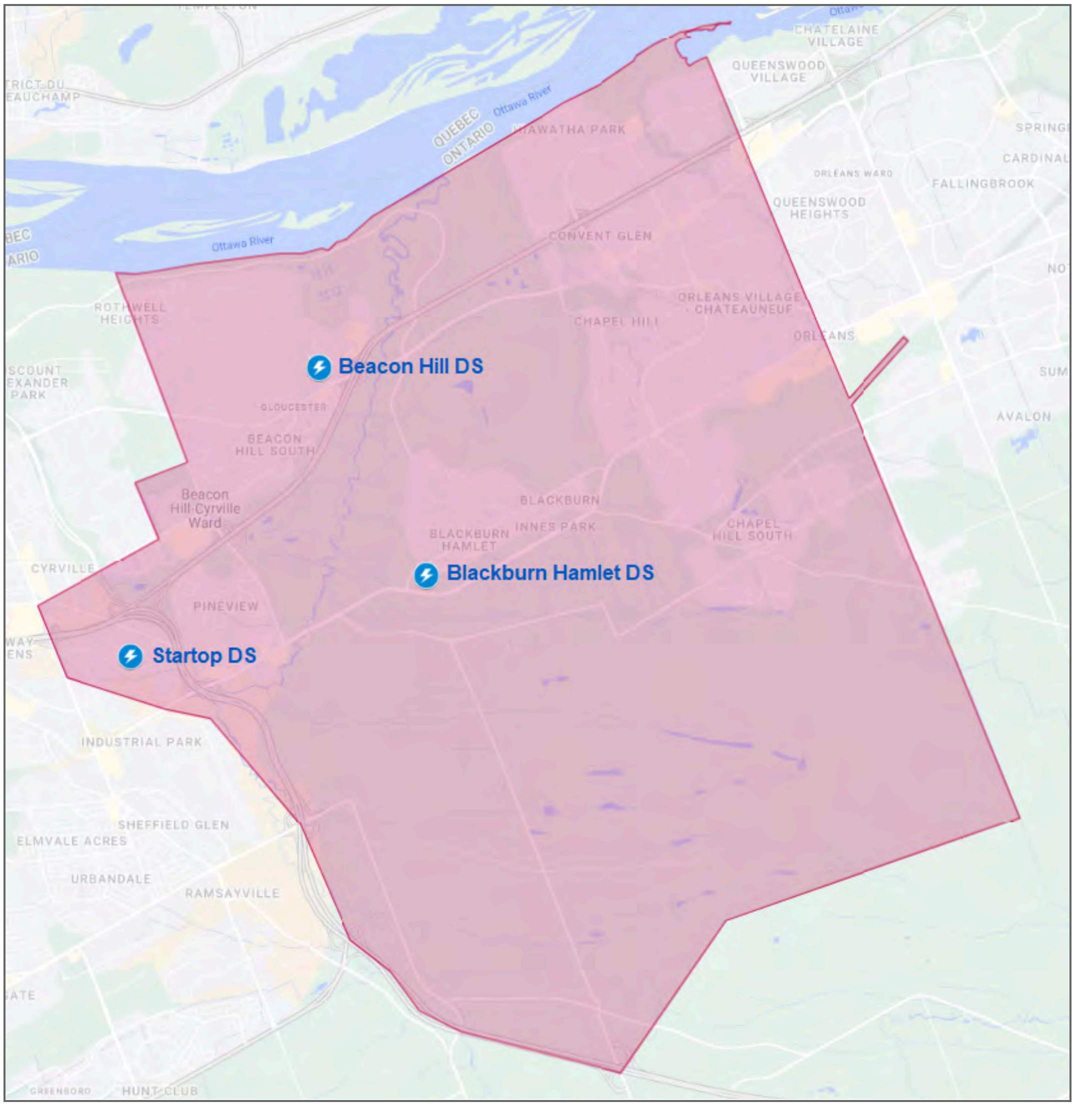
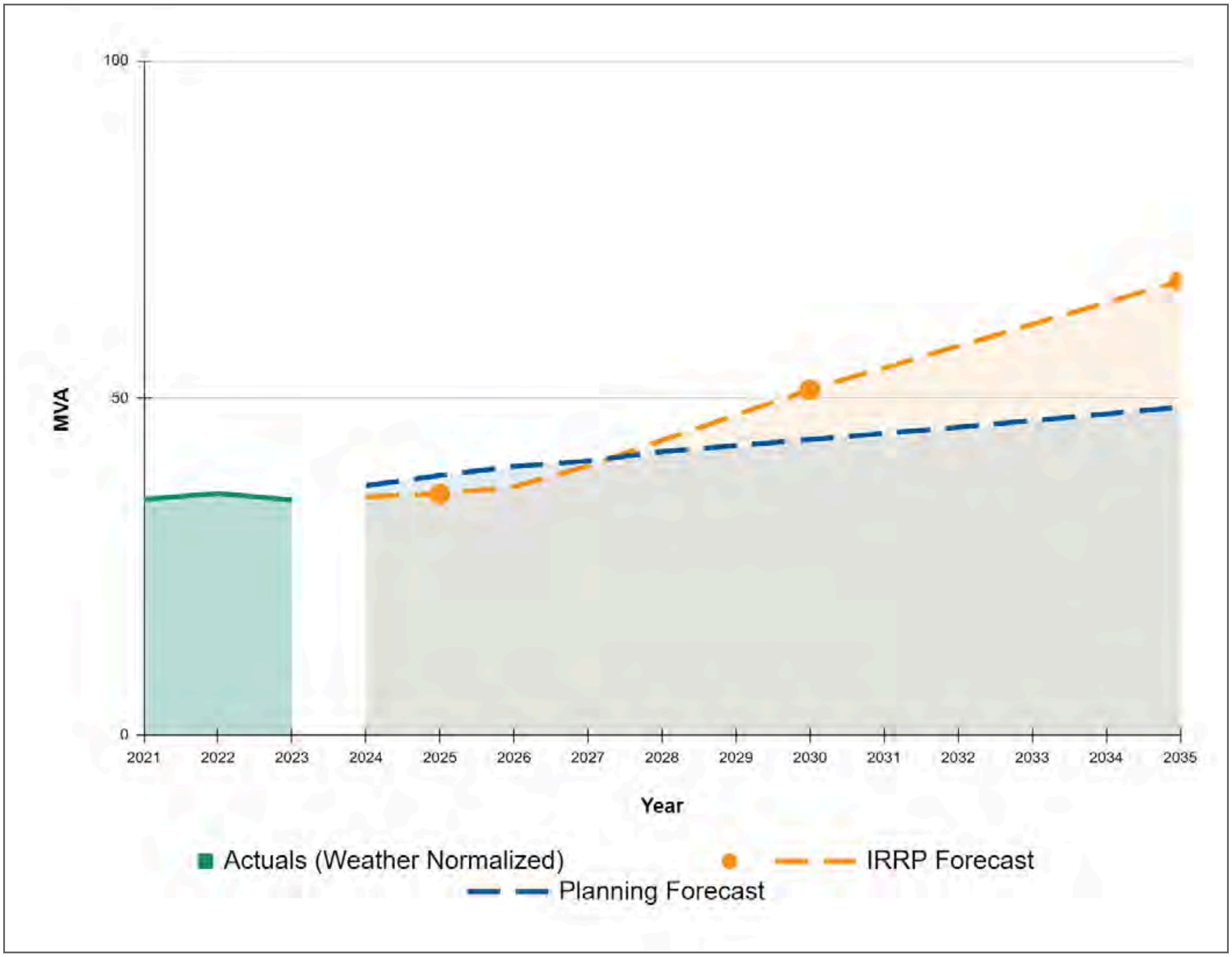


Figure 96 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 96 - East 8kV Supply Area Planning Forecast and IRRP Forecast



One feeder from each of the three stations is currently overloaded, see Table 32 above. To address this, Hydro Ottawa has planned several mitigation strategies. Switching operations are planned to redistribute load from the overloaded feeder at Startop DS and to balance the load at Beacon Hill DS, which has available capacity on other feeders. Additionally, a voltage conversion has been planned at Blackburn DS to transfer several sections to the 28kV system. Since the East 28kV supply region is nearby, any large developments will connect to the 28kV system instead of the East

8kV due to limitations in the 8kV system. This multi-pronged approach aims to ensure the continued reliable operation of the East 8kV system while accommodating future growth and development in the region.

9.1.4.4. 12 kV System

The 12kV system supplies two areas of Kanata, located north and south of Highway 417 at Eagleson Road. These communities are supplied by Beaverbrook MS and South March DS, with the only 12kV distribution ties being connections between these two stations. Refer to Figure 97 for a visual representation of this region.

Figure 97 - 12kV Supply Area

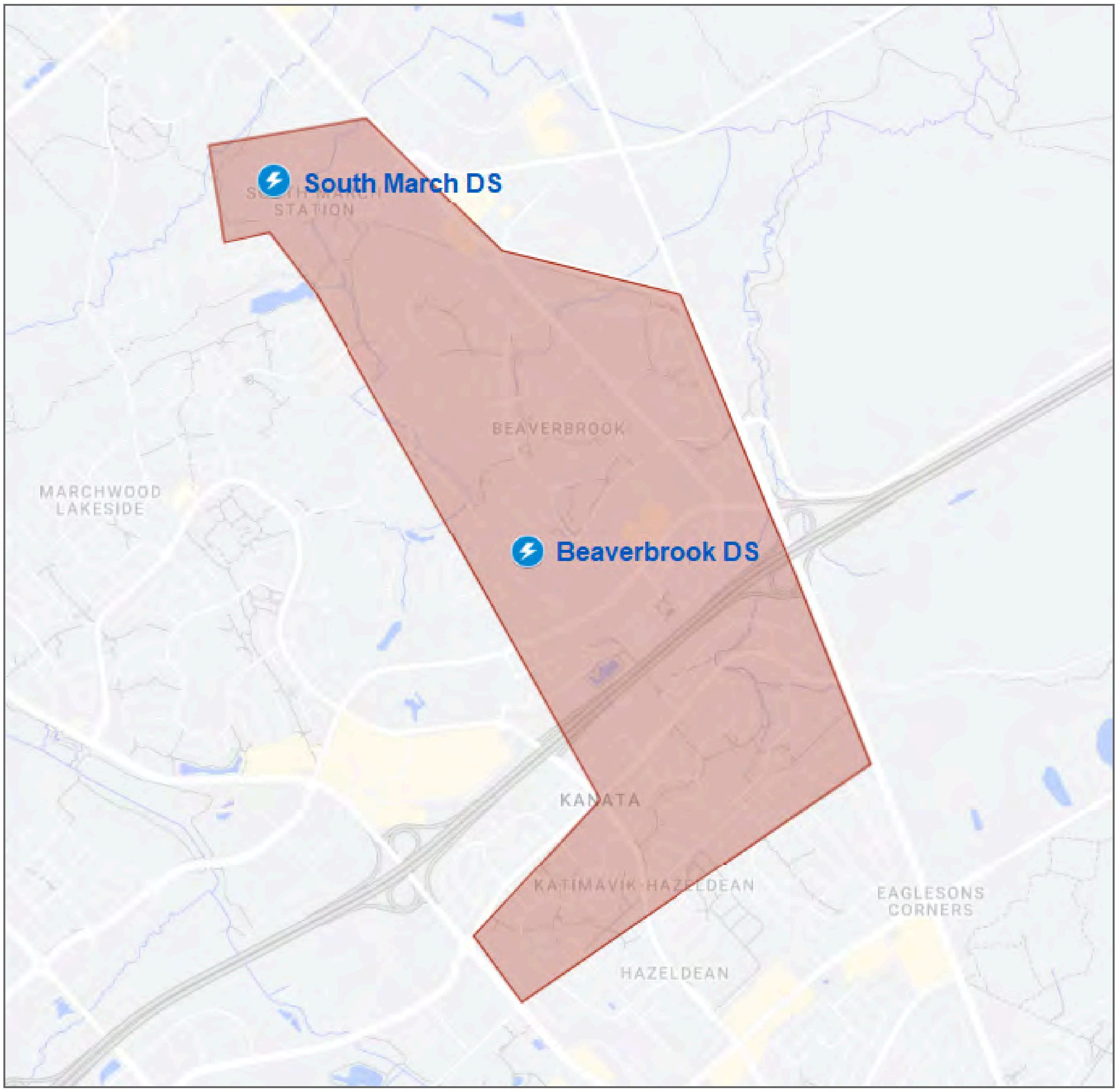
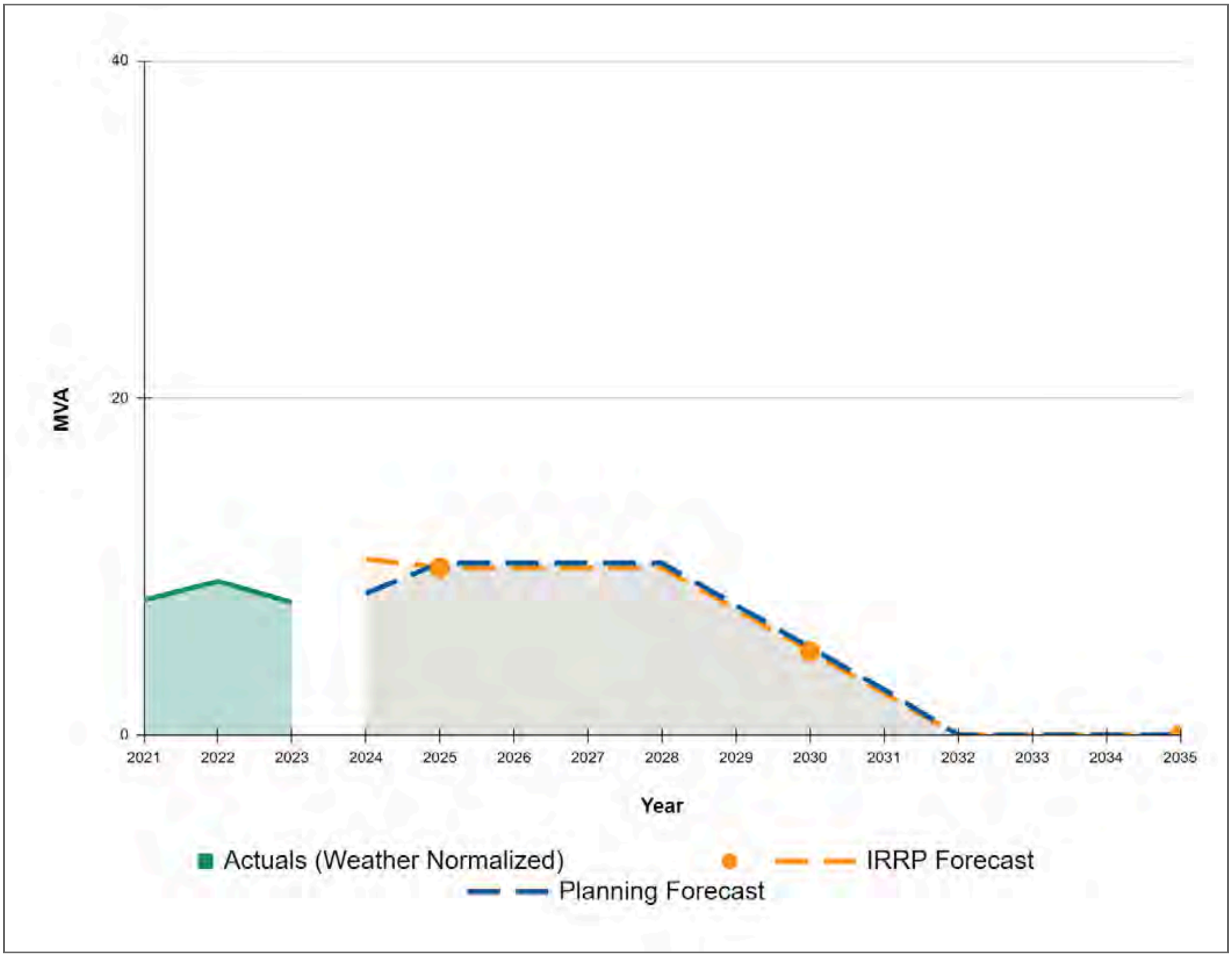


Figure 98 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 98 - 12kV Planning Forecast and IRRP Forecast

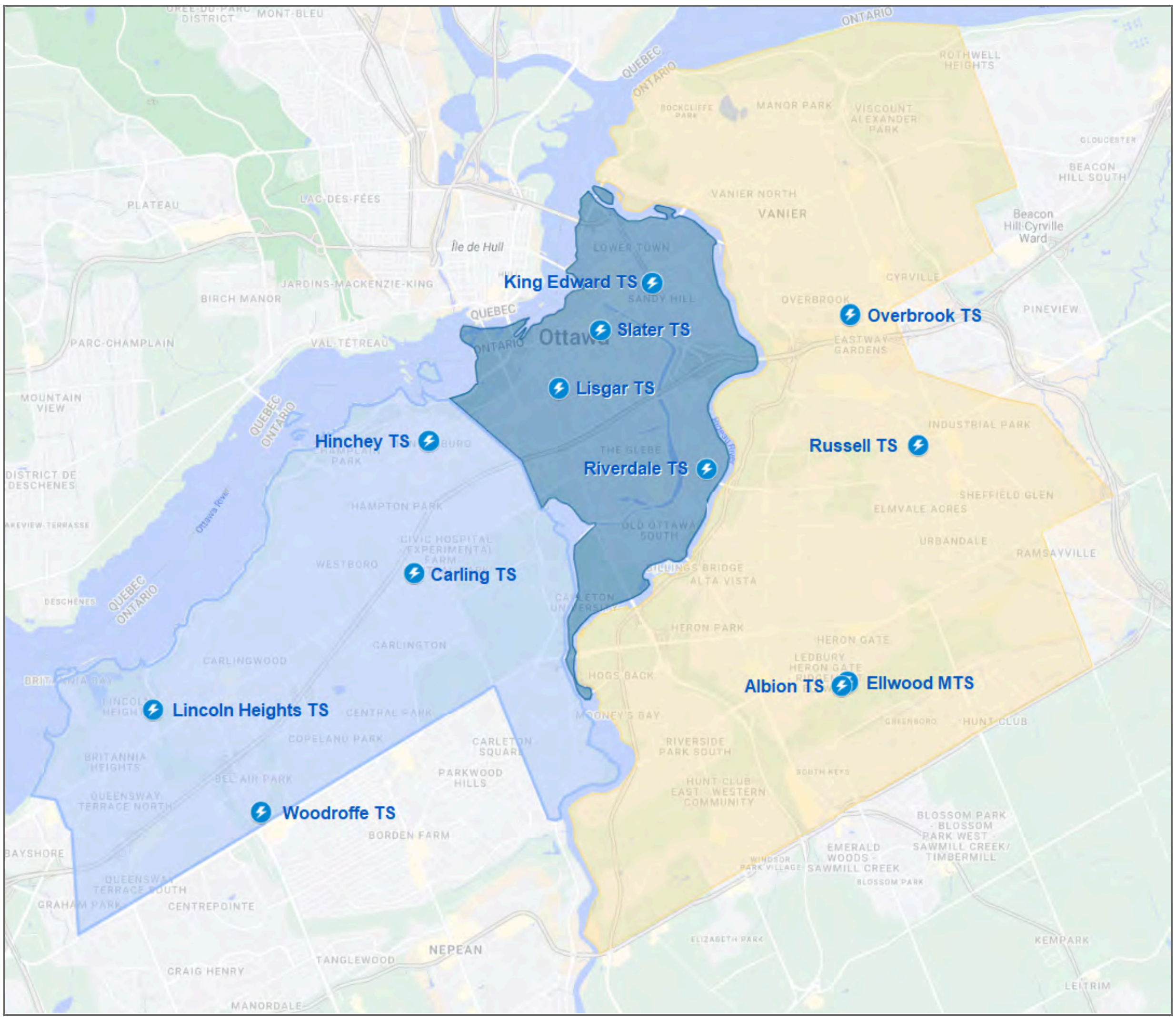


Work has begun to replace end-of-life distribution cables and transformers in preparation for a 28kV conversion. After the new 28kV station in Kanata North, see more details in Section 9.1.4.2.5 - West 28kV (North) System, is energized and the 12kV load is fully transitioned, Beaverbrook DS and South March DS will be decommissioned in phases, starting in 2028.

9.1.4.5. 13 kV System

The Hydro Ottawa 13kV supply region is divided into three areas: West 13kV, Core 13kV, and East 13kV, encompassing 12 stations. These areas align with the 4kV system described in Section 9.1.4.6 - 4kV System. Figure 99 shows the 13kV supply region and station locations.

Figure 99 - 13kV Supply Region

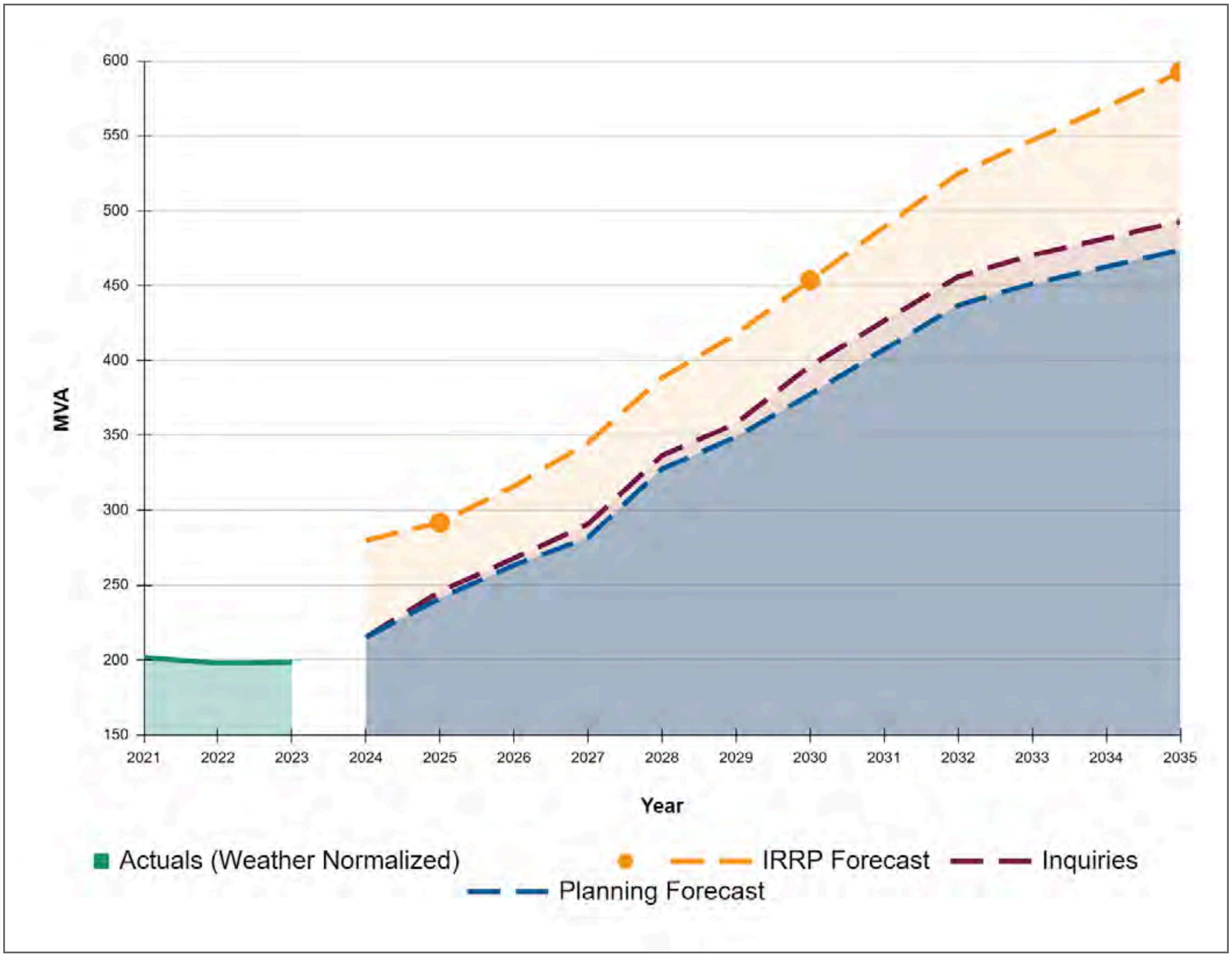


Through the Official Plan, the City of Ottawa is promoting new growth by means of intensification within central Ottawa. This impacts the 13kV system as it covers mostly established areas. Many new developments are trading in low-rise apartments for larger, high-density residential buildings.

West 13kV System

The West 13kV supply region extends from Bayview Yards and west of Preston Street to Bayshore Drive, north of Baseline Road. This region is supplied by Hinchey TH, Carling TS, Woodroffe TS, and Lincoln Heights TS. Hinchey TH also supports the Core 13kV supply region. Figure 100 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

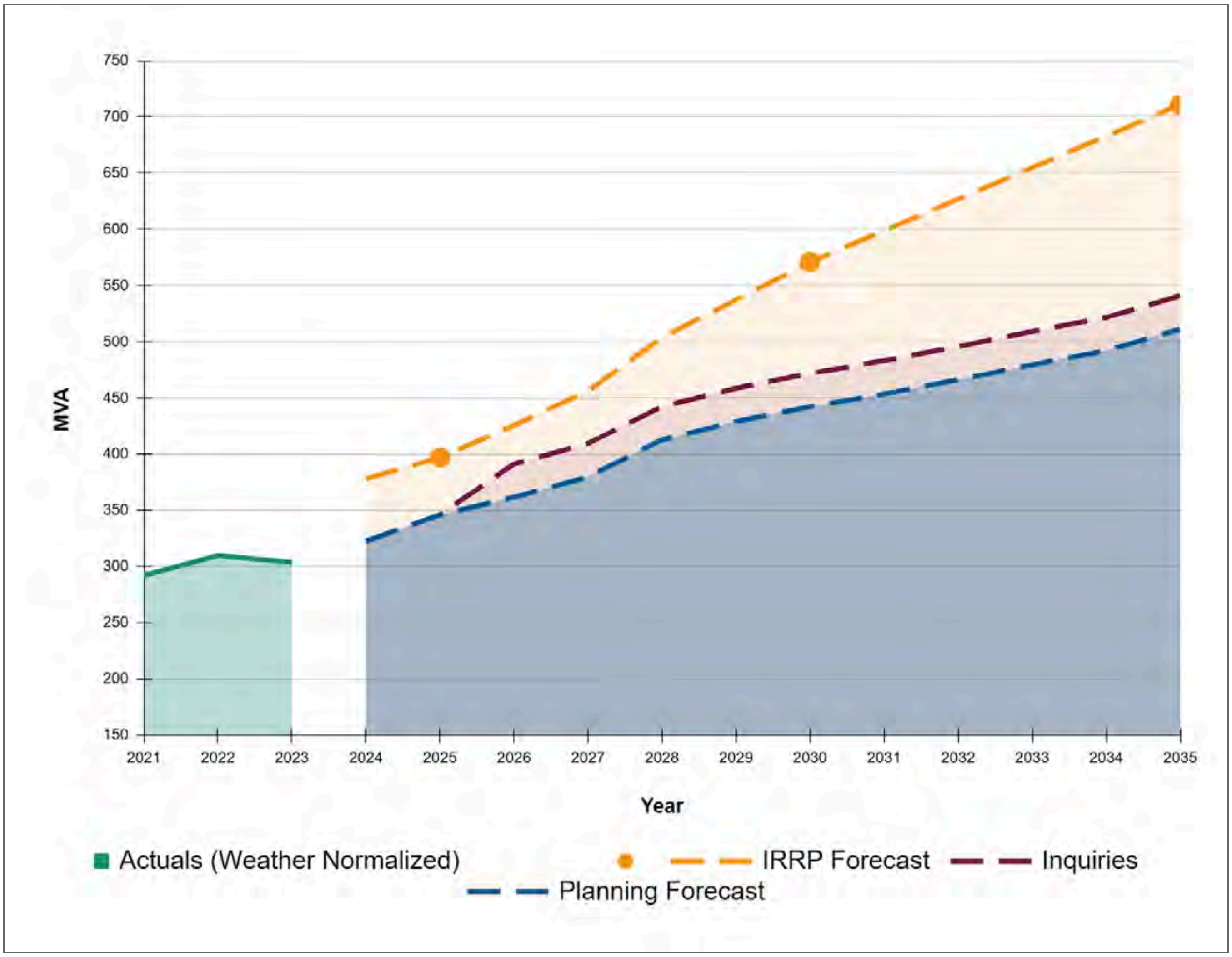
Figure 100 - West 13kV Planning Forecast and IRRP Forecast



Core 13kV System

The Core 13kV area follows the Rideau River to the east and covers LeBreton Flats to the west. This region is supplied by King Edward TS, Slater TS, Lisgar TS and Riverdale TS. Riverdale TS and King Edward TS also support the East 13kV supply region. Figure 101 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

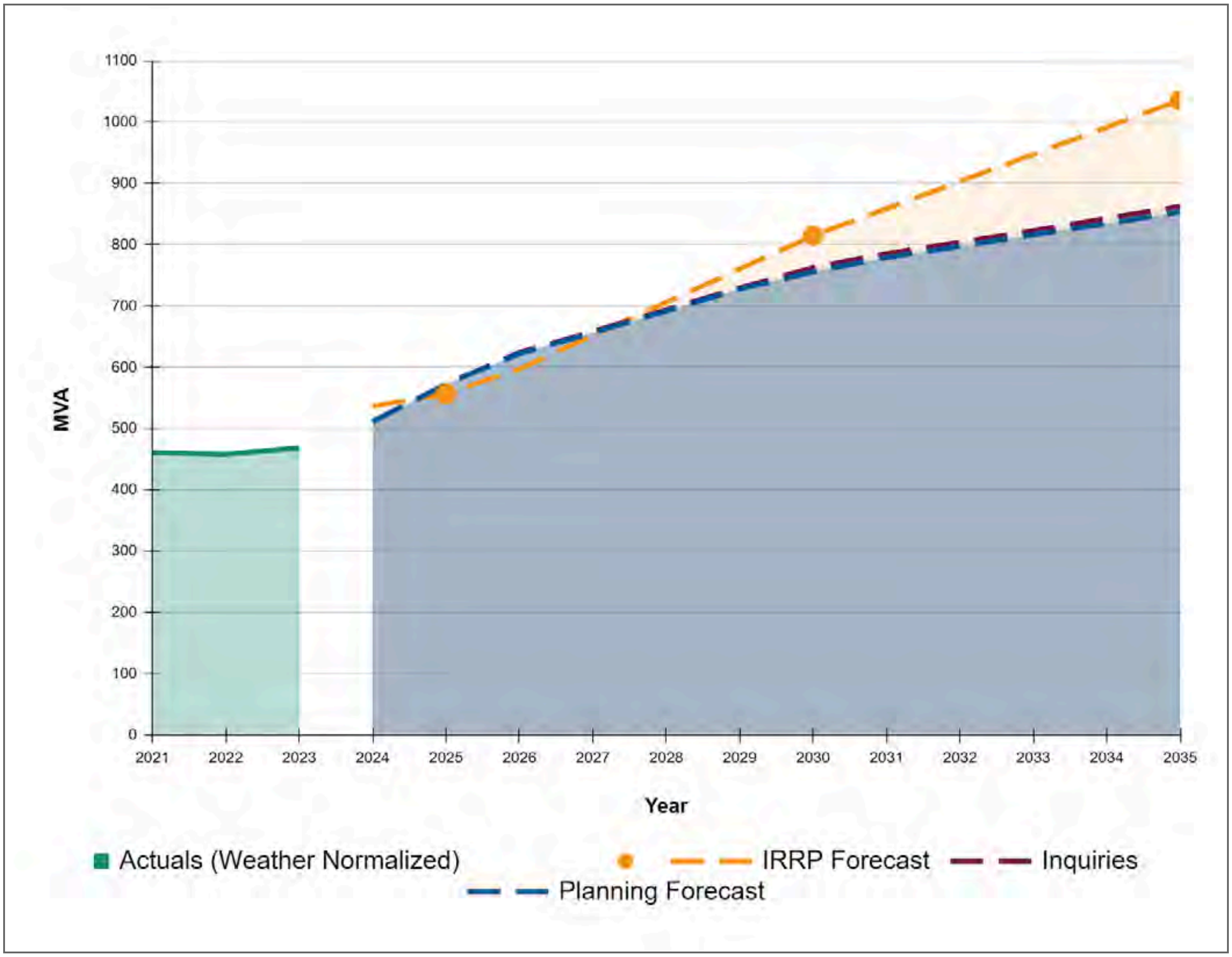
Figure 101 - Core 13kV Planning Forecast and IRRP Forecast



East 13kV System

The East 13kV supply region covers the eastern portion of the Old City of Ottawa. This region is supplied by the Russell TS, Albion TS, Ellwood MTS and Overbrook TS. Figure 102 shows the weather normalized actuals, planning forecast, the IRRP forecast and customer inquiries in planning stages for the region out to 2035.

Figure 102 - East 13kV Planning Forecast and IRRP Forecast



Overall Strategy

Capacity upgrades and new station interconnections are needed to manage and transfer load within the 13kV system. System expansions will also be necessary to meet growing demand. Feeders with minor overloads and minimal growth forecasts will be monitored.

Several limitations currently prevent some Hydro One owned stations from operating at full capacity. These station-specific limitations include issues with secondary cables, transformers, switches, and protection and control equipment. Plans are in place to address and eliminate these constraints as explained below. In addition, conversion of Bronson DS from 4kV to 13kV and NWSs will further increase 13kV system capacity and support load growth in the adjacent stations like Riverdale TS, Carling TS and Lisgar TS, see further details in Section 9.1.4.6 - 4kV system.

These initiatives are vital for supporting regional growth and electrification plans. By enabling each station to operate at its full potential, Hydro Ottawa can provide more reliable service and meet the increasing electricity needs of its customers and large load requests such as the Ottawa Hospital[35] slated to be connected to the 13kV system, facilitating the transition to a more electrified and sustainable future. The investments detailed below are consistent with the Needs Assessments by the IRRP working group as part of the regional planning process, see Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Riverdale TS Switchgear Capacity Upgrade (System Service-Capacity Upgrade)

The overall station capacity is limited by a lack of available breakers in the secondary switchgear lineup. To address this, the switchgear will be replaced by 2027, adding eight feeder breakers. This project, approved as part of the 2021-2025 Rate Application, will allow the station to utilize the full capacity, connect new customers, and support future growth in Old Ottawa East and South regions. Additionally, the bus ampacity will be increased to accommodate potential future transformer upgrades. These enhancements will ensure Riverdale TS can meet the region's growing electricity needs.

Slater TS Transformer Upgrade (Hydro One Investment)

Slater TS's T1 transformer failed in early 2018 and was replaced by Hydro One with a larger 100 MVA unit to support future growth and provide contingency capacity for the Core 13kV region. The

[35] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/.

remaining transformers, T2 and T3, are nearing end-of-life and have been replaced with larger 100 MVA units in 2024. This upgrade also eliminated short circuit constraints, allowing for greater DER integration in the region.

Lisgar TS Transformer and Cable Upgrade (Hydro One Investment)

Lisgar TS currently has two transformers with a total capacity of 81 MVA. Thermal constraints due to existing generation sources are limiting the connection of new DERs. To address this and increase the station's capacity, Transformer T1 will be replaced by 2026.

In addition to the transformer replacement, the secondary cable at Lisgar TS is also limiting its operational capacity. Upgrading this cable will allow the station to operate at its full potential, supporting future developments and customer connections.

King Edward TS Cable Upgrade (Hydro One Investment)

The secondary cable at King Edward TS is currently preventing the transformers from operating at full capacity. The station, with two transformers and an available capacity of 97 MVA, is projected to exceed its N-1 rating in 2026 due to near-term load growth. Upgrading the secondary cable will increase the station's capacity, relieving capacity constraints in the Core 13kV system and supporting the load growth resulting from the Ottawa LRT project.

Carling TS Cable Upgrade (Hydro One Investment)

The cables at Carling TS are currently preventing the transformers from operating at full capacity. Replacing aging and limiting cables at the station will increase the available station capacity, relieving capacity constraints and supporting the load growth.

Russell TS Transformer Upgrade (Hydro One Investment)

Russell TS is projected to exceed its capacity by 2027. To address this, the two transformers will be replaced in 2027, increasing capacity. Additionally, new distribution ties will allow transfer from Russell TS to neighboring stations including Ellwood MTS, Albion TS, and Overbrook TS.

Albion TS Transformer Upgrade (Hydro One Investment)

Albion TS is projected to exceed its limits by 2034. Hydro One plans to replace the two transformers due to end-of-life equipment and the new transformers will be efficiently sized to meet the forecasted growth. Additionally, new distribution ties will enable load transfer from Albion TS to neighboring stations including Ellwood MTS, Russell TS, and Overbrook TS. Loads across the 13kV system will be continuously monitored and forecasted to ensure adequate supply.

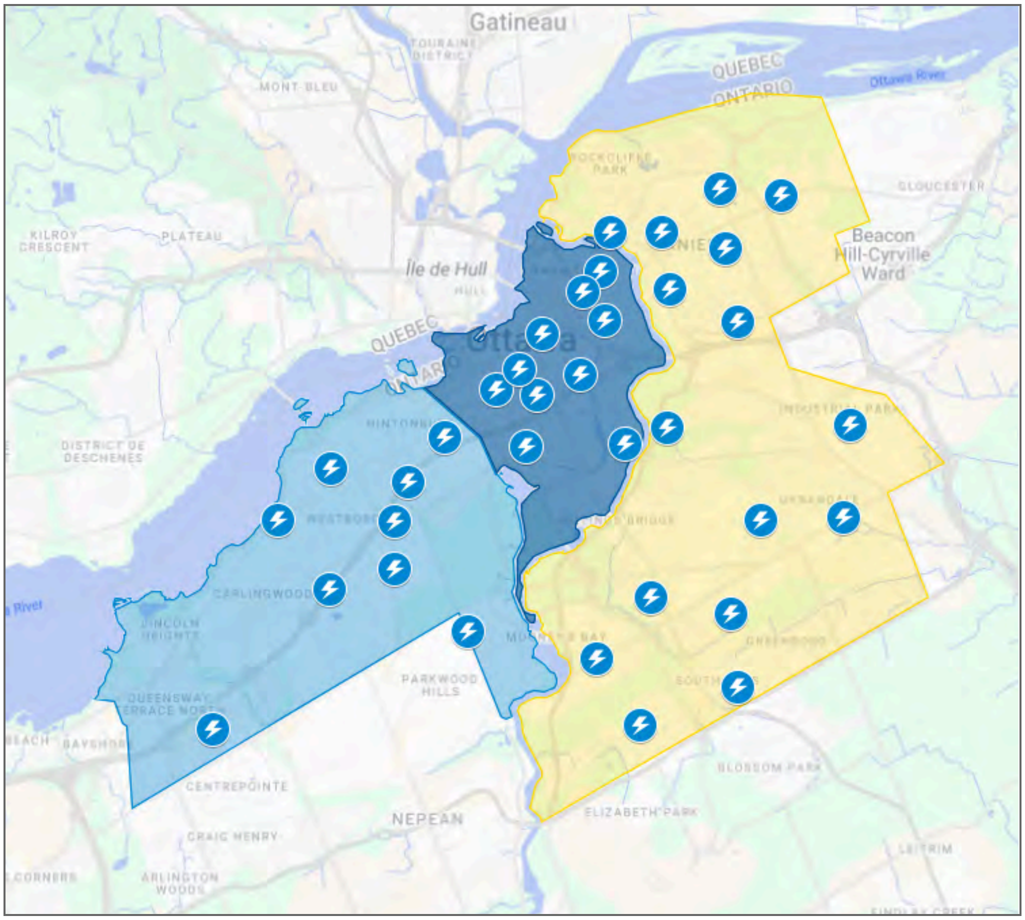
Non-Wires Solutions

Hydro Ottawa proposes 10 MW of utility owned BESS and non-wire customer solutions to manage short term and long term peak load in this region. For more details on the need and justification of this solution refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.1.4.6. 4kV System

Hydro Ottawa's 4kV system consists of two supply regions, Central 4kV (highlighted in blues), and East 4kV (highlighted in yellow). Figure 103 below illustrates this region as it spans across the more historical parts of Ottawa.

Figure 103 - Overall 4kV Supply Region[36]



Central 4kV

The Central 4kV supply region covers the area west of the Rideau River, east of Highway 416, along the north shore of the Ottawa River, and south to Baseline Road. This region includes 19 stations: Augusta DS, Bayswater DS, Bronson DS, Cambridge DS, Carling DS, Clifton DS, Clyde DS, Edwin DS, Fisher DS, Florence DS, Gladstone DS, Henderson DS, Hillcrest DS, Holland DS, King Edward DS, Nepean DS, Riverdale DS, Shillington DS, Slater DS. Figure 104 shows the Central 4kV supply region.

[36] The station names are deliberately left out as it would be too cluttered to have all of them on the same map; see Figure 106 (Central 4kV Supply Region) and Figure 108 (East 4kV Supply Region) for the station names.

Figure 104 - Central 4kV Supply Region

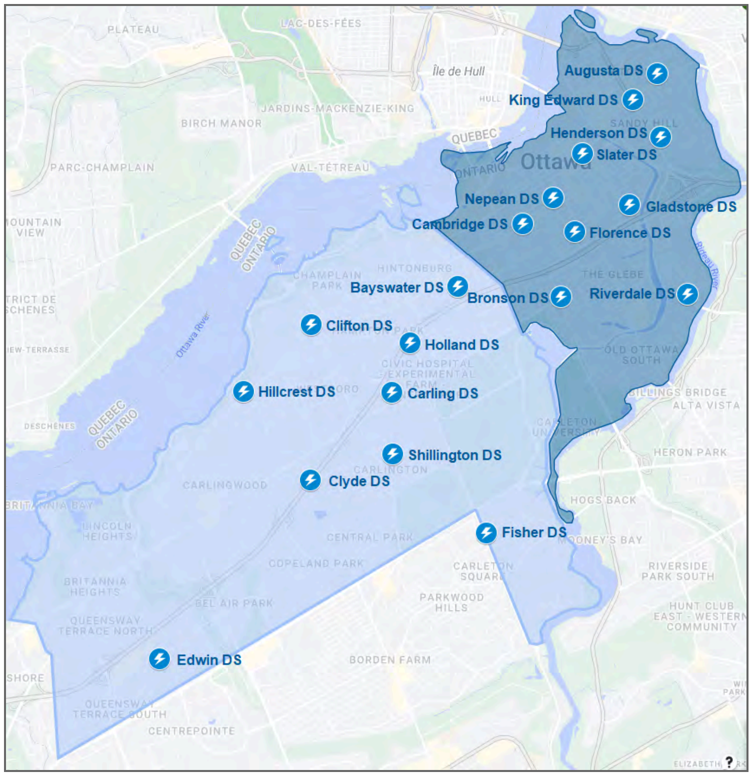
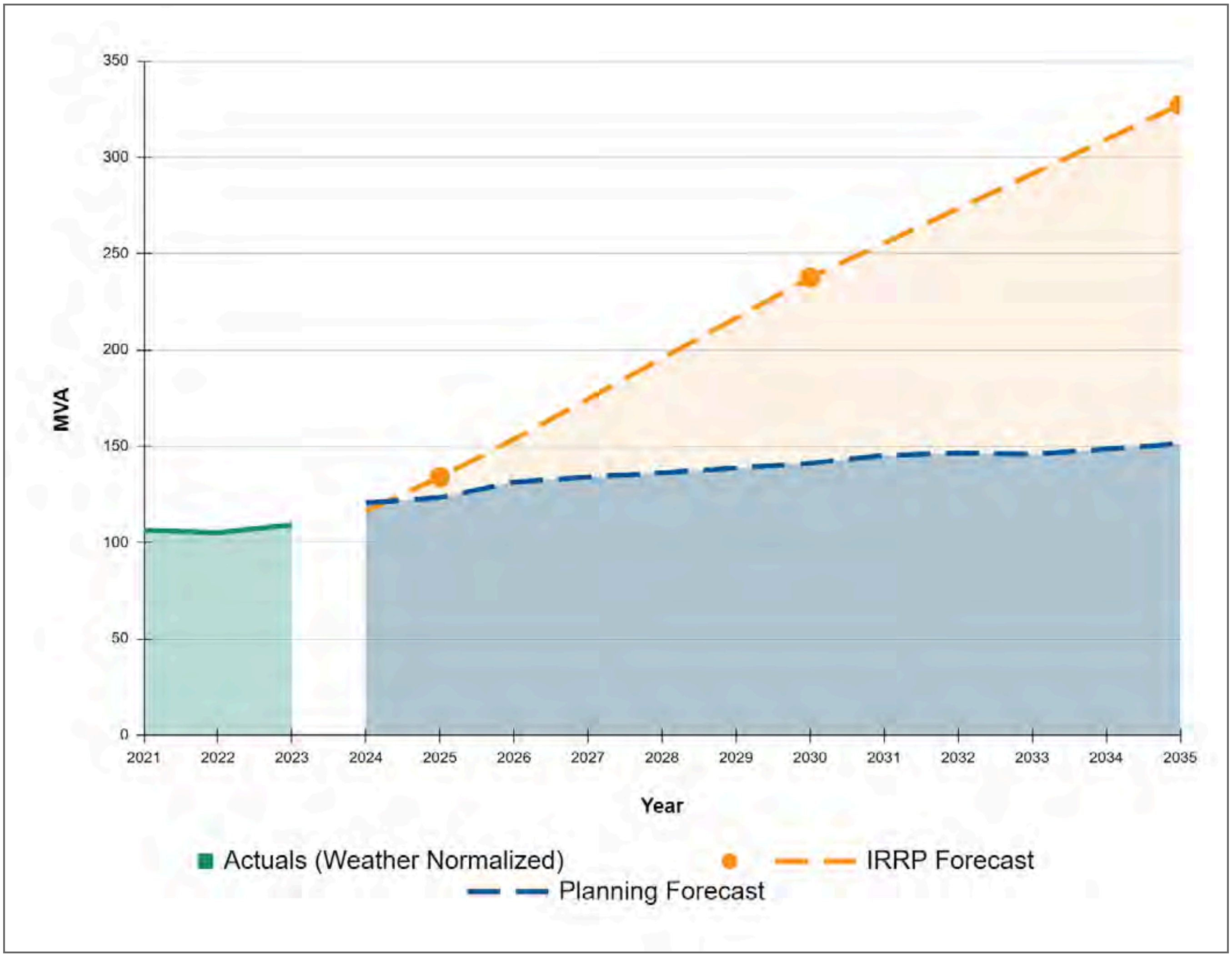


Figure 105 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 105 - Central 4kV Planning Forecast and IRRP Forecast



East 4kV

The East 4kV supply region covers the area west of Blair Road, east of the Rideau River, and north of Hunt Club Road. This region is supplied by 16 substations: Albion DS, Bantree DS, Beechwood DS, Brookfield DS, Cahill DS, Church DS, Dagmar DS, Eastview DS, Langs Road DS, McCarthy DS, Overbrook DS, Playfair DS, Queens DS, Urbandale DS, Vaughan DS, and Walkley DS. Figure 106 shows the East 4kV supply region and substations.

Figure 106 - East 4kV Supply Region

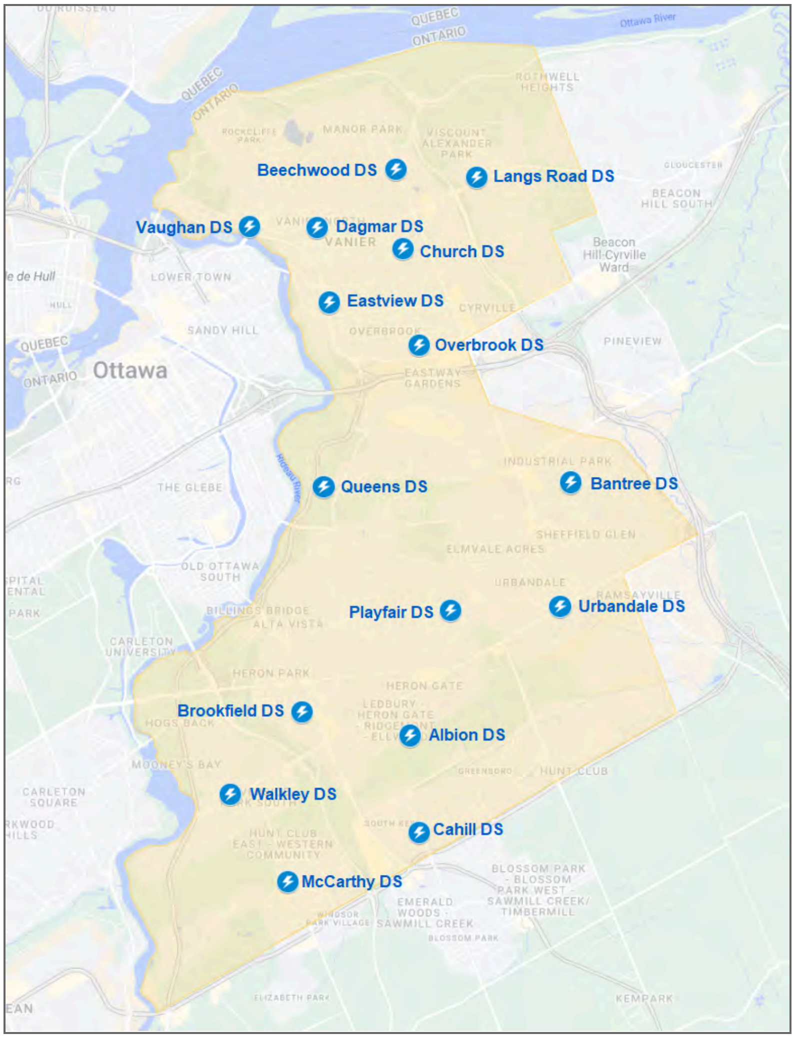
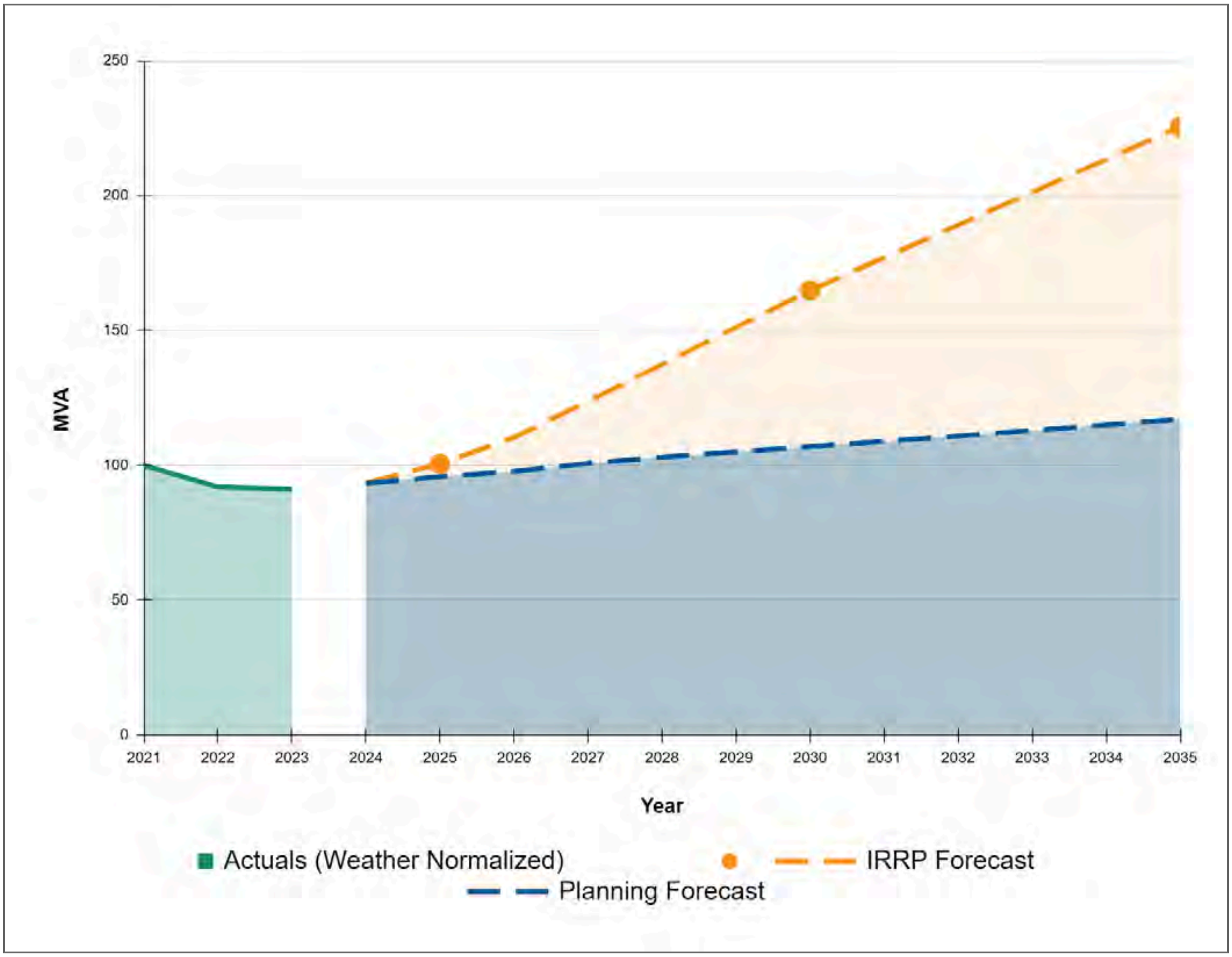


Figure 107 shows the weather normalized actuals, the planning forecast and the IRRP forecast for the region out to 2035.

Figure 107 - East 4kV Planning Forecast and IRRP Forecast



All thirty-five 4kV substations are supplied by twelve 13kV stations, providing electricity for the majority of the residential load in the regions. The City of Ottawa's Official Plan promotes intensification, with many new developments transitioning from low-rise apartments to larger, high-density condos and apartment buildings and transit oriented development. This growth, teamed up with electrification needs, speaks towards demand growth in the 4kV system. Areas like the Glebe, Rideauview, and Vanier are expected to experience significant growth in the near future.

Voltage Conversion Strategy

Hydro Ottawa is phasing out its 4kV system by strategically converting to 13kV during renewal. This shift is driven by the 4kV system's inability to handle increasing loads from electrification, which require higher service sizes and loop transformation only achievable at 13kV. Instead of rebuilding aging 4kV stations, Hydro Ottawa is prioritizing voltage conversions to enhance system reliability, accessibility, and capacity. The challenges faced by the 4 kV system is elaborated below:

- Compared to 13 kV, 4 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 13 kV remains effective up to 10km.
- The maximum capacity of a 4 kV feeder is 2.3MVA, versus 9.7MVA for 13 kV, significantly limiting the ability to accommodate the large load requests.

Beyond completion of the planned conversions of Dagmar DS and Fisher DS initiated in the 2021-2025 period, Vaughan DS, Henderson DS, and Church DS will also be converted to 13kV due to the condition and age of their 4kV assets, Section 2 of Schedule 2-5-7 - System Renewal Investments. Additionally, strategic voltage conversions are planned in the Bronson DS region to prepare for its upgrade to 13kV mainly driven by capacity constraints.

Dagmar DS voltage conversion

Dagmar DS, a 4kV substation in the East 4kV region serving part of Vanier, as well as its distribution network, have reached end-of-life. Due to capacity and site space constraints, voltage conversion to 13kV was chosen over asset renewal. Initially planned for completion within this application, the project is now expected to start in 2025 and be completed by 2027.

Fisher DS voltage conversion

Fisher DS, a 4kV substation in the Central 4kV region serving Rideauview as its distribution network, has reached end-of-life. Voltage conversion to 13kV was determined to be more beneficial than a station rebuild at 4kV, offering improved reliability and capacity to meet growing demand. This conversion requires replacing and upgrading all distribution assets to 13kV standards. Construction began in 2022 and is expected to be complete by 2027.

Henderson UN, Church AA and Vaughan UG voltage conversion

As part of the overall voltage conversion strategy, Henderson DS, parts of Church DS, and Vaughan DS, will be converted to 13kV. This is primarily driven by end-of-life 4kV station assets. Converting these customers to a 13kV supply and decommissioning the 4kV stations is advantageous to meet growing demand, support electrification, and progress towards phasing out the end-of-life 4kV system in the service territory.

Bronson DS upgrade and associated voltage conversion

Bronson DS, a 4kV substation serving the Glebe and part of Bank Street, will be upgraded to 13kV to increase capacity and reliability. For more details on the need and justification of this investment please refer to Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments.

This capacity upgrade aligns with the Needs Assessments completed by the IRRP working group as part of the regional planning process, see Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

9.2. NON-WIRES SOLUTIONS TO ADDRESS SYSTEM NEEDS

In March 2024, the OEB updated its "Non-Wires Solutions Guidelines for Electricity Distributors"[37] (previously known as the CDM Guidelines for Electricity Distributors) to reflect "the fact that Non-Wires Solutions to address system needs can encompass a broader range of solutions than traditional conservation and demand management, including, but not limited to, third-party distributed energy resources such as energy storage and distributed (embedded) generation".

It is the OEB's expectation that LDCs submitting rate filings in 2026 and beyond be fully consistent with the OEB's Benefit-Cost Analysis Framework (BCA Framework) and will be "required to incorporate consideration of NWSs into their distribution system planning process, by considering whether a distribution rate-funded NWSs may be a preferred approach to meeting a system need, thus avoiding or deferring spending on traditional infrastructure."[37] While Hydro Ottawa's Application is submitted in advance of requirements for rate applications to be fully consistent with the BCA Framework, Hydro Ottawa has been working to update its planning process to include evaluating NWSs potential for meeting local distribution system needs. Where feasible, and where there is overlap between local distribution system and bulk system needs, this process has and will continue to include collaborating with the IESO, and making use of their Local Initiatives Program (LIP) within the Electricity Demand Side Management (eDSM) Framework for mutual benefit. Also within the eDSM Framework, there is proposed new funding dedicated for LDCs to develop and implement local eDSM programs that address distribution system needs and also provide upstream benefits to the IESO-controlled bulk system.

Of note, regulatory and policy work regarding funding and implementing NWSs and local eDSM activities is evolving, with updated mechanisms and additional guidance anticipated in 2026 or 2027. When regulatory policy solidifies, and guidance and the process to share costs between the local and bulk systems are formalized, Hydro Ottawa will adjust its NWSs Assessment Process

[37] Non Wire Solutions Guidelines for Electricity Distributors- https://www.oeb.ca/sites/default/files/uploads/documents/regulatorycodes/2024-04/OEB_2024%20NWSs%20Guidelines_20240328.pdf

described below accordingly. Refer to Section 9.2.4.3 - “Stream 2” Local NWSs Program Opportunities for additional insight around future regulatory and policy changes.

9.2.1 Hydro Ottawa NWSs Assessment Criteria

Hydro Ottawa's System Capacity Assessment is a crucial process that analyzes planning forecasts to inform decisions about necessary system upgrades and expansions. This ensures that Hydro Ottawa can reliably and adequately meet both current and future customer energy needs. The NWSs assessment utilizes the IRRP forecast, which specifically focuses on the medium- to long-term outlook (beyond 2030) and takes into account the potential effects of decarbonization efforts. By considering these long-term impacts, Hydro Ottawa can better contextualize potential challenges and opportunities that may arise in the future. For more details regarding the IRRP Forecast refer to Section 9.4.2.

A key benefit of this forward-looking approach is that it allows Hydro Ottawa to validate that the capacity investments made to address immediate needs in the near term (until 2030)—as informed by Hydro Ottawa’s planning forecast—are also strategically aligned with the anticipated long-term energy requirements. This alignment ensures efficient capital deployment and optimizes asset utilization.

Based on a thorough analysis of the needs identified for each of the Hydro Ottawa planning regions described in Section 9.1.4 - Investments by Planning Region; it has been determined that the majority of these needs will require wire solutions, meaning upgrades and expansions to the physical grid infrastructure. While NWSs are not expected to cause substantial avoidance or deferral of the identified wire capacity investment needs, they will play a crucial role in moderating the pace of system demand growth and enhancing reliability in the 2026-2030 period, while continuing to support the grid in the long term. This moderation will provide Hydro Ottawa with the lead time to construct the necessary long-term grid infrastructure solutions that are aligned with the evolving system demand. There are three scenarios identified where NWSs would have the greatest potential in supporting capacity needs:

Scenario 1: Stations Requiring Capacity Risk Mitigation in the Near-Term

This scenario applies to stations that are currently facing capacity constraints and require immediate risk mitigation measures until a permanent wire solution can be implemented. This may be due to an inability to transfer loads to nearby stations or due to anticipated additional capacity needs in the near term. In these cases, NWSs can manage demand and ensure reliable service while the necessary grid infrastructure upgrades are being planned and constructed.

Scenario 2: Distribution Connected Stations with Minor Overloads

This scenario focuses on distribution connected stations where both the planning and IRRP forecasts project overloads of less than 7.5MVA (50% of maximum capacity for a new 8kV station/ 50% of maximum capacity of a 28kV feeder) by 2030. These stations must have limited connections to adjacent stations to support overloads. Additionally, wire alternatives would require a combination of distribution and station expansion along with potential transmission upgrades, resulting in significant capital investments which is not economically feasible. NWSs can play a supportive role by managing demand and reducing the need for near-term infrastructure investments, and they can provide additional reliability benefits by helping to balance loads.

Scenario 3: Planning Regions Overloaded by 2030

This scenario pertains to planning regions where overloads by 2030 are expected based on the IRRP forecast, even after the implementation of proposed wire solutions. It also includes planning regions that are already experiencing transmission system constraints, as identified through Regional Planning. In these cases, NWSs will be essential in managing demand to ensure that the system can operate reliably within limits.

9.2.2 NWSs Under Consideration

The rapid advancement and adoption of DER present an unprecedented opportunity to revolutionize grid planning, operations and management. By strategically leveraging DER technologies as NWSs, Hydro Ottawa can innovate its approach to planning and addressing distribution system needs and empower customers while paving the way for a more reliable, resilient and sustainable energy future.

9.2.2.1 Non-Wires Customer Solutions Program

There are four initial programs under further evaluation within the Non-Wires Customer Solutions portfolio for deployment, which are described below. Hydro Ottawa also expects to use outputs from the IESO's Local Achievable Potential Study (L-APS), scheduled to complete in Q2 2025, to validate the programs. Hydro Ottawa expects that its Non-Wires Customer Solutions Program could eventually include, where feasible and cost effective, other demand side management programs delivering both distribution grid benefit as well as greenhouse gas emission reductions.

These programs will build on province-wide incentive offers available within the eDSM Framework, where applicable. It is anticipated that cost-sharing will be determined based on the split of bulk and local system benefits determined by the BCA and informed by the L-APS. Funding requested will support customer participation with incentives, and will be used to raise awareness of these local programs through targeted marketing. As advancements and understanding of the broader use of DER technology continues to evolve, regulatory policy around DERs solidifies, and additional sources of funding emerge, additional opportunities for NWSs will be reviewed and considered for implementation.

1. **Save on Energy Retrofit Adder Program**

   Hydro Ottawa is working with the IESO to explore relaunching an updated version of a retrofit adder program, similar to the "Kanata North Retrofit+" (KNR+) program. From 2020-2022 and funded by Interim Framework (IF), Hydro Ottawa administered the KNR+ program cost effectively in the targeted area of Kanata North and achieved 2.47MW of gross demand savings by providing enhanced incentives and technical support to eligible customers, leveraging the existing platform used for the province-wide Retrofit Program. During recent conversations, IESO has signaled that opening access to the Retrofit Regional Adder[38] - required for this program concept - is a strong possibility.

As stated in the KNR+ program evaluation report,[39] enhanced technical support provided to customers by Hydro Ottawa was a key differentiator in the success of the KNR+ program. Under this new program, Hydro Ottawa will assign a CDM Energy Conservation engineer to assist customers in identifying and developing potential projects in the targeted area of need. Existing customer relationships and communication channels can be utilized to promote the program as Hydro Ottawa has CDM staff already in place who can leverage these relationships for initial engagement and technical support. Please refer to Schedule 1-4-1 - Customer Engagement Ongoing for greater detail on how the CDM team is engaging with and supporting customers. Funding within the Non-Wires Customer Solutions Program would be used for targeted marketing campaigns, and a possible local incentive adder further encouraging customers to participate.

2. Residential Demand Response (DR) Program

Residential DR has the potential to deliver significant benefits to both the local distribution grid and the bulk system. To achieve maximum benefits, Hydro Ottawa would need to establish reliable and predictable load reduction through the program by effectively monitoring enrollment and leveraging technology to schedule and operate curtailment events. Curtailment events would need to be targeted to specifically address distribution system needs while prioritizing a positive customer experience.

Hydro Ottawa has been exploring the potential of leveraging IESO's existing "Peak Perks"[40] residential DR platform for mutual benefit. Peak Perks offers incentives to customers with

[38] https://www.saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Local-Initiatives#regionaladders
[39] Kanata North Retrofit+ program evaluation report, https://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2022/PY2022-IF-Hydro Ottawa-Kanata-North-Evaluation-Report.pdf
[40] https://saveonenergy.ca/en/For-Your-Home/Peak-Perks

eligible smart thermostats in exchange for allowing minor temperature setbacks during peak demand periods. Further evaluation with IESO is needed in order to determine whether the Peak Perks program and platform can support Hydro Ottawa's system planning and deliver tangible distribution system benefits in its current form. Funding within the Non-Wires Customer Solutions Program would be used for targeted marketing campaigns, and allow for the possibility of an enhanced incentive to further encourage customers located in priority areas of need to enroll.

3. Commercial Demand Response Program

While the IESO's Capacity Auction already allows for commercial customer participation in DR, Hydro Ottawa recognizes the potential for further opportunity adjacent to the Capacity Auction.

Program operation is expected to involve third-party aggregators for customer qualification, event management, and measurement/verification. In addition to those activities, funding within the Non-Wires Customer Solution Program could be used for targeted marketing campaigns and incentive payments to enroll participants.

IESO's 2025-2027 eDSM plan[41] also states IESO plans to launch a new commercial HVAC DR program in 2026. Hydro Ottawa will explore the possibility of a commercial DR program that - following BCA evaluation - addresses distribution needs and delivers bulk system benefit.

4. Solar PV and Energy Storage Program

Hydro Ottawa has collaborated with the IESO and supported the delivery of the Ottawa DER Large Solar PV Funding Incentive that was operating within the IESO 2021-2024 CDM Framework. This measure, launched on January 8, 2024, was available to commercial customers within eligible postal codes in the Ottawa area. This regional program attracted strong interest from customers, and solar incentive programs have now been expanded to all

[41] 2025-2027 Electricity Demand Side Management Program Plan- https://ieso.ca/-/media/Files/IESO/Document-Library/eDSM/2025-2027-DSM-Plan-with-Beneficial-Electrification.pdf

customers across the province as part of the new eDSM Framework announced on January 9, 2025.[42]

To maximize the value of intermittent solar generation, Hydro Ottawa is evaluating the benefits of local incentive adders for behind the meter customer owned solar PV and energy storage. A combined offering would enhance benefits to both the local distribution grid and the bulk system by allowing for predictability in output during times of system need.

Funding within the Non-Wires Customer Solution Program would be used to incentivize customers and for targeted marketing campaigns to encourage participation.

For further details on the costs associated with the Non-Wires Customer Solutions Program, see Schedules 6-3-5 - Other Income & Deductions and 4-1-2 - Operations, Maintenance and Administrative Program Costs.

9.2.2.2 Battery Energy Storage System (BESS)

In the electric utility industry, BESS is emerging as a viable solution to address a variety of challenges, including peak load management, grid reliability, and the integration of renewable energy sources. BESS involves the use of advanced battery technologies to store excess energy generated during periods of low demand or high production and release it during periods of high demand or low production. This capability offers numerous benefits to the overall electricity grid.

9.2.2.2.1 Utility Owned Battery Energy Storage System

Utility-owned BESS installations are being strategically deployed in areas where minor grid overloads are predicted that do not necessitate the construction of an entirely new substation, and where options to offload are limited or nonexistent. Additionally, BESS solutions will play a crucial

[42] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

role in areas where wire solutions are being implemented, but smaller-scale overloads are still anticipated in the mid-term. These installations align with the assessment criteria outlined in Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria and aim to provide targeted support where traditional grid infrastructure may not be immediately necessary or where additional capacity is required in the near future.

Utility-owned BESS installations present several advantages, including direct control and localized grid support. By owning and operating these installations, Hydro Ottawa can efficiently integrate them into the existing grid infrastructure, allowing for streamlined maintenance, optimized performance, and reduced reliance on third-party providers. This is critical since the areas selected for utility owned BESS installations have limited to no alternative options to support excess demand in the near term.

9.2.2.2.2 Commercial Customer Owned Battery Energy Storage Systems

BESS solutions that are located behind the meter, and owned and operated by commercial customers in partnership with the LDC, have the potential to deliver tangible distribution system grid benefits when located in targeted areas and deployed in concert with system needs. Although interest in BESS facilities is growing, current penetration of these systems is low across Hydro Ottawa's service territory, with only 3 BESS assets larger than 100kW connected to the distribution system, none of which are located in areas of need.

Hydro Ottawa has been exploring partnering with a customer planning for a behind the meter BESS in an area of need. After extensive discussions over several years, significant challenges remain. Namely the complexities of the customer's decision-making process including needs assessment, Industrial Conservation Initiative participation, cost-benefit analysis for both parties and implementation timelines. Despite technical, economic, regulatory, and customer-related barriers, Hydro Ottawa is continuing to pursue the potential of partnering with customers interested in BESS to support grid needs as policy and regulatory frameworks adapt around the use of DERs.

9.2.3 Proposed NWSs by Planning Region

Following the assessment criteria outlined in 9.2.1, NWSs were considered as part of the capacity planning process by Hydro Ottawa's planning region. Table 36 summarizes the regions and solutions being proposed.

Table 36 - Non-Wires Solutions by Planning Region

NWSs Assessment Criteria	Planning Regions	Non-Wires Solutions
Scenario 1, 3	West 28kV (North)	● Non-Wires Customer Solutions Program
Scenario 2	West 28 kV	● 2.5 MW of Utility Owned BESS at Beckwith DS
Scenario 2	Bells Corners/ Bayshore 8 kV	● 7 MW of Utility Owned BESS in the Bells Corners/Bayshore 8kV region
Scenario 2	Casselman 8 kV	● 5 MW of Utility Owned BESS at Casselman DS
Scenario 1, 3	Core 13 kV, West 13kV	● 10 MW of Utility Owned BESS in the 13kV region ● Non-Wires Customer Solutions Program

9.2.3.1 West 28kV (North)

Selection of this region for the deployment of NWSs was based on Scenario 1 and 3 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. There are existing capacity constraints in the Kanata North region due to rapid technology sector growth which has spurred a surge in large load requests. Immediate risk mitigation through Non-Wire Customer Solutions is being proposed until the new Kanata North station is energized. Non-Wires Customer Solutions will continue supporting this region in the long term considering the IRRP forecast. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments

9.2.3.2 West 28kV

Selection of this region for the deployment of NWSs was based on Scenario 2 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. The Beckwith DS is currently capacity constrained and has limited transfer capability with adjacent stations. The demand forecast of this station until 2030 is minimal and wire upgrades will not be economically viable. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.2.3.3 Bells Corners/Bayshore 8kV

Selection of this region for the deployment of NWSs was based on Scenario 2 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. Bayshore DS and Q.C.H DS are approaching their planned capacity and are forecasted to exceed their capacity by 2030. They have limited inter-station ties between each other and are otherwise isolated from the rest of the 8kV system. The demand forecast of this station until 2030 is minimal and wire upgrades will not be economically viable. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.2.3.4 Casselman 8kV

Selection of this region for the deployment of NWSs was based on Scenario 2 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. The forecasted demand at Casselman DS is expected to exceed its planning capacity by 2030 and is isolated from Hydro Ottawa's distribution system not allowing for the capability to create inter-station ties. The demand forecast of this station until 2030 is minimal and wire upgrades will not be economically viable. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.2.3.5 Core 13kV and West 13kV

Selection of this region for the deployment of NWSs was based on Scenario 1 and 3 of the NWSs Assessment criteria, Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria. The combined forecast of Carling TM, Lisgar TL and Riverdale TR is expected to exceed planned capacity by 2028 and the 115kV transmission supply for this region is constrained. Even with the proposed wire upgrade (Bronson DS upgrade in 2032), support will be required from NWSs considering the long term outlook. Immediate risk mitigation through Non-Wire Customer Solutions and Utility Owned

BESS solutions are being proposed until Bronson station is upgraded. Non-Wires Customer Solutions will continue supporting this region in the long term considering the IRRP forecast. For more details on the need and justification for this solution please refer to Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments.

9.2.4 Evolution of the NWSs Assessment Process

Hydro Ottawa has evolved to incorporate the NWSs evaluation process within the capacity planning process. As with all processes, the expectation is to make continued improvements by integrating lessons learned from the deployment of NWSs by Hydro Ottawa, its customers, and peers in Ontario and across North America, as the technology, regulations and landscape evolves. For example, the Non-Wires Customer Solutions Program described in Section 9.2.2.1 - Non-Wires Customer Solutions Program has the potential to be deployed across other areas of the distribution system in the future to address the scenarios described in Section 9.2.1 - Hydro Ottawa NWSs Assessment Criteria as they occur. Additionally, Hydro Ottawa is making investments in systems and tools - including behind the meter disaggregation technology and energy analytics tools - that are able to provide powerful insights and further inform both the NWSs assessment process and the design and deployment of Non-Wires Customer Solutions. Refer to Section 6 of Schedule 2-5-9 - General Plant Investments for additional details. By adapting its process, Hydro Ottawa will ensure that NWSs become an integral part of meeting local system needs to drive customer value.

9.2.4.1 EV Everywhere Pilot

Hydro Ottawa has been working with project partner BluWave-ai on EV Everywhere[43] - an innovation project funded in part by the IESO's Grid Innovation Fund. The pilot project pairs PA with local DR programming for electric vehicles as well as battery storage with the aim to test how the technology can help address localized system needs as EV adoption increases. The intent is to further understand the potential impacts and operational needs of EVs for DR. With over 150 customers enrolled in the pilot, surpassing the pilot target of 50 customers, electric vehicle

[43] https://hydroottawa.com/en/save-energy/save-energy-homes/ev-everywhere

on-command charging dispatch is being tested with participating customers. The learnings for the EV dispatch portion of EV Everywhere include:

- Determining how to accurately forecast available NWSs capacity;
- Understanding the coordination required to communicate with EV users;
- Designing and testing the DR system, the actual response rates (i.e. registrants that are plugged in and are not opting out) amongst participants, and evaluating the benefits.

In parallel, to provide a proxy of the impact of a future state with wider adoption of EVs with bi-directional energy flow, two BESS solutions will be installed within the Hydro Ottawa system in early 2025 to prepare and familiarize the company with the operation and dispatch of energy storage in response to a predicted overload scenario. Lessons learned from the EV Everywhere BESS portion are intended to support standards creation, selection considerations for BESS units (such as siting, MW and MWh capacity, and battery and energy management system features), BESS Integration (use impact assessment, data value, information visibility to stakeholders), strategic application, and maintenance.

A key component to the EV Everywhere project is communication network, data management, and data security. In a prior residential EV charging pilot, as described in Section 2.1.1.4 of Schedule 1-4-1 - Customer Engagement Ongoing, pilot data was obtained that was used to help provide initial expectations of how EVSEs would be used. This data has also supported forecasting load expectations and assessing how to size electrical service entrances and distribution transformers to meet expected capacity needs and adjust distribution and power design standards accordingly. Overall, the EV Everywhere project will drive learnings and inform opportunities to further expand the use of NWSs to address local system needs.

9.2.4.2 Ottawa DER Accelerator Project (ODERA)

The ODERA project is envisioned to build on the learnings from EV Everywhere, to further develop PA and granular demand-response technology for application to a larger ecosystem of customer devices (e.g. thermostats, EV chargers, battery storage and electric water heaters), while advancing Hydro Ottawa's grid modernization roadmap. With further technology development, this project could become a scalable and viable NWSs option to address needs in other areas. This project - which has received the support of federal funding - is further described in Section 3 of Schedule 2-5-8 - System Service Investments.

9.2.4.3 "Stream 2" Local NWSs Program Opportunities

Regulatory and policy work around NWSs will continue to evolve. The OEB has released the phase 1 BCA Framework - the Distribution Service Test (DST) - while phase 2, which will outline the approach to calculate both local and bulk system benefits and costs, known as the Energy System Test (EST) is forthcoming. Secondly, an IESO-LDC working group was established to assist with operationalizing "Stream 2" eDSM activities and in which Hydro Ottawa participates, has not completed its work.

Stream 2 programs are local NWSs programs, designed and administered by local distribution companies, that benefit both the local and bulk systems. The IESO's initial eDSM plan allocates funding to LDCs for local eDSM programs addressing distribution system needs, beginning in 2027. Once the working group's work is finalized and the process and funding mechanisms are available, Hydro Ottawa will align its NWSs efforts accordingly.

9.2.4.4 Alternative Energy Models

Alternative Energy Models such as local flexibility markets, Distribution System Operator capabilities, and Total Grid Orchestration capabilities are relatively new approaches in the energy sector to help manage the complex grid of the future. As Ontario pushes for greater DER participation, Hydro Ottawa will continue to evolve its processes and capabilities to be ready to unlock the value DERs can provide at the local level. Hydro Ottawa is exploring the constructs of these models and is starting to put in place the controlling elements for DER enablement needed to support any of these alternative models. Hydro Ottawa will continue to explore options to achieve benefits and will adapt to new responsibilities in the future around planning, facilitation, and coordination of DERs as these energy business models continue to evolve.

9.3. SYSTEM CAPABILITY ASSESSMENT FOR RENEWABLE ENERGY GENERATION AND DISTRIBUTION ENERGY RESOURCES

9.3.1. Historical Connections DER Applications

Within Hydro Ottawa's service territory, there is a considerable amount of connected distributed generation, or DERs. These energy resources represent all manners of electric generation and storage, including grid-connected solar panels, hydro-electric generators, natural-gas turbines, and battery storage facilities. In the last five years, the Hydro Ottawa service region has seen strong growth in the connected capacity of renewable generation, entirely as grid-connected photovoltaic generators, as can be seen in Figure 108.

Non-photovoltaic DERs have not seen significant growth. The Ottawa region's natural hydroelectric potential has largely been captured already, and there is strong disincentivization to construct carbon-producing combustion generation facilities, while there are strong incentives to construct renewable energy facilities. Additionally, BESS facilities continue to grow, with four in its service territory with an aggregate capacity of ~2MW, the highest individual capacity being 1,000kW.

In 2017, the IESO discontinued the microFIT program, which was a popular means of connecting small-scale residential photovoltaic systems (less than 10kW) to the grid. Despite the end of this program, Hydro Ottawa remains committed to ensuring that proposed DERs may connect to the grid whenever possible. Hydro Ottawa's programs for net metering (bidirectional flow of power to a premise) or load displacement (on-site generation that offsets premise's load) are available to customers as an alternative to the microFIT program. From 2019 to 2023, almost 300 new renewable DERs were connected under the net metering and load displacement programs, as can be seen in Figure 109 below, representing a 26% increase over that period. Of these, 88% were 10kW or under DERs.

Figure 108 - Total System DER Capacity 2019-2023

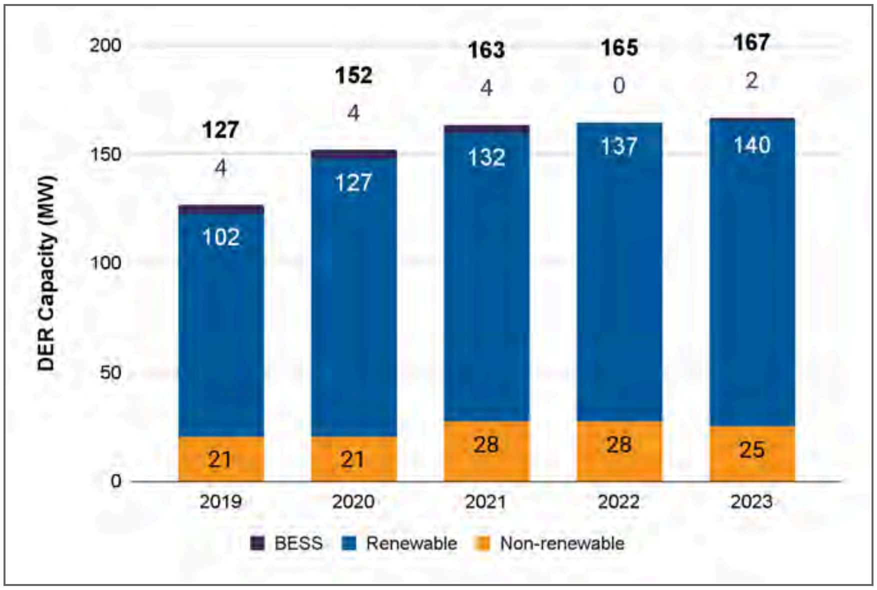
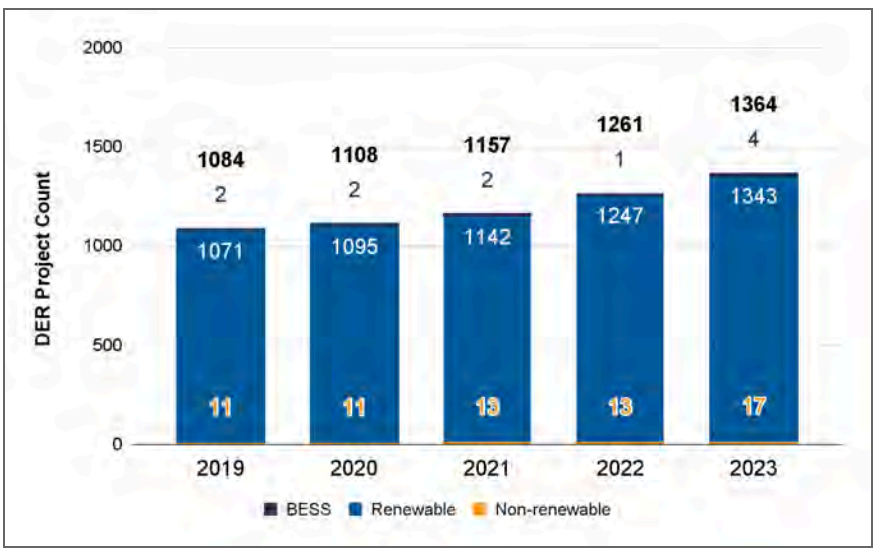
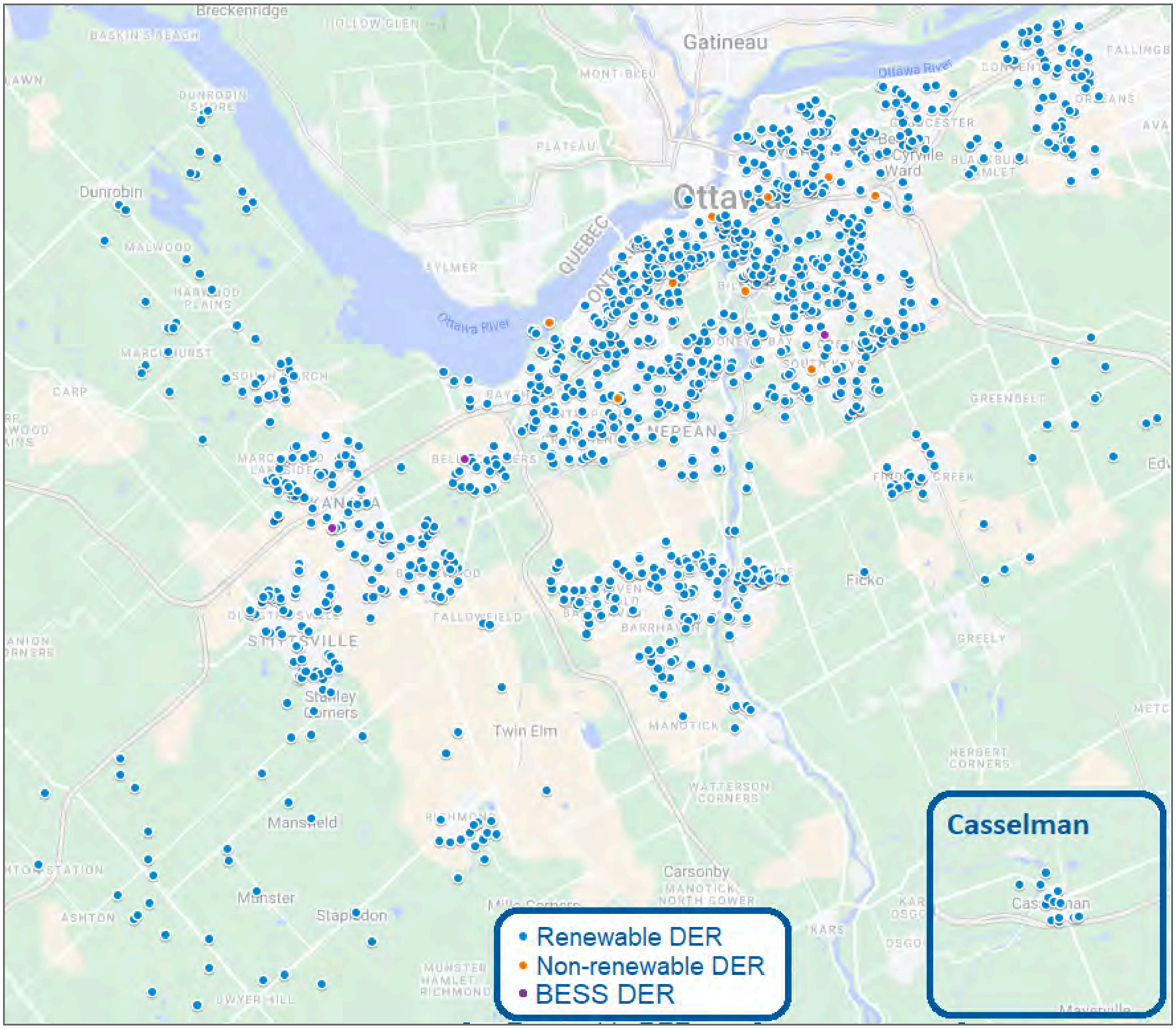


Figure 109 - Total System DER Count 2019-2023



The continuing success of DERs is visible in Figure 110, which maps the existing renewable and non-renewable DERs across the Hydro Ottawa service territory.

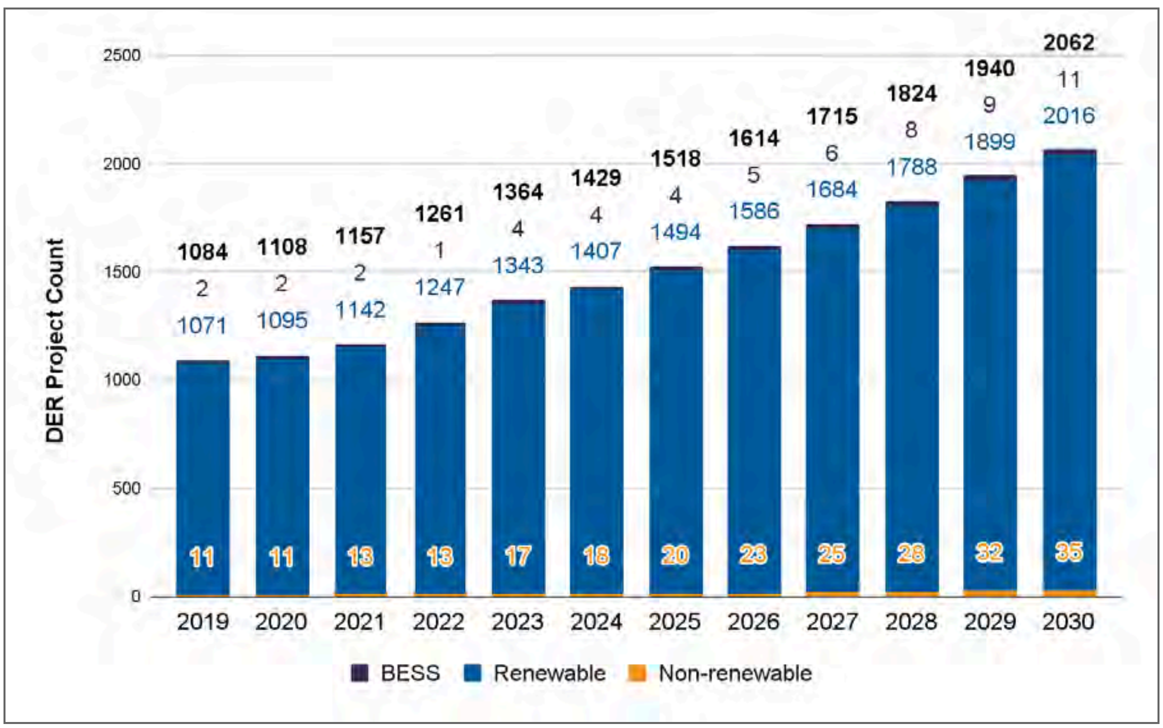
Figure 110 - Map of DER Projects in Hydro Ottawa Service Area



9.3.2 Generation Forecast

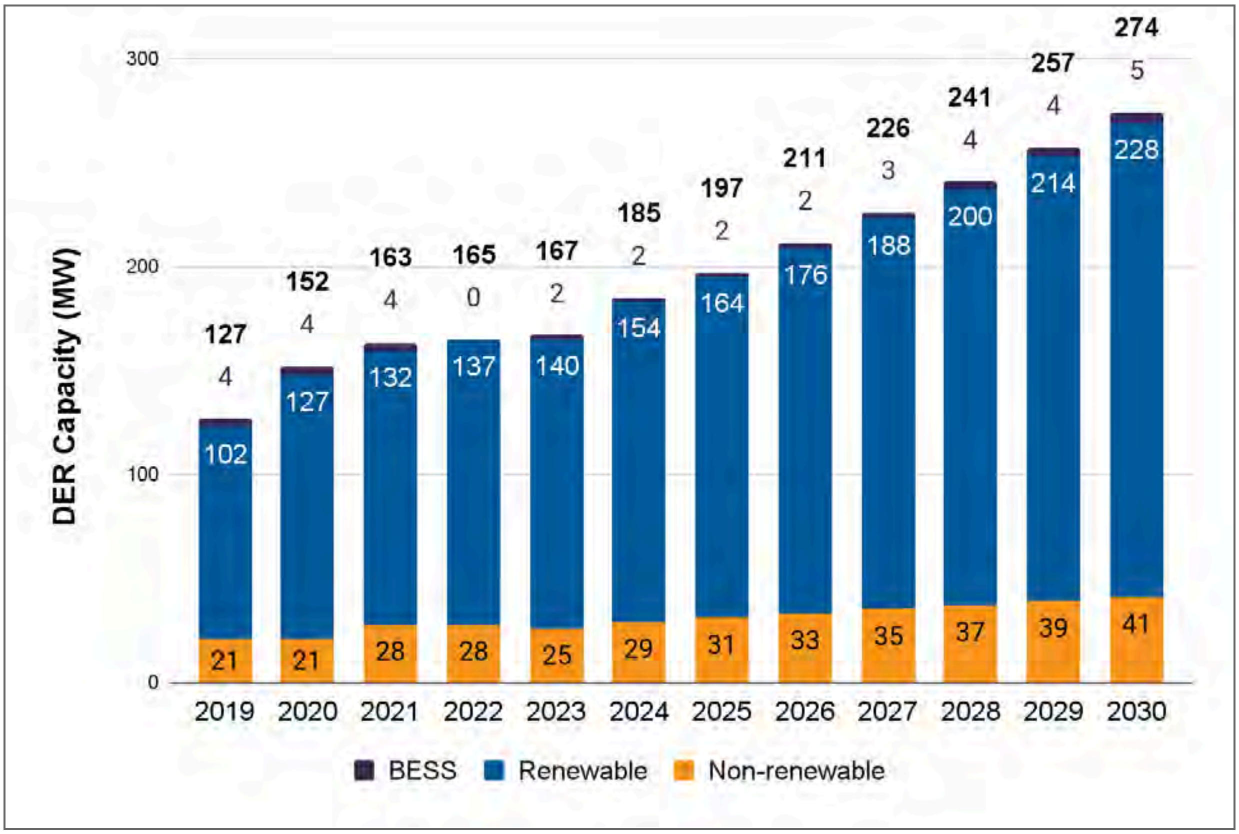
Hydro Ottawa's 2026-2030 DER forecast takes into account historical data, planned projects, current customer programs and the prevailing economic climate. Ultimately, customer choice fuels the demand for DERs and this demand is highly sensitive to policy influences, particularly the availability of funding and incentive programs. Predicting the precise timing, magnitude, and likelihood of customer adoption is challenging due to the numerous policy, economic, and technological variables at play - actual growth could deviate if new programs, incentives or technologies are introduced. The latest Hydro Ottawa forecast anticipates a total of 2,016 renewable projects by the end of 2030, in comparison to the 1,343 installed as of the end of December 2023. The forecast also anticipates 35 non-renewable and 11 BESS projects by the end of 2030, shown in Figure 111.

Figure 111 - Historical and Forecasted DER Projects



The forecast anticipates the cumulative installed renewable DER capacity to reach 228 MW by the end of 2030, as per Figure 112. The cumulative non-renewable DER capacity is projected to increase to 41 MW by the end of 2030, with BESS capacity increasing to 5 MW. With policy emphasis on decarbonization, it is expected that the number of renewable and energy storage DER projects will continue to increase beyond 2030.

Figure 112 - Historical and Forecasted DER Capacity



9.3.3. System Capability to Connect DER

Connecting new DERs to the distribution system requires careful evaluation of several key factors. Hydro Ottawa must ensure that the grid can safely and reliably accommodate the additional generation without compromising existing infrastructure or the quality of service to customers. This assessment includes analyzing the system's short-circuit capacity, thermal limits, and the potential impact of reverse power flow.

Furthermore, Hydro Ottawa must consider the effects of DERs on power quality. Maintaining stable voltage and frequency levels is crucial, and the connection of a DER should not introduce disturbances or create issues for other grid users. The potential for islanding, where a DER becomes isolated from the main grid but remains energized, also requires thorough investigation to prevent safety hazards. Each of these considerations is described in greater detail below as related to current system capacity and forecasted DER capacity from 2026-2030.

Short Circuit Capacity Constraints

Connection of DERs will increase the available current that flows through the distribution system during faults. The total available current during faults cannot exceed the equipment ratings. Currently Ellwood MTS is restricted due to short circuit capacity constraints. Consequently, substations fed from Ellwood MTS are also restricted - all Cahill AN feeders, Brookfield feeders AF02 through AF04, McCarthy AQ02 through AQ04, Albion feeders UA05 through UA07, and Walkley feeders UZ05 through UZ12. The Ellwood MTS short circuit constraint results in a total of 36 restricted feeders, as outlined in Table 37. More details on steps being taken by Hydro Ottawa to deal with the Ellwood MTS constraints is elaborated in Section 9.3.4 - Capacity Investments for DER Connections.

1 **Table 37 - Restricted Feeders and Number of Connected Customers**

Station Name	Feeder Designation	Restriction	# of Connected Customers
Ellwood	ELW01	Short Circuit Capacity	-
	ELW02	Short Circuit Capacity	64
	ELW03	Short Circuit Capacity	-
	ELW04	Short Circuit Capacity	1,038
	ELW05	Short Circuit Capacity	1,131
	ELW06	Short Circuit Capacity	5
	ELW07	Short Circuit Capacity	1,771
	ELW08	Short Circuit Capacity	1,149
	ELW09	Short Circuit Capacity	1,048
	ELW10	Short Circuit Capacity	973
	ELW11	Short Circuit Capacity	836
	ELW12	Short Circuit Capacity	673
	ELW13	Short Circuit Capacity	1,044
	ELW14	Short Circuit Capacity	808
Cahill	AN02	Short Circuit Capacity	-
	AN03	Short Circuit Capacity	-
	AN04	Short Circuit Capacity	365
	AN05	Short Circuit Capacity	399
	AN06	Short Circuit Capacity	251
	AN07	Short Circuit Capacity	-
	AN00	Short Circuit Capacity	-
Brookfield	AF02	Short Circuit Capacity	61
	AF03	Short Circuit Capacity	381
	AF04	Short Circuit Capacity	252
McCarthy	AQ02	Short Circuit Capacity	187
	AQ03	Short Circuit Capacity	453

Station Name	Feeder Designation	Restriction	# of Connected Customers
	AQ04	Short Circuit Capacity	330
Albion	UA05	Short Circuit Capacity	501
	UA06	Short Circuit Capacity	307
	UA07	Short Circuit Capacity	341
Walkley	UZ05	Short Circuit Capacity	382
	UZ06	Short Circuit Capacity	654
	UZ07	Short Circuit Capacity	241
	UZ10	Short Circuit Capacity	-
	UZ11	Short Circuit Capacity	665
	UZ12	Short Circuit Capacity	277
Lisgar	TL01	Thermal Capacity	6
	TL03	Thermal Capacity	-
	TL05	Thermal Capacity	755
	TL07	Thermal Capacity	-
	TL09	Thermal Capacity	215
	TL11	Thermal Capacity	-
	TL13	Thermal Capacity	2
	TL15	Thermal Capacity	-
	TL17	Thermal Capacity	-
	TL19	Thermal Capacity	674
	TL21	Thermal Capacity	364
	TL23	Thermal Capacity	31
	TL25	Thermal Capacity	424

Thermal Capacity Constraints

Exceeding the feeder ampacity rating results in overheating the conductors and connected equipment, thereby reducing the effective life of the asset or causing immediate equipment failure.

For DERs, the available thermal capacity is the full feeder ampacity rating, less the contingency loading. Lisgar TS currently has thermal constraints on T1, resulting in a total of 13 restricted feeders, as shown in Table 37. More details on steps being taken by Hydro Ottawa to deal with these constraints is elaborated in Section 9.3.4 - Capacity Investments for DER Connections.

Reverse Power Flow Considerations

When transformers are identified as having reverse flow capability as per manufacturer specification, the limiting factor is 60% of the top transformer rating plus minimum station load. For station transformers that have limited or no capability for reverse power flow, the limiting factor is the station minimum load. Only Lisgar TS is currently restricted by reverse power flow at the station.

Power Quality Considerations

There are various power quality concerns that are considered when connecting distributed generation on the system, including harmonics, phase imbalance, voltage instability, and flicker. Each of these factors is investigated as part of the connection impact assessment for proposed DERs.

Anti-islanding Considerations

DERs may introduce safety and power quality issues in the event of continued unsanctioned generation after the loss of distribution supply. The installation of transfer trip functionality and alternate anti-islanding methods such as reverse power flow protection may be used to mitigate the potential for the unsanctioned islanding of individual generators. Currently transfer-trip is required for generation connections equal to or larger than 500kW. Anti-islanding measures are investigated as part of the connection impact assessment for proposed DERs.

9.3.4. Capacity Investments for DER Connections

Hydro Ottawa currently has two stations in its distribution system with restrictions on generation connection. Ellwood MTS restrictions are due to short circuit limitations, while Lisgar TS is limited by minimum normal loading on the station bus, thus raising reverse power flow concerns should additional generation be installed.

Options are being assessed to remove short circuit limitations at Ellwood MTS. One of the alternatives being assessed is installing fast switching protective devices at the closed bus tie, thereby removing the short circuit constraint at the station and all downstream substations fed from Ellwood MTS. This solution is still at the planning stages and feasibility is left to be determined. In the interim, Hydro Ottawa is investigating the feasibility of operating Ellwood MTS with an open bus tie to temporarily remove the short circuit limitation until a permanent solution can be implemented.

Hydro One is addressing the constraint at Lisgar TS through the replacement of the T1 transformer to a unit that has reverse flow capability - the work will be completed by 2025. In addition, Hydro Ottawa is currently in discussions with Hydro One through the IRRP on timings to replace the T2 transformer at Lisgar TS with a larger unit to address future demand growth within the downtown area.

Hydro Ottawa is actively pursuing the solutions above to remove the short circuit restrictions on 36 feeders and the thermal restriction on 13 feeders, in order to accommodate new DERs. These initiatives demonstrate Hydro Ottawa's commitment to exploring and implementing feasible alternatives to enable DER connections even in areas with existing network constraints. This approach ensures that customers seeking to integrate DERs can be effectively accommodated wherever possible.

9.4. PLANNING LOAD FORECASTING

Hydro Ottawa's capacity planning process evaluates the distribution grid's ability to serve current and future customers safely and reliably, using the system load forecast as its foundation. The system load forecast was informed by two types of forecasts: Hydro Ottawa Planning Forecast and the IRRP Forecast. It is important to note that these forecasts are different from the revenue load forecast explained in detail in Section 9.4.3 - Planning Load Forecast vs. Revenue Load Forecast.

9.4.1. Hydro Ottawa Planning Forecast

Hydro Ottawa's Planning Forecast projects station-level load increases until 2030. It is guided by the City of Ottawa's Official Plan, City planning circulations, CDPs and consultations with developers and considers:

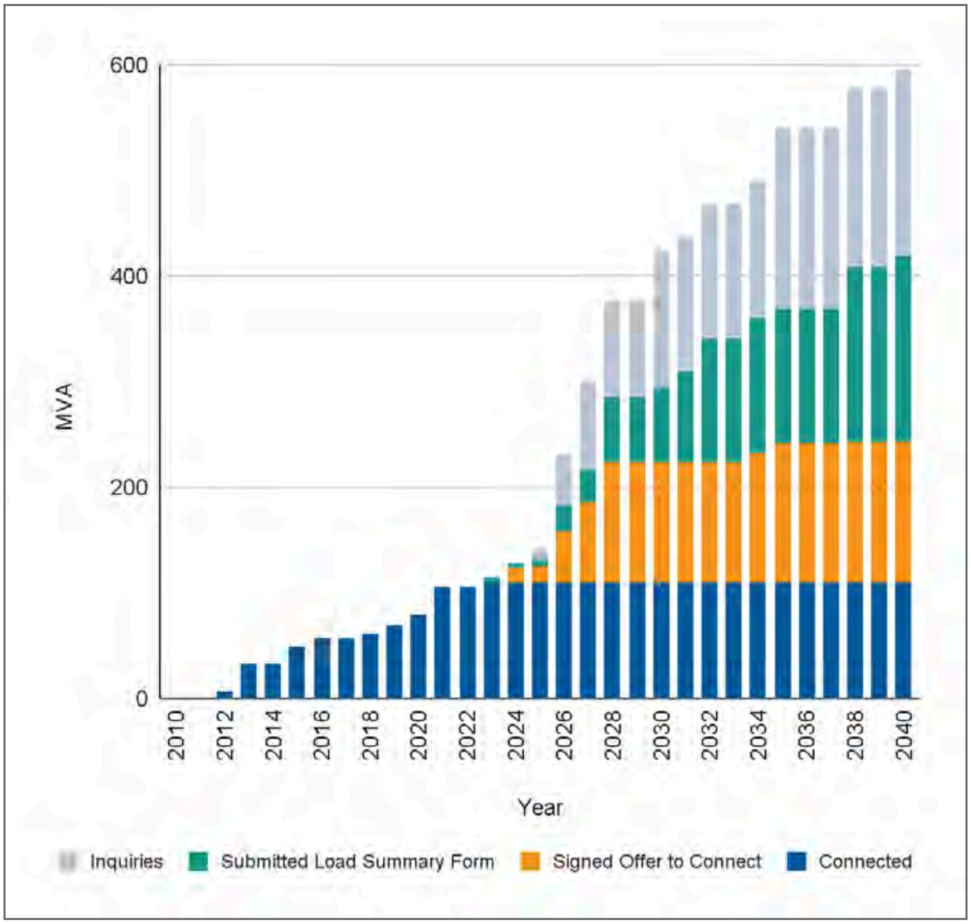
- Historical weather-normalized load from system coincident peak (currently summer) at the station level,
- Planned developments (residential, mixed-use, and employment)
- Known large load requests, see Section 9.4.1.1 - Large Load Request Trends and
- Customer requests in initial planning phases

While systemic impacts of space heating and transport electrification are not explicitly modeled, known large load requests, some of which are driven by electrification, are included. This detailed station-level approach is specifically used to inform near-term capacity needs across distribution subsystems, out to 2030.

9.4.1.1. Large Load Request Trends

Hydro Ottawa received large electrification load requests in the 2021-2025 period ranging from 5 MVA to 57 MVA. These requests encompass a variety of customers, from large institutions, like universities and hospitals, to technology companies and federal agencies. The main driver for the majority of large load requests was electrification of space heating, water heating, and transportation in order to align with municipal and federal decarbonization goals. The use of electric heat pumps, electric bus charging, and electric industrial water heating results in a significant increase in loading for large facilities, particularly when transitioning the entire facility to electric. The cumulative demand requests received through to January 1st 2025, with the respective energization timelines, are illustrated in Figure 113. Figure 113 highlights 110 MVA of large loads successfully integrated into the grid between 2010 and 2023 (blue), 113 MVA of confirmed customer commitments, secured through signed Offers to Connect and slated for completion by 2028 (orange), and a further 199 MVA of potential load requests, encompassing preliminary inquiries through to formal load summary submissions (grey and green). Should these potential requests materialize by 2030, Hydro Ottawa anticipates an unprecedented 312 MVA increase in its total load demand over the 6 year span of 2024-2030; a three-fold increase from the 110MVA connected in the previous 10 years.

Figure 113 - Cumulative MVA Large Load Requests



9.4.2. IRRP Forecast

The IRRP forecast submitted by Hydro Ottawa to the IESO for the regional planning process is built with a focus on the medium to long-term outlook (beyond 2030) that considers a sensitivity analysis due to effects of decarbonization goals. This is in alignment with the Regional Planning Process Advisory Group's (RPPAG) Load Forecasting Guideline.[44] Previously, mid to long-term forecasting relied on historical consumption patterns and projected growth rates based on observable past trends. However, with the introduction of decarbonization goals and the resulting electrification of

[44] RPPAG Load Forecasting Guideline- https://www.oeb.ca/sites/default/files/Load-Forecast-Guidance-Document-RPPAG-20221013.pdf

buildings, water heating, and transportation, this methodology is no longer adequate to model the potential impacts these shifts have on electricity demand.

Hydro Ottawa leveraged the hourly system coincident peak forecasts from the Decarbonization Study's Reference Scenario, see details in Section 9.4.2.1 - Decarbonization Study to inform the IRRP forecast. This helps contextualize potential long-term impacts of decarbonization. Aligning with the Decarbonization Reference Scenario in the medium to long-term is required for the regional planning process as transmission level investments that add capacity to the provincial grid have longer lead times (> 5 years). This also allows Hydro Ottawa to validate that capacity investments for immediate needs (informed through Hydro Ottawa's planning forecast) strategically align with indications of long-term needs, ensuring efficient capital deployment and optimizing asset utilization.

9.4.2.1. Decarbonization Study

To support the transition to a more advanced forecasting methodology for medium to long-term system needs, Hydro Ottawa engaged Black & Veatch to conduct a Decarbonization Study to examine the impact of decarbonization initiatives on Hydro Ottawa's distribution system through 2050. Refer to Attachment 2-5-4(F) - Decarbonization Study for details on the study.

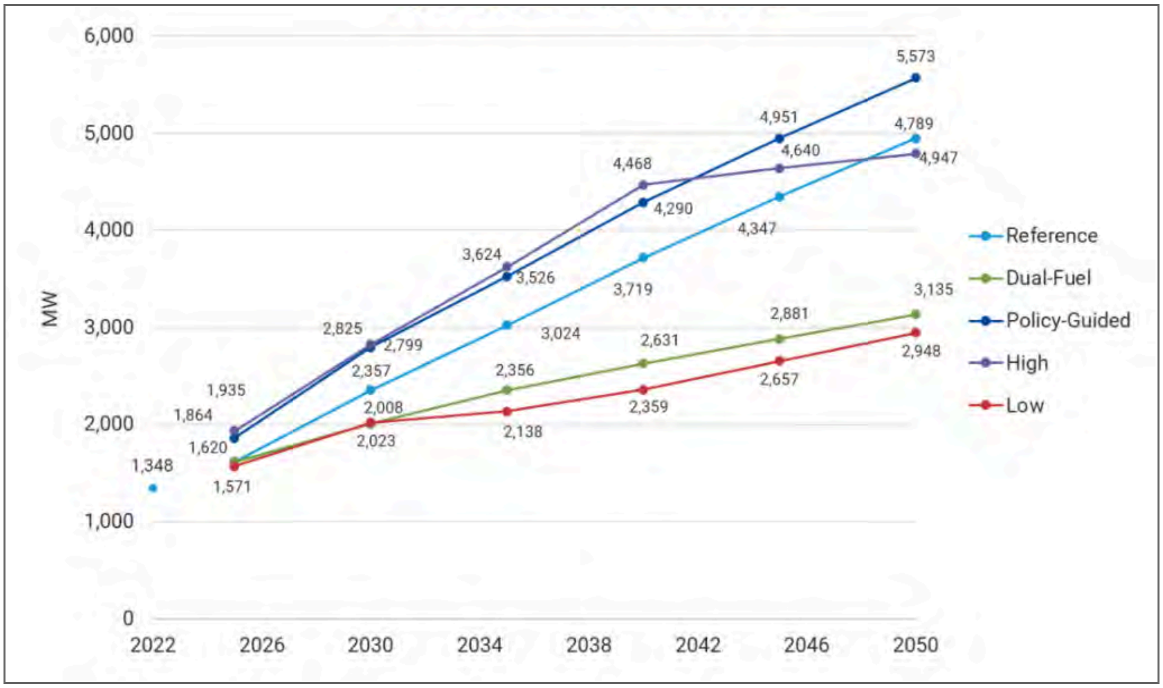
The Decarbonization Study outlines five scenarios that assess the impact of decarbonization initiatives on Hydro Ottawa's distribution system until 2050. Decarbonization levers such as population growth, energy efficiency, electric vehicle adoption, and building heating assumptions were adjusted within each scenario. Load modeling was divided into Baseline and New Electrification load categories. These scenarios illustrate potential impacts on Hydro Ottawa's load profiles. The five scenarios are outlined in Table 38 below.

Table 38 - Decarbonization Study Scenarios

Scenario	Description
Policy-Guided Scenario	• Models strict adherence to Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. • Assumes full electrification of buildings and transportation, representing an aggressive decarbonization pathway. • Provides insights into the potential challenges and infrastructure requirements under ambitious climate goals.
Reference Scenario	• Represents the most likely outcome based on current trends in Hydro Ottawa's load forecast. • Assumes a moderate pace of decarbonization, with increasing electrification in the mid-to-long term. • Serves as the primary basis for evaluating the distribution system impact and potential solutions.
Dual-Fuel Scenario	• Sensitivity analysis applied to the Reference Scenario, focusing on space heating and water heating. • Assumes a significant portion of buildings will adopt dual-fuel heating systems, using both electricity and low-carbon gas. • Helps assess the impact of continued gas use on peak demand during extreme cold temperature and overall load growth.
High Case Sensitivity	• Explores a more aggressive decarbonization and electrification pathway than the Policy-Guided Scenario. • Assumes accelerated adoption of electric vehicles (EVs) and higher efficiency gains in heating technologies. • Helps evaluate the potential for rapid load growth and the need for proactive grid investments.
Low Case Sensitivity	• Considers a less aggressive decarbonization and electrification pathway than the Policy-Guided Scenario. • Assumes slower EV adoption and a higher proportion of buildings continuing to rely on decarbonized gaseous fuels. • Provides insights into the potential for slower load growth and the implications for infrastructure planning.

Hydro Ottawa leveraged Black & Veatch projections for the Reference Scenario to inform its medium to long-term forecast that was submitted to the IESO as part of the regional planning process - the IRRP Forecast. The five scenarios are depicted in Figure 114.

Figure 114 - Decarbonization Scenario Peak by Year[45]



The Reference scenario is based on historical data and existing trends, and assumes increasing policy-driven decarbonization leading to electrification in the medium to long-term. This scenario was selected because in the Reference Scenario, the new electrification load forecast is characterized by a tempered pace of decarbonization in the short-term which meets Canada's 2030 Emissions Reduction Plan and Canada's wider 2050 decarbonization goals. Further, this scenario assumes full electrification of most buildings, with a minority continuing to utilize gas distribution networks by 2050. The Reference scenario sees the system transition to winter peaking by 2030, largely driven by projections on space heating, where electrification rates in buildings lead to spikes in space heating when temperatures are low and impact heating efficiency.

9.4.3. Planning Load Forecast vs. Revenue Load Forecast

The planning forecast serves as the foundation for evaluating the distribution system's capacity to

[45] Figure 38 in Attachment 2-5-4(F) - Decarbonization Study

accommodate future electricity demand. This forecast plays a pivotal role in identifying both the locations and the timing of necessary system upgrades. By considering factors at various levels of granularity—including the station and planning region—the planning forecast allows for a nuanced and targeted approach to system expansion. Its emphasis on location specificity and its incorporation of coincident peak demand requirements—the periods when electricity demand is at its highest—ensure that the distribution system remains robust and capable of meeting the needs of consumers, even during peak load periods. More details on justification for station capacity needs are available in Section 2.3.2 in Schedule 2-5-8 - System Service Investments.

In contrast, the revenue load forecast, outlined in Schedule 3-1-1 - Revenue Load and Customer Forecast, is primarily employed for financial planning and the determination of distribution rates and allocating revenue requirements. This forecast centers on billing consumption and billing demand rather than the locational coincident peak demand, measured in MWs. While the planning forecast is granular and location-specific, the revenue load forecast takes a more aggregated approach. It considers a broader array of factors, such as economic trends, population growth, energy efficiency initiatives, and the impacts of CDM programs. The development of the revenue load forecast typically relies on historical billing data, sophisticated econometric models, and customer class segmentation, enabling a comprehensive understanding of revenue requirements and informing the establishment of distribution rates.

In essence, the planning forecast and the revenue load forecast serve distinct yet complementary purposes within the electricity distribution system. Both forecasts use the same foundational considerations built upon shared core principles, influencing elements, and underlying assumptions on how energy consumption will evolve. However, the planning forecast ensures the system's physical capacity to meet future peak demand (the worst case scenario), while the revenue load forecast supports financial planning and rate setting through annual consumption. By recognizing the differences in their focus and level of aggregation, Hydro Ottawa leverages these forecasts effectively to optimize both the operational and financial performance of the electricity distribution system.

ea technology

CERTIFICATE OF CONFORMANCE

Certificate of Conformance

This is to certify that the Asset Management System of

Hydro Ottawa Limited

2711 Hunt Club Road, Ottawa, K1G 4G2, Canada

is in conformance with the requirements specified within the following Asset Management Standard:

ISO55001: 2014

The scope of the Asset Management System is applicable to:

- The electricity distribution and electrical energy supply assets owned, managed and operated by Hydro Ottawa Ltd. including:
  - All electricity distribution system assets.
    - This includes metering assets and communication systems between all applicable sets of assets.
    - This excludes fleet and IT businesses.
  - All core processes that are applicable to the Asset Management System, including internal resources and control of external service providers contributing to asset management.

This certificate is applicable to the following Hydro Ottawa Ltd. locations:

- Main Office & East Operations (2711 Hunt Club Road, Ottawa, K1G 4G2, Canada)
- Training Centre (4565 Bank Street, Gloucester, K1T 3W6, ON, Canada)
- West Operations (100 Maple Grove Road, Kanata, K2V 1B8, ON, Canada)
- Warehouse & South Operations (201 Dibblee Road, Nepean, K2R 1J2, ON, Canada)
- Central Operations (1275 Carling Avenue, Ottawa, K1Z 1A2, ON, Canada)

Signed For EA Technology

A McHarrie: Head of Asset Management
Issued by: EA Technology Limited
Capenhurst Technology Park
Capenhurst
Chester. CH1 6ES

Certificate Number: EA2309001

Certification issue date: 18th September 2023

Certificate expiry date: 17th September 2026

IAM endorsed ASSESSOR

Stantec

Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan

FINAL REPORT

December 4, 2023

Prepared for:
Hydro Ottawa Limited

Prepared by:
Stantec

Project Number:
160925222

Limitations and Sign-off

The conclusions in the Report titled Addendum Report to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. This report should be read in conjunction with the original Distribution System Climate Risk and Vulnerability Assessment, 2019 and Hydro Ottawa Climate Change Adaptation Plan, 2019. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from Hydro Ottawa Limited (the "Client") and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

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Executive Summary

Stantec Consulting Ltd. (Stantec) was retained to by Hydro Ottawa Limited (HOL) to conduct an update to the Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019. The main objective of the study was to identify if the climate adaptation and risk mitigation measures recommended in the 2019 adaptation plan are still appropriate for the existing risk levels and consequences. This study uses additional and updated climate projection data to estimate climate parameter probabilities and identifies whether these changes lead to materially different risk scores for Hydro Ottawa's infrastructure assets over the study period. The study involved updating the list of climate parameters to include additional high wind thresholds representative of recent extreme weather events, update climate parameter probabilities, impact severity (based on input from Hydro Ottawa personnel), and risk scores, completing a forensic analysis of the May 21, 2022 Derecho event; and a workshop with staff to evaluate adaptation plan progress and assess potential changes to consequence ratings from the 2019 risk assessment, updating where appropriate the adaptation and risk mitigation plan using input from the review workshop and where risk scores changed to medium-very high under current and future climate. For consistency, the same methods used in the 2019 report were also used in this reassessment.

Two additional high wind thresholds were established for this update based on updated Environment and Climate Change Canada (ECCC) criteria for severe thunderstorm winds and the damages observed by the Northern Tornadoes Project in surveys following the 2022 May Derecho event. The thresholds established included:

- Wind speeds > 130 km/h – Based on new ECCC severe thunderstorm winds and with 17% higher loading factor than the 120 km/h gust threshold used in the 2019 study.
- Wind speeds > 180 km/h (Derecho event equivalent) – based on consistent EF-2 style observed damage in Ottawa region and Doppler Radar near surface wind speed recordings.

The climate analysis completed for the 2019 study was based on Coupled Model Intercomparison Project Phase 5 (CMIP5) Global Climate Models (GCMs) climate projections. CMIP5 climate projections formed the basis of the *IPCC Fifth Assessment Report* (IPCC, 2013). The "Delta Approach" downscaling method was used to generate localised climate change projections from 37 CMIP5 GCMs. Projected frequencies of occurrence and likelihoods were assessed based on the multi-model ensemble projections under the RCP8.5 scenario.

Following the completion of the 2019 study, new climate projection data has become available. In 2020, the National Capital Commission and the City of Ottawa released climate projection data for the RCP4.5 and RCP8.5 scenarios for the National Capital Region (NCR). In 2021/2022, the Intergovernmental Panel on Climate Change (IPCC) released its *Sixth Assessment Report* (AR6) based on climate projections from the Coupled Model Intercomparison Project Phase 6 (CMIP6) and based on the new Shared Socio-economic Pathway (SSP) climate change scenarios. Where possible, the projected frequency of occurrence and probability of the selected climate parameters for the CRVA were updated based on these new climate projection data sources.

The climate parameter frequency of occurrence and probabilities were updated using, where possible, the downscaled National Capital Region projections and downscaled CMIP6 projections. Annual and/or 30-year probabilities for the 2050s (2041-2070) changed for the following climate parameters:

- Rain: 50 mm in 1 hr
- Invasive species: Emerald Ash Borer kill temperature (daily minimum temperature of -30°C or colder)
- Frost: Hard freeze-thaw cycles (daily Tmax/Tmin temperature fluctuation of ±4°C around 0°C)

While tornadoes have impacted the Ottawa region more frequently in the last decade, the probability rating for tornado occurrence has not changed. Probability ratings were established for two scenarios: 1) the likelihood of a single point within Hydro Ottawa's service area being struck by a tornado and 2) the likelihood of a tornado occurring anywhere within the service area. In the risk assessment, the higher likelihood was carried forward and used to estabilsh potential risk.

Frequency of occurrence and probabilities were also established for the new high wind thresholds of wind speeds > 130 km/hr and > 180 km/hr.

Risk scores increased due to higher consequence ratings for current and future climate for higher threshold wind speeds (120 km/hr) and for newly established thresholds (130 km/hr and 180 km/hr). However, for most risks, no risk level change was observed.

To handle additional risks from higher wind thresholds, the following risk adaptation measures should be considered:

- Consider a study on pole characteristics (i.e. age and guying locations) from the 2022 Derecho to determine potential vulnerability of pole tops.
- Consider the impact of climate change on recently (or future) hydro poles being grown (i.e. wood density and strength)
- Consider establishing additional supply capacity and storage for key components (e.g. poles) in the event that a major or catastrophic event impacts a large portion of the service area
- Consider real-time or automated monitoring system for severe weather events or creating a staff position for a meteorologist to handle coordination between utilities and monitoring potential upstream outages before they impact HOL service area
- Continue with planned adaptation planning actions already underway, including an undergrounding study, anti-cascading study and strategy, and asset hardening however, new risk should be utilized in decision making a cost/benefit studies underway.

Other risk mitigation measures developed in the 2019 study remain relevant based on the conversations conducted at the 2023 reaffirmation workshop.

Acronyms / Abbreviations

AEP	Annual Exceedance Probability
AR5	5th Assessment Report
AR6	6th Assessment Report
BCCAQv2	Bias Correction/Constructed Analogues with Quantile delta mapping reordering, version 2
CanDCS-U5	Canadian Downscaled Climate Scenarios – Univariate (CMIP5)
CanDCS-U6	Canadian Downscaled Climate Scenarios – Univariate (CMIP6)
CMIP5	Coupled Model Intercomparison Project 5
CMIP6	Coupled Model Intercomparison Project 6
ECCC	Environment and Climate Change Canada
EF	Enhanced Fujita Scale
GCM	Global Climate Model
IDF	Intensity-Duration-Frequency
IPCC	Intergovernmental Panel on Climate Change
NTP	Northern Tornadoes Project
PCIC	Pacific Climate Impacts Consortium
PIEVC	Public Infrastructure Engineering Vulnerability Committee
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
RSI	Risk Sciences International
SSP	Shared Socioeconomic Pathway

1 Introduction

Stantec Consulting Ltd. (Stantec) completed this scope of work to provide Hydro Ottawa Limited (HOL) with an Updated Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan, as appropriate, given some of the recent major weather events, specifically:

- September 21, 2018 – Tornadoes
- April 15, 2019 – Lightning storm and flooding
- July 5, 2019 – Windstorm
- June 14, 2021 – Summer/Lightning storm
- May 21, 2022 – Derecho storm
- December 23, 2022 – Winter storm

This update addresses only the revised risks and adaptation measures and should be read in conjunction with the original reports:

- Distribution System Climate Risk and Vulnerability Assessment, dated September 11, 2019 (Stantec, 2019a)
- Hydro Ottawa Climate Change Adaptation Plan, dated November 11, 2019 (Stantec, 2019b)

1.1 Background

A Climate Risk and Vulnerability Assessment (CRVA) and an Adaptation Plan was conducted was developed for HOL conducted by Stantec in 2019 (Stantec, 2019a-b) using:

- Available climate data for the region and their projection into the future using internationally accepted Intergovernmental Panel on Climate Change (IPCC) projection data, and
- Forensic analysis of three significant weather events that occurred in 2018 and resulted in widespread outages / costly recoveries, including a freezing rain event in April, a heavy wind event in May, and a series of tornados that touched down in September in the Ottawa region.

The climate data was used to conduct a climate risk assessment using Engineers Canada's Public Infrastructure Engineering Vulnerability Committee's (PIEVC) assessment protocol (Engineers Canada, 2011) and estimate the vulnerability and risk of Hydro Ottawa's electrical distribution system to climate change and extreme weather events.

The risk assessment included a workshop with Hydro Ottawa personnel, interviews with stakeholders, and an analysis of past climatic events to characterize the impacts and consequences of climate on Hydro Ottawa's assets. Risks were evaluated by combining the climate hazard likelihood with the consequence information. The results of the 2019 report were used to determine where infrastructure vulnerabilities to climate change were present and identify adaptation options to increase resilience.

1.2 Objective

The main objective of this update was to add new climate parameters for wind, utilize new climate data, revise risk based on more extreme weather events and establish new climate risk scores and risk mitigation measures as part of the update to the climate risk and adaptation plans. The outcome of the project is to identify revised climate risk scoring and whether there are any additional climate adaptation and risk mitigation measures required as a result of the revised assessment.

1.3 Scope

The following scope of work has been completed as part of this assessment.

1. **Climate Parameter Probability Update:** Assessment of past and recent weather events looking for new and more accurate climate data that has been available since the most recent assessment. Revision of likelihood scores for the Hydro Ottawa service area where necessary.
2. **Risk Assessment Update:** Evaluating the possible changes to the consequence ratings for any events, in particular focusing on the high and very high risks from the 2019 report.
3. Incorporation of an evaluation of the six weather related events into the impact rating and adding layers of wind speeds between 80 and 180 km/hr with the representative frequency data (for the same current and future scenarios developed in the 2019 report).
4. Provision of a forensic evaluation of the Derecho event that occurred on May 21, 2022. For this task, Stantec included the services of a subconsultant form the University of Western Ontario Northern Tornadoes Project (NTP), the foremost severe weather experts in Canada. This task included access to data from the NTP collected past event, leveraging extensive damage survey, impacts data, and mapping as well as engagement during the risk assessment workshops and executive board presentation. The primary resource from NTP were also part of the 2019 report, which allows for continuity with service delivery between Stantec, NTP, and Hydro Ottawa.
5. Identification of the impacts of various wind events across the additional laminations identified and rank the impacts / consequences (i.e., probability x impact) to provide overall risk levels in accordance with the Enterprise Risk Management rating system.
6. **Adaptation Plan Update:** Review of the status of climate adaptation and risk mitigation measures from the 2019 report using input from a review workshop to determine appropriateness based on updated risk levels and hazards.
7. **Addendum Report and Presentation of Results:** Provide an addendum report for both the 2019 Climate Risk and Vulnerability Assessment and Climate Change Adaptation plan based on the to reflect the new findings. Prepare and deliver an executive summary presentation to senior management, including an overview of the Derecho event and findings from the forensic study.

2 Climate Analysis Update

This section describes the data and methods used to update climate parameter frequencies of occurrence and probabilities, followed by a discussion on the climate parameters with adjusted probability scores based on the updated climate projection data reviewed. The climate parameters investigated, and methods used to estimate probabilities align with the 2019 report, except where otherwise noted.

2.1 Methodology

2.1.1 Climate Data

The climate analysis completed for the 2019 study was based on Coupled Model Intercomparison Project Phase 5 (CMIP5) Global Climate Models (GCMs) climate projections. CMIP5 climate projections formed the basis of the *IPCC Fifth Assessment Report* (IPCC, 2013). The “Delta Approach” downscaling method was used to generate localised climate change projections from 37 CMIP5 GCMs. Projected frequencies of occurrence and likelihoods were assessed based on the multi-model ensemble projections under the RCP8.5 scenario.

Since the completion of the 2019 study new climate projection data has become available. In 2020, the National Capital Commission and the City of Ottawa released climate projection data for the RCP4.5 and RCP8.5 scenarios for the National Capital Region (NCR). In 2021/2022, the Intergovernmental Panel on Climate Change (IPCC) released its *Sixth Assessment Report* (AR6) based on climate projections from the Coupled Model Intercomparison Project Phase 6 (CMIP6) and based on the new Shared Socio-economic Pathway (SSP) climate change scenarios. Where possible, the projected frequency of occurrence and probability of the selected climate parameters for the CRVA were updated based on these new climate projection data sources.

2.1.1.1 NCR Projections

The National Capital Commission (NCC) and the City of Ottawa have released a comprehensive climate change projection study for the National Capital Region (NCR). The NCR projections were developed using a collaborative and impacts driven approach and relying on ECCC and various GCMs and Regional Climate Model (RCM) datasets (City of Ottawa, 2020). The downscaled NCR climate projections have a high spatial resolution (10 km) and output numerous climate variables and indices for the RCP4.5 and RCP8.5 scenarios over the period of 2011-2100.

The primary source of climate projections for the NCR projections was high -resolution (~10 km) downscaled climate projections for Canada from 24 CMIP5 GCMs, referred to as the Canadian Downscaled Climate Scenarios – Univariate (CMIP5) (CanDCS-U5). The Pacific Climate Impacts Consortium (PCIC) has produced the CanDCS-U5 projections using the hybrid BCCAQv2 (Bias Correction/Constructed Analogues with Quantile delta mapping reordering, version 2) downscaling method (Cannon, 2015; Cannon et al., 2015). Additional climate projection data used for the NCR projections came from RCMs include CORDEX/UQAM, CanRCM4 (ECCC), INRS/Ouranos, and the University of PEI.

2.1.1.2 Shared Socio-economic Pathways

The IPCC's *Sixth Assessment Report* presents the latest global and regional assessments of climate change and its impacts using a set of five new illustrative emissions scenarios, referred to as Shared Socioeconomic Pathways (SSPs). The SSPs are based on five narratives describing alternative socioeconomic developments, including "sustainable development" (SSP1), "middle-of-the-road development" (SSP2), "regional rivalry" (SSP3), "inequality" (SSP4), and "fossil-fueled development" (SSP5) (see Table 2 in Riahi et al., 2017 for detailed descriptions). SSP5-8.5 represents a scenario with very high GHG emissions, with CO2 emissions that roughly double from current levels by 2050.

The climate analysis in the 2019 report used climate projections for the high emissions Representative Concentration Pathway – RCP8.5. The radiative forcing trajectories in RCP8.5 and SSP5 generally correspond (Riahi et al., 2017) and represent similar climate projection scenarios. Of the RCP and SSP scenarios, the RCP8.5 and SSP5 trajectories more closely match historical emissions, respectively, and therefore represent plausible emissions tracks into the future (Smith and Myers, 2018; Schwalm et al., 2020; Mohanty and Simonovic, 2021). Therefore, to provide a conservatively high estimate of projected climate change and its associated impacts, the CVRA focuses on the RCP8.5 and SSP5 emissions scenarios.

2.1.1.3 CanDCS-U6 Projections

Recently, global climate models (GCMs) driven by the SSPs have contributed to CMIP Phase 6 (Eyring et al., 2016), which forms the basis of the IPCC *Sixth Assessment Report* (IPCC, 2021). Downscaling methods are often used to produce finer spatial resolution projections from these GCMs. PCIC has produced high-resolution (~10 km) downscaled climate projections for Canada for 26 CMIP6 GCMs for three Shared Socioeconomic Pathway (SSP) projection scenarios, referred to as the Canadian Downscaled Climate Scenarios – Univariate (CMIP6) (CanDCS-U6). PCIC produced the downscaled projections for the simulated period of 1950-2100 using the hybrid BCCAQv2 downscaling method.

2.1.1.4 Levels of Confidence in Projections

Future climate conditions presented in this climate profile are retrieved from climate projections produced by downscaled GCMs, specialized literature, and professional judgement of Stantec's climate scientists. Some climate variables can be projected into the future with more confidence than others. The level of confidence in climate projections is dependent on the understanding of the processes involved in the climate phenomena, ability of climate models to simulate the phenomena, degree of agreement among the climate models (e.g., range of uncertainty), and the supporting evidence (e.g., theory, specialized literature, expert judgement, etc.). For example, projections based on GCMs and downscaling of such models are considered:

- Adequate (high confidence) for general temperature and precipitation projections,
- Less adequate (moderate confidence) for extreme parameters, and
- Inadequate for combined events (low confidence) such as freezing rain.

Combined or complex climate variables are normally inferred from other climate variables and result in lower confidence for projections. For example, freezing rain is a complex process and the projected prevalence of freezing rain events under future climate conditions is not as well understood as other variables such as temperatures.

All climate models have inherent shortcomings in fully and accurately representing the real climate system. Therefore, it is not recommended to rely only on one or two climate models to estimate future climate. Instead, an average of several climate models (a multi-model mean) tends to give a more reliable estimate of future climate (IPCC, 2013; 2021). The use of ensembles and multi-model means is common in climate science and is strongly encouraged as “best practice” (IPCC, 2013; 2021). Using ensembles and multi-model means provide insight into uncertainties in climate model projections. Therefore, the ensemble mean of the 26 CMIP6 GCMs is presented in this assessment.

2.1.2 Derecho Event May 21, 2022 Forensic Analysis

As part of the reaffirmation study, Stantec included the expertise of meteorologists from Western University’s Northern Tornadoes Project (NTP) and Northern Hail Project (NHP) to provide expert advice and analysis in the form of a forensic assessment of the May 21, 2022, severe windstorm. Termed a “derecho”, this storm severely impacted Hydro Ottawa’s infrastructure.

Doctor David Sills, Executive Director of the Northern Tornadoes Project (NTP), and Simon Eng, Research Meteorologist with the Northern Hail Project (NHP) and former consulting meteorologist on the original 2019 study, were asked to support the Hydro Ottawa reaffirmation study to address the following questions and concerns:

- *Significant concern regarding impacts associated with 120 km/h winds:* A peak wind gust reading of 120 km/h was recorded at Ottawa International Airport during the event. Wind speeds of this magnitude were included in the original climate risk assessment (Stantec 2019) but the May 21, 2022, storm generated impacts far greater than had been anticipated for winds of this magnitude.
- *The number and severity of weather-related outage events in recent years:* Several very high impact severe weather events have affected Hydro Ottawa’s system since the late-2010s. This has triggered concerns that these events are increasing in frequency to such an extent that their effects may not be manageable.
  - In particular, the southern-portion of the City has been severely affected by both the 2022 Derecho event and one of the September 2018 tornadoes: This raised concerns that this specific region within Hydro Ottawa’s service area was particularly vulnerable to severe thunderstorm-related wind events.
- *The May 21, 2022, storm indicated the need for identifying additional damage thresholds:* To help support future planning and continued efforts to increase resilience to current and future climate impacts, the risk assessment framework required the identification of additional, higher wind speed thresholds than had been previously identified in the original 2019 risk assessment (Stantec 2019).

Evidence using damage-based wind speed estimates, coupled with a review of Doppler radar wind velocity information, as well as evidence from other locations along the Derecho path, strongly indicates that the 120 km/hr wind gust measured at Ottawa International Airport was *not* representative of the wind speeds experienced during the event in the most severely impacted portions of Hydro Ottawa’s system.

These pieces of evidence generally indicate much stronger winds which likely reached 180-195 km/h. As a result, additional wind thresholds were established and are further described in Section 2.1.3. Further information from the forensic analysis of the Derecho event can be found in Appendix C.

2.1.3 Additional High Wind Thresholds

Initial wind thresholds for the 2019 study included high wind gusts of 120 km/h and easterly winds of 60 km/h and 80 km/h at seasonal and annual time periods. Two additional high wind thresholds were established for this update based on updated Environment and Climate Change Canada (ECCC) criteria for severe thunderstorm winds and the damages observed by the Northern Tornadoes Project in surveys following the 2022 May Derecho event. The thresholds established included:

- Wind speeds > 130 km/h – Based on new ECCC severe thunderstorm winds and with 17% higher loading factor than the 120 km/h gust threshold used in the 2019 study
- Wind speeds > 180 km/h (Derecho event equivalent) – based on consistent EF-2 style observed damage in Ottawa region and Doppler Radar near surface wind speed recordings

2.1.4 Climate Parameter Probabilities

Climate parameter frequency of occurrence and probability were based on either the NCR projections, CanDCS-U6 projections, or literature review (which included specialized studies, climate analogues, and professional judgement). The climate projections data sources used for each climate parameter, for the 2019 study and the 2023 update, are presented in Table 1. The baseline probabilities from the 2019 report are maintained in this study because their calculation relied on high-quality measurements obtained from the Ottawa Macdonald-Cartier International Airport weather station.

Annual probabilities were calculated for the baseline period (1981-2010) and the 2050s (2041-2070) for each climate parameter. The annual probabilities were then translated to study period probabilities by estimating the likelihood of occurrence over a 30-year period.

Table 1: Climate Projections Data Sources used in the 2019 Report and the 2023 Update

Climate Parameter	Threshold(s)	Climate Projections Data Source	
		2019 Report	2023 Update
Temperature – Extreme Heat	Tmax ≥ 25°C; Tmax ≥ 35°C	CMIP5 Projections Downscaled with Delta Approach	NCR Projections
	Tmax ≥ 30°C; Tmax ≥ 40°C; Tmean ≥ 30°C; Heat waves	CMIP5 Projections Downscaled with Delta Approach	CanDCS-U6 Projections
Temperature – Extreme Cold	Tmin ≤ -35°C	CMIP5 Projections Downscaled with Delta Approach	CanDCS-U6 Projections

Climate Parameter	Threshold(s)	Climate Projections Data Source	
		2019 Report	2023 Update
Rain (Short Intensity – High Duration)	50 mm in 1 hr	Historic IDF data adjusted using Clausius-Clapeyron rate	NCR Projections
Freezing Rain & Ice Storms	Ice accumulation of 25 mm; 40 mm	Literature	Literature
Snow	≥ 5 cm in 24 hrs; ≥ 30 cm in 24 hrs	Literature	Literature
	≥ 10 cm in 24 hrs	Literature	NCR Projections
High Winds	Wind speeds of 60 km/hr; 80 km/hr; 90 km/hr; 120 km/hr	Literature	Literature
High Winds	Wind speeds of 130 km/hr; 180 km/hr	N/A	Literature
Lightning	Flash density	Literature	Literature
Tornadoes	EF1+	Literature	Literature
Invasive Species	Emerald Ash Borer (kill temperature); Giant Hogweed (germination temperature requirement)	CMIP5 Projections Downscaled with Delta Approach	CanDCS-U6 Projections
Fog	≥ 50 fog days (Nov.-March)	Literature	Literature
Frost	Freeze-thaw cycles (Tmax Tmin fluctuation around 0°C)	CMIP5 Projections Downscaled with Delta Approach	NCR Projections
	Hard freeze-thaw cycles (Tmax Tmin fluctuation of ±4°C around 0°C)	CMIP5 Projections Downscaled with Delta Approach	CanDCS-U6 Projections

Climate parameter probabilities were assigned using the five-point scoring scale used in Hydro Ottawa's Asset Management System Risk Procedures (Table 2). This five-point probability scoring scale was used in the 2019 study and, therefore, maintains consistency and allows comparability between the 2019 study and the 2023 update.

Table 2: Probability Scoring Scaled Used in Hydro Ottawa's Asset Management System Risk Procedures

Probability Score	Descriptor	Detailed Description	Probability Range
1	Rare	May only occur in time period under exceptional circumstances	p ≤ 5%
2	Unlikely	Could occur in time period	5% < p ≤ 35%
3	Possible	Might occur in time period	35% < p ≤ 65%
4	Likely	Will probably occur in time period	65% < p ≤ 95%
5	Almost Certain	Is expected to occur	95% < p

2.2 Results

Updated projected frequency of occurrence, annual and 30-year probabilities, for each climate parameter assessed in the 2019 study, as well as baseline (1981-2010) and 1991-2020 data, are provided in Appendix A. Climate parameters for which the annual and/or 30-year probability changed as well as for the additional high wind thresholds (laminations) are presented in Table 3. Probabilities for any parameters from the 2019 study that did not change remain with the same ratings as were previously calculated. While tornadoes have impacted the Ottawa region more frequently in the last decade, the probability rating for tornado occurrence has not changed. Probability ratings were established for two scenarios: 1) the likelihood of a single point within Hydro Ottawa's service area being struck by a tornado and 2) the likelihood of a tornado occurring anywhere within the service area. In the risk assessment, the higher likelihood was carried forward and used to establish potential risk.

Table 3: Changes in Climate Parameter Probabilities and Additional Wind Threshold Probabilities

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Rain	50 mm in 1 hr	4.5% (< 1 yr^{-1})	1	75%	4	32% (< 1 yr^{-1})	2	> 99%	5
Invasive Species: Emerald Ash Borer	Daily min. temp. of -30°C or colder (kill temp.)	3% (< 1 yr^{-1})	1	60%	3	4% (< 1 yr^{-1})	1	71%	4
Frost	Hard freeze-thaw cycles (Daily Tmax Tmin temp. fluctuation of ±4°C around 0°C) (30 cycles)	38% (< 1 yr^{-1})	3	> 99%	5	18% (< 1 yr^{-1})	2	> 99%	5
High Wind	Wind speeds > 130 km/hr	N/A	N/A	N/A	N/A	2.90% (<1 yr^{-1})	1	58%	3
	Wind speeds > 180 km/hr	N/A	N/A	N/A	N/A	1.25% (<1 yr^{-1})	1	31%	2

3 Review Workshop and Prioritizing Actions

Stantec organized an in-person (with a virtual option) climate risks and adaptation plan working session with Hydro Ottawa personnel on May 3, 2023. The workshop included a summary of the 2022 Derecho event forensic evaluation, the introduction of two additional thresholds for the high wind climate parameter, and a review of the consequence / risk scores. Additionally, Stantec sought input from attendees to determine the status of the 2019 climate adaptation and risk mitigation measures from the 2019 reports (Stantec, 2019a-b), and to determine their appropriateness for existing risk levels.

Revised consequence scores, where a change occurred, are presented in Section 4.2. Section 4 presents the updated adaptation recommendations for medium to very high risks, where a change has occurred.

4 Updates to Risk Assessment

4.1 2023 Methods

Each combination of climate parameter and infrastructure asset class is referred to as an interaction. To assess material changes in risk, Stantec calculated risk for the baseline (1981-2010) and 2050s (2041-2070) time horizons for each interaction. Risk is calculated following the approach outlined in the 2019 report, where ***Risk Score = Probability Score x Severity Score*** (Engineers Canada, 2011). Updated risk scores were only calculated for the following interactions:

- Interactions with climate parameters with a changed 2050s probability score,
- Interactions with the new high wind thresholds, or
- Interactions with updated consequence scores.

Consequence scores were assigned using a 1- to 25-point severity scale and performance descriptors extracted directly from Hydro Ottawa's Asset Management System Risk Procedures. The resulting risk matrix is presented in Table 4.

Table 4: Severity Ratings used in the Risk Assessment

Severity Score and Descriptor		Infrastructure Performance and Severity Rating			
		Level of Service: System Accessibility	Level of Service: Service Quality	Resource Efficiency	Asset Value - Financial
Insignificant	**1**	N/A	Service interruption resulting in <10,000 customer minutes interrupted. Service quality resulting in customer complaint, but meets CSA standards	Requires <10 hours of overtime to complete O&M work or undergo training. Requires <100 hours of overtime to complete capital work.	Financial risk resulting in an O&M expense of <$1k. Financial risk resulting in a capital expense of <$10k.
Minor	**4**	N/A	Service interruption resulting in >10,000 customer minutes interrupted. Service quality resulting in customer escalation, but meets CSA standards	Requires >10 hours of overtime to complete O&M work or undergo training. Requires >100 hours of overtime to complete capital work.	Financial risk resulting in an O&M expense of >$1k. Financial risk resulting in a capital expense of >$10k.
Moderate	**9**	Load demand/generation is exceeding planning limits.	Service interruption resulting in >500,000 customer minutes interrupted.	Requires >250 hours of overtime to complete O&M work or undergo training. Requires >2,500 hours of overtime to complete capital work.	Financial risk resulting in an O&M expense of >$50k. Financial risk resulting in a capital expense of >$500k.

Severity Score and Descriptor		Infrastructure Performance and Severity Rating			
		Level of Service: System Accessibility	**Level of Service: Service Quality**	**Resource Efficiency**	**Asset Value - Financial**
Extensive	**16**	Load demand/generation is exceeding thermal limits.	Service interruption resulting in >3,000,000 customer minutes interrupted.	Requires >1,500 hours of overtime to complete O&M work or undergo training. Requires >15,000 hours of overtime to complete capital work.	Financial risk resulting in an O&M expense of >$300k. Financial risk resulting in a capital expense of >$3M.
Significant	**25**	Unable to service new load/ERFs	Service interruption resulting in >10,000,000 customer minutes interrupted. Service quality resulting in not meeting CSA standards.	Unable to complete work with internal and/or external resources due to volume or skill gap.	Financial risk resulting in an O&M expense of >$1M. Financial risk resulting in a capital expense of >$10M.

Table 5: Hydro Ottawa Asset Management Risk Procedure Matrix

			Impact				
			1	4	9	16	25
			Insignificant	Minor	Moderate	Extensive	Significant
Likelihood	1	Rare	1	4	9	16	25
	2	Unlikely	2	8	18	32	50
	3	Possible	3	12	27	48	75
	4	Likely	4	16	36	64	100
	5	Almost Certain	5	20	45	80	125

Risk Score	Risk Rating
Low	≤10
Medium	11-30
High	31-60
Very High	≥60

Risk ratings for individual components were taken by summing the total consequence across all evaluated columns and multiplying by the event likelihood. For example, if consequence of 9 was assigned for all for categories for an event with a probability rating of 3, the resultant total cumulative risk would be calculated as:

Table 6: Sample Consequence and Cumulative Risk Rating Calculation

Level of Service: System Accessibility	Level of Service: Service Quality	Resource Efficiency	Asset Value - Financial	Likelihood of Event	Cumulative Risk
9	9	9	9	3	**108**

4.2 2023 Consequence and Risk Score Updates and Additions

Updates and additions to consequence scores occurred for the following parameters:

- For the wind threshold of 120 km/hr, consequence score updates included revising upward the consequence score of the Asset Value – Financial from a 9 to a 16 for Power Distribution – Overhead (N-S and E-W orientations) due to recent extreme wind experienced by Hydro Ottawa that led to more operational and capital expenses than previously rated in the 2019 study. During the workshop it was felt that the initial rating should be raised to reflect consequences reflective of extreme wind impacts that had not been felt by Hydro Ottawa prior to the derecho event.
- For the new wind threshold of 130 km/hr, consequence scores mirror the updated values for the 120 km/hr threshold. While there is a 17% increase in overall force, it was felt that the increase in consequence score for the 120 km/hr threshold would also be felt under a 130 km/hr event occurring in the service area.
- For the new 180 km/hr wind threshold, developed based upon the findings by UWO in the analysis of damage for the 2022 Derecho event, consequence scores of a 16 were assigned for system accessibility, service quality, and resource efficiency for Power Distribution lines and poles (N-S and E-W orientations). For financial, consequence scores were assigned a 25 due to the damage experienced by Hydro Ottawa in the 2022 Derecho event. These scores are reflective of severe damage and demand posed on Hydro Ottawa during and following the event, including challenges to restore power and the duration of the major event.
- For freezing rain, with ice accumulation of 25 mm, the consequence score for Asset Value – Financial was revised from a 4 to a 9 for Power Distribution – Overhead (N-S and E-W orientations), due to the impacts of recent freezing rain events that led to more operational and capital expenses than previously rated in the 2019 study.

A summary of the updated consequence scores and associated 2050s risk scores are presented in Table 7.

Table 7: Summary of Changes and Additions to Consequence and Risk Scores

Climate Parameter: Threshold	Infrastructure Performance Category	Consequence Update	2019 Study		2023 Update	
			Consequence Score	2050s Cumulative Risk Score	Consequence Score	2050s Cumulative Risk Score
High wind: 120 km/hr	Asset Value - Financial score for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Increased consequence scores from 9 to 16 due to recent extreme wind experienced by Hydro Ottawa that led to more operational and capital expenses	9	81	16	102
High wind: 130 km/hr	All categories	Consequence scores mirror those of the 120 km/hr threshold	N/A	N/A	16	102
High wind: 180 km/hr	System accessibility, service quality, and resource efficiency for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Consequence scores assigned a 16 based on UWO's analysis of damage for the 2022 Derecho event	N/A	N/A	16	114
	Financial for Power Distribution - Overhead (N-S and E-W orientations) Lines and Poles	Consequence scores assigned a 25 due to damage experienced by Hydro Ottawa in the 2022 Derecho event	N/A	N/A	25	
Freezing rain: Ice accumulation of 25 mm	Financial for Power Distribution - Overhead (N-S and E-W orientations) Lines	Increased consequence scores for 4 to 9 due to due to recent freezing rain events experienced by Hydro Ottawa that led to more operational and capital expenses	4	16	9	26

5 Updates to Adaptation Plan

This section presents additional recommendations to mitigate climate risk where a risk level has changed since the original scope of work. The recommendations in this section are made to supplement the original recommendations (Stantec, 2019b).

5.1 2019 Scope of Work

The development of the 2019 Adaptation Plan consisted of the following steps (Stantec, 2019b):

1. Validation of medium to very high risks to infrastructure and operations as well as the impacts in a workshop with Hydro Ottawa staff.
2. Selection of risk mitigation or adaptation measures to reduce the impacts of medium to very high future climate risks; developed through the workshop with Hydro Ottawa.
3. Prioritization of actions based on the risk levels, change in risk (current to future) and Hydro Ottawa's Asset Management System Risk Procedures.
4. Assignment of responsibilities and the development of indicators to track and monitor progress in the Enterprise Risk Management System (ERMS).

5.2 2023 Results

5.2.1 Executed Adaptation Actions

Hydro Ottawa has made significant progress on implementing the risk recommendations from the Adaptation Plan (Stantec, 2019b). A summary of work that was completed, the status update and next steps as provided by HOL is included in Appendix B.

5.2.2 Additional Suggested Adaptation Measures

Hydro Ottawa is progressing and moving forward on implementing climate change adaptation measures to build resilience from extreme events. It is recommended that HOL work to continue addressing climate change risk through ongoing work and consider additional adaptation measures brought forward during the review workshop to specifically address new climate and accelerating related risks. All new adaptation recommendations were related to the pole line systems and new measures are provided in Table 8. No additional recommendations for operations, underground systems or substations.

5.2.2.1 Pole Line System

Table 8: Updated Impacts and Adaptation Measures

<table>
<tr><th>Climate Parameter</th><th>System / Component Affected</th><th>Description of Impact</th><th>Current Risk Score</th><th>Future Risk Score</th><th>2023 Update to Future Risk Score</th><th>New Adaptation Recommendations</th></tr>
<tr><td colspan="6">New Wind Thresholds from Derecho Event and Extreme Wind Speeds</td><td rowspan="14">Consider a study on pole characteristics (i.e. age and guying locations) from the 2022 Derecho to determine potential vulnerability of pole tops.
Consider the impact of climate change on recently (or future) hydro poles being grown (i.e. wood density and strength)
Consider establishing additional supply capacity and storage for key components (e.g. poles) in the event that a major or catastrophic event impacts a large portion of the service area
Consider real-time or automated monitoring system for severe weather events or creating a staff position for a meteorologist to handle coordination between utilities and monitoring potential upstream outages before they impact HOL service area
Continue with planned adaptation planning actions already underway, including an undergrounding study, anti-cascading study and strategy, and asset hardening however, new risk should be utilized in decision making a cost/benefit studies underway.
Consider establishing a shared resource MoU with other utilities (e.g. Hydro One, Hydro Quebec) to work toward open data sharing of risks, opportunities, and best practices for handling extreme events.
Other risk mitigation measures developed in the 2019 study remain relevant based on the conversations conducted at the 2023 reaffirmation workshop.</td></tr>
<tr><td>Annual wind speeds of 180 km/hr or higher (30-year occurrence)</td><td>Power Distribution: East-West lines and poles</td><td>Damage to poles and lines from high wind events.</td><td>114</td><td>114</td><td>114</td></tr>
<tr><td>Annual wind speeds of 180 km/hr or higher (30-year occurrence)</td><td>Power Distribution: East-West lines and poles</td><td>Risk of damages from falling trees, broken tree limbs or flying debris.</td><td>114</td><td>114</td><td>114</td></tr>
<tr><td>Annual wind speeds of 180 km/hr or higher (30-year occurrence)</td><td>Power Distribution: North-South lines and poles</td><td>Damage to poles and lines from high wind events.</td><td>132</td><td>146</td><td>146</td></tr>
<tr><td>Annual wind speeds of 180 km/hr or higher (30-year occurrence)</td><td>Power Distribution: North-South lines and poles</td><td>Risk of damages from falling trees, broken tree limbs or flying debris.</td><td>132</td><td>146</td><td>146</td></tr>
<tr><td>Annual wind speeds of 130 km/hr or higher (30-year occurrence)</td><td>Power Distribution: East-West lines and poles</td><td>Damage to poles and lines from high wind events.</td><td>102</td><td>102</td><td>102</td></tr>
<tr><td>Annual wind speeds of 130 km/hr or higher (30-year occurrence)</td><td>Power Distribution: East-West lines and poles</td><td>Risk of damages from falling trees, broken tree limbs or flying debris.</td><td>102</td><td>102</td><td>102</td></tr>
<tr><td>Annual wind speeds of 130 km/hr or higher (30-year occurrence)</td><td>Power Distribution: North-South lines and poles</td><td>Damage to poles and lines from high wind events.</td><td>129</td><td>129</td><td>129</td></tr>
<tr><td>Annual wind speeds of 130 km/hr or higher (30-year occurrence)</td><td>Power Distribution: North-South lines and poles</td><td>Risk of damages from falling trees, broken tree limbs or flying debris.</td><td>129</td><td>129</td><td>129</td></tr>
<tr><td colspan="6">Revised Risk Scores Based on New Consequence Scoring</td></tr>
<tr><td>Annual wind speeds of 120 km/hr or higher (30-year occurrence)</td><td>Power Distribution: East-West lines and poles</td><td>Damage to poles and lines from high wind events.</td><td>81</td><td>81</td><td>102</td></tr>
<tr><td>Annual wind speeds of 120 km/hr or higher (30-year occurrence)</td><td>Power Distribution: East-West lines and poles</td><td>Risk of damages from falling trees, broken tree limbs or flying debris.</td><td>81</td><td>81</td><td>102</td></tr>
<tr><td>Annual wind speeds of 120 km/hr or higher (30-year occurrence)</td><td>Power Distribution: North-South lines and poles</td><td>Damage to poles and lines from high wind events.</td><td>108</td><td>108</td><td>129</td></tr>
<tr><td>Annual wind speeds of 120 km/hr or higher (30-year occurrence)</td><td>Power Distribution: North-South lines and poles</td><td>Risk of damages from falling trees, broken tree limbs or flying debris.</td><td>108</td><td>108</td><td>129</td></tr>
</table>

Climate Parameter	System / Component Affected	Description of Impact	Current Risk Score	Future Risk Score	2023 Update to Future Risk Score	New Adaptation Recommendations
Ice accumulation (25 mm)	Power Distribution: North-South lines and poles	Damage from increased weight on overhead lines. Ice accretion on lines in excess of 12.5 mm (0.5 inches) accompanied by a 90km/h wind could result in structural failure and uneven ice accretion could cause swinging or 'galloping' in the lines Damages to lines from fallen trees or broken tree limbs. Damage to poles and other surface equipment from vehicles losing control on icy roads.	10	13	26	Complete an inventory of switches for critical equipment and consider looking at alternatives for implementing measures to prevent freezing.
Ice accumulation (25 mm)	Power Distribution: North-South lines and poles	Damages to lines from fallen trees or broken tree limbs.	8	16	26	

6 Limitations

The findings in this report are subject to several limitations. Section 2 discusses specific uncertainties associated with each climate parameter. Some overarching limitations are noted below.

Climate data is inherently uncertain. The climate parameter probabilities provided should be considered as high-level estimates of future conditions. The primary source of uncertainty in climate projections is the estimate of greenhouse gas emissions that will be observed over the current century. Additional sources of uncertainty include (but are not limited to) climate model parameterization, bias, and resolution.

Some of the climate parameters investigated are associated with very high degrees of uncertainty, because they are difficult to constrain using the outputs from climate models. Stantec has reviewed recently published scientific literature and guidance to provide an estimate of likely future conditions.

7 Conclusion

This Update to Distribution System Climate Vulnerability Risk Assessment and Climate Change Adaptation Plan was conducted by Stantec to provide Hydro Ottawa Limited (HOL) with updated climate parameter probabilities, consequence scores, risk levels, and adaptation plan. Recent extreme weather resulting in major weather events, specifically:

- September 21, 2018 – Tornadoes
- April 15, 2019 – Lightning storm and flooding
- July 5, 2019 – Windstorm
- June 14, 2021 – Summer/Lightning storm
- May 21, 2022 – Derecho storm
- December 23, 2022 – Winter storm

The findings in this report are based on the evaluation of impacts from the recent major weather-related events, a forensic analysis of the May 2022 Derecho event, and input from the review workshop.

The two main tasks completed within this study were to (1) update the list of climate parameters to include additional high wind thresholds representative of recent extreme weather events, update climate parameter probabilities, impact severity (based on input from Hydro Ottawa personnel), and risk scores, as well as completing a forensic analysis of the May 21, 2022 Derecho event; and (2) update where appropriate the adaptation and risk mitigation plan using input from the review workshop and where risk scores changed to medium-very high under current and future climate. For consistency, the same methods used in the 2019 report were also used in this reassessment.

Two additional high wind thresholds were established for this update based on updated Environment and Climate Change Canada (ECCC) criteria for severe thunderstorm winds and the damages observed by the Northern Tornadoes Project in surveys following the 2022 May Derecho event. The thresholds established included:

- Wind speeds > 130 km/h – Based on new ECCC severe thunderstorm winds and with 17% higher loading factor than the 120 km/h gust threshold used in the 2019 study
- Wind speeds > 180 km/h (Derecho event equivalent) – based on consistent EF-2 style observed damage in Ottawa region and Doppler Radar near surface wind speed recordings

Risk scores increased due to higher consequence ratings for current and future climate for higher threshold wind speeds (120 km/hr) and for newly established thresholds (130 km/hr and 180 km/hr). However, for most risks, no risk level change was observed.

To handle additional risks from higher wind thresholds, the following risk adaptation measures should be considered:

- Consider a study on pole characteristics (i.e. age and guying locations) from the 2022 Derecho to determine potential vulnerability of pole tops.
- Consider the impact of climate change on recently (or future) hydro poles being grown (i.e. wood density and strength)
- Consider establishing additional supply capacity and storage for key components (e.g. poles) in the event that a major or catastrophic event impacts a large portion of the service area
- Consider real-time or automated monitoring system for severe weather events or creating a staff position for a meteorologist to handle coordination between utilities and monitoring potential upstream outages before they impact HOL service area.
- Continue with planned adaptation planning actions already underway, including an undergrounding study, anti-cascading study and strategy, and asset hardening however, new risk should be utilized in decision making a cost/benefit studies underway.

Other risk mitigation measures developed in the 2019 study remain relevant based on the conversations conducted at the 2023 reaffirmation workshop.

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Appendices

Appendix A 2023 Climate Parameter Probability Update

Table A-1: Climate Parameter Probabilities and Additional Wind Threshold Probabilities in the Historical Baselines (1981-2010 and 1991-2020)

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Temperature – Extreme Heat	Daily max. temp. of 25°C or higher	100% (~62-63 yr^{-1})	5	100%	5	100% (~68-69 yr^{-1})	5	100%	5
	Daily max. temp. of 30°C or higher	100% (~14-15 yr^{-1})	5	100%	5	100% (~15-16 yr^{-1})	5	100%	5
	Daily max. temp. of 35°C or higher	50% (<1 yr^{-1})	3	>99%	5	80% (<1 yr^{-1})	3	100%	5
	Daily max. temp. of 40°C or higher	6% (<1 yr^{-1})	2	84%	4	6% (<1 yr^{-1})	2	84%	4
	Daily avg. temp. of 30°C or higher	3% (<1 yr^{-1})	1	60%	3	3% (<1 yr^{-1})	1	60%	3
	Heat waves: Consecutive days with max temp ≥ 30°C and min temp ≥ 23°C	7% (<1 yr^{-1})	2	89%	4	7% (<1 yr^{-1})	2	89%	4
	Heat waves: Consecutive days with max temp ≥ 30°C and min temp ≥ 25°C	~0% (~0 yr^{-1})	1	~0%	1	~0% (~0 yr^{-1})	1	~0%	1

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Temperature – Extreme Cold	Daily min. temp. of -35°C or colder	3% (<1 yr^{-1})	1	60%	3	~0% (rare)	1	~0%	1
Rain (Short Intensity – High Duration)	50 mm in 1 hr	1% (<1 yr^{-1})	1	~25%	2	1% (<1 yr^{-1})	1	~25%	2
Freezing Rain & Ice Storms	Ice accumulation of 25 mm	5% (<1 yr^{-1})	1	79%	4	5% (<1 yr^{-1})	1	79%	4
	Ice accumulation of 40 mm	2.5% (<1 yr^{-1})	1	>50%	3	2.5% (<1 yr^{-1})	1	>50%	3
Snow	Days with 5 cm of more of snowfall	100% (~15 yr^{-1})	5	100%	5	100% (~15 yr^{-1})	5	100%	5
	Days with 10 cm of more of snowfall	100% ($\sim5\text{-}6$ yr^{-1})	5	100%	5	100% ($\sim5\text{-}6$ yr^{-1})	5	100%	5
	Days with 30 cm of more of snowfall	13% (<1 yr^{-1})	2	98%	5	17% (<1 yr^{-1})	2	>99%	5
High Winds	Annual wind speeds of 60 km/hr	100% ($\sim14\text{-}15$ yr^{-1})	5	100%	5	100% ($\sim15\text{-}16$ yr^{-1})	5	100%	5
	Easterly winds of 60 km/hr or higher (warm season [April-September])	28.9% (<1 yr^{-1})	2	100%	5	47% (<1 yr^{-1})	2	>99%	5
	Easterly winds of 60 km/hr or higher	2.6% (<1 yr^{-1})	1	55%	3	3% (<1 yr^{-1})	1	60%	3

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
	(summer [June-August])								
	Annual wind speeds of 80 km/hr	100% (~1-2 yr^{-1})	5	100%	5	100% (~1-2 yr^{-1})	5	100%	5
	Easterly winds of 80 km/hr or higher (cool season [October - March])	5.3% (<1 yr^{-1})	2	80%	5	5.3% (<1 yr^{-1})	2	80%	5
	Easterly winds of 80 km/hr or higher (winter [December - February])	2.6% (<1 yr^{-1})	1	55%	3	2.6% (<1 yr^{-1})	1	55%	3
	Annual wind speeds of 90 km/hr	23% (<1 yr^{-1})	2	>99%	5	23% (<1 yr^{-1})	2	>99%	5
	Annual wind speeds of 120 km/hr	2.5% (<1 yr^{-1})	1	53%	3	3.10% (<1 yr^{-1})	1	53%	3
	Annual wind speeds of 130 km/hr	2.5% (<1 yr^{-1})	1	53% (rare)	3	3.10% (<1 yr^{-1})	1	>60% (rare)	3
	Annual wind speeds of 180 km/hr	1.25% (<1 yr^{-1})	1	31% (rare)	2	1.25% (<1 yr^{-1})	1	31% (rare)	2
Lightning	Strikes near infrastructure (flashes/ km^2/ year)	1.1% (<1 yr^{-1})	1	28%	2	1.1% (<1 yr^{-1})	1	28%	2

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	**Annual Probability Score**	**30-Year Probability**	**30-Year Probability Score**	**Annual Probability**	**Annual Probability Score**	**30-Year Probability**	**30-Year Probability Score**
Tornadoes	EF1+ in Hydro Ottawa service area (City of Ottawa)	14.6% (<1 yr^{-1})	2	>99%	5	14.6% (<1 yr^{-1})	2	>99%	5
	EF1+ point probability (i.e., striking a specific asset in City of Ottawa service area)	0.02% (rare)	1	0.6%	1	0.02% (rare)	1	0.6%	1
Invasive Species: Emerald Ash Borer	Emerald Ash Borer (Daily min. temp. of -30°C or colder [kill temp.])	53% (<1 yr^{-1})	3	>99%	5	47% (<1 yr^{-1})	3	>99%	5
	Giant Hogweed (3 consecutive days of -8°C or colder [gemination requirement])	100% (25 yr^{-1})	5	100%	5	100% (9 yr^{-1})	5	100%	5
Fog	Season with ≥ 50 fog days (Nov.-March)	37% (~3-4 yr^{-1}	3	100%	5	37% (~3-4 yr^{-1})	3	>99%	5

Climate Parameter	Threshold	2019 Study Historical Baseline (1981-2010)				2023 Update Historical Baseline (1991-2020)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Frost	Freeze-thaw cycles – (Daily Tmax Tmin temp. fluctuation of ±1°C around 0°C) (30 cycles)	100% (~2-3 yr^{-1})	5	100%	5	100% (~2-3 yr^{-1})	5	100%	5
	Hard freeze-thaw cycles (Daily Tmax Tmin temp. fluctuation of ±4°C around 0°C) (30 cycles)	30% (<1 yr^{-1})	2	>99%	5	30% (<1 yr^{-1})	2	>99%	5

Table A-2: Climate Parameter Probabilities and Additional Wind Threshold Probabilities in the 2050s from the 2019 Study and the 2023 Update

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Temperature – Extreme Heat	Daily max. temp. of 25°C or higher	100% (~99 yr^{-1})	5	100%	5	100% (~105 yr^{-1})	5	100%	5
	Daily max. temp. of 30°C or higher	100% (~42 yr^{-1})	5	100%	5	100% (~48 yr^{-1})	5	100%	5
	Daily max. temp. of 35°C or higher	100% (~6 yr^{-1})	5	100%	5	100% (~9 yr^{-1})	5	100%	5
	Daily max. temp. of 40°C or higher	100% (~1-2 yr^{-1})	5	100%	5	100% (~1-2 yr^{-1})	5	100%	5
	Daily avg. temp. of 30°C or higher	100% (~1-2 yr^{-1})	5	100%	5	100% (~4 yr^{-1})	5	100%	5
	Heat waves: Consecutive days with max temp ≥ 30°C and min temp ≥ 23°C	100% (~2 yr^{-1})	5	100%	5	100% (~3 yr^{-1})	5	100%	5
	Heat waves: Consecutive days with max temp ≥ 30°C and min temp ≥ 25°C	37% (<1 yr^{-1})	3	>99%	5	37% (<1 yr^{-1})	3	>99%	5
Temperature – Extreme Cold	Daily min. temp. of -35°C or colder	0.1% (rare)	1	3%	1	0.1% (rare)	1	3%	1

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Rain (Short Intensity – High Duration)	50 mm in 1 hr	4.5% (<1 yr^{-1})	1	75%	4	32.0% (<1 yr^{-1})	2	>99%	5
Freezing Rain & Ice Storms	Ice accumulation of 25 mm	6% (<1 yr^{-1})	2	84%	4	6% (<1 yr^{-1})	2	84%	4
	Ice accumulation of 40 mm	3.8% (<1 yr^{-1})	1	~70%	4	3.8% (<1 yr^{-1})	1	~70%	4
Snow	Days with 5 cm of more of snowfall	100% (~15 yr^{-1})	5	100%	5	100% (~15 yr^{-1})	5	100%	5
	Days with 10 cm of more of snowfall	100% (~5 yr^{-1})	5	100%	5	100% (~4 yr^{-1})	5	100%	5
	Days with 30 cm of more of snowfall	10% (<1 yr^{-1})	2	>95%	5	10% (<1 yr^{-1})	2	>95%	5
High Winds	Annual wind speeds of 60 km/hr	100% (~16 yr^{-1})	5	100%	5	100% (~16 yr^{-1})	5	100%	5
	Easterly winds of 60 km/hr or higher (warm season [April-September])	32.4% (<1 yr^{-1})	2	>99%	5	32.4% (<1 yr^{-1})	2	>99%	5
	Easterly winds of 60 km/hr or higher (summer [June-August])	2.9% (<1 yr^{-1})	1	~60%	3	2.9% (<1 yr^{-1})	1	~60%	3

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
	Annual wind speeds of 80 km/hr	100% (~1-2 yr^{-1})	5	100%	5	100% (~1-2 yr^{-1})	5	100%	5
	Easterly winds of 80 km/hr or higher (cool season [October - March])	6.3% (<1 yr^{-1})	2	85%	4	6.3% (<1 yr^{-1})	2	85%	4
	Easterly winds of 80 km/hr or higher (winter [December - February])	3.2% (<1 yr^{-1})	1	>60%	3	3.2% (<1 yr^{-1})	1	>60%	3
	Annual wind speeds of 90 km/hr	29% (<1 yr^{-1})	2	>99%	5	29% (<1 yr^{-1})	2	>99%	5
	Annual wind speeds of 120 km/hr	3.1% (<1 yr^{-1})	1	61%	3	3.1% (<1 yr^{-1})	1	61%	3
	Annual wind speeds of 130 km/hr	N/A	N/A	N/A	N/A	2.90% (<1 yr^{-1})	1	58%	3
	Annual wind speeds of 180 km/hr	N/A	N/A	N/A	N/A	1.25% (<1 yr^{-1})	1	31%	2
Lightning	Strikes near infrastructure (flashes/ km^2/ year)	1.5% (<1 yr^{-1})	1	36%	3	1.56% (<1 yr^{-1})	1	38%	3
Tornadoes	EF1+ in Hydro Ottawa service	18.2% (<1 yr^{-1})	2	>99%	5	18.2% (<1 yr^{-1})	2	>99%	5

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
	area (City of Ottawa)								
	EF1+ point probability (i.e., striking a specific asset in City of Ottawa service area)	0.02% (rare)	1	0.7%	1	0.02% (rare)	1	0.7%	1
Invasive Species: Emerald Ash Borer	Emerald Ash Borer (Daily min. temp. of -30°C or colder [kill temp.])	3% (<1 yr^{-1})	1	60%	3	4% (<1 yr^{-1})	1	71%	4
	Giant Hogweed (3 consecutive days of -8°C or colder [gemination requirement])	100% (17 yr^{-1})	5	100%	5	100% (3 yr^{-1})	5	100%	5
Fog	Season with ≥ 50 fog days (Nov.-March)	Likely increase	4	100%	5	Likely increase	4	100%	5

Climate Parameter	Threshold	2019 Study 2050s Probabilities (RCP8.5)				2023 Update 2050s Probabilities (RCP8.5/SSP5-8.5)			
		Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score	Annual Probability	Annual Probability Score	30-Year Probability	30-Year Probability Score
Frost	Freeze-thaw cycles – (Daily Tmax Tmin temp. fluctuation of ±1°C around 0°C) (30 cycles)	100% (~2 yr^{-1})	5	100%	5	100% (~2-3 yr^{-1})	5	100%	5
	Hard freeze-thaw cycles (Daily Tmax Tmin temp. fluctuation of ±4°C around 0°C) (30 cycles)	38% (<1 yr^{-1})	3	>99%	5	18% (<1 yr^{-1})	2	>99%	5

Appendix B 2023 Adaptation Status, Next Steps, and Barriers

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Forensic Analysis of the May 21, 2022 Derecho for the Ottawa Area

Following the announcement of the reaffirmation study – consisting of an update of the 2019 Hydro Ottawa Climate Risk Assessment (Stantec, 2019), meteorologists from Western University's Northern Tornadoes Project (NTP) and Northern Hail Project (NHP) were retained to provide expert advice and analysis in the form of a forensic assessment of the May 21, 2022, severe windstorm. Termed a "derecho", this storm severely impacted Hydro Ottawa's infrastructure.

Doctor David Sills, Executive Director of the Northern Tornadoes Project (NTP), and Simon Eng, Research Meteorologist with the Northern Hail Project (NHP) and former consulting meteorologist on the original 2019 study, were asked to support the Hydro Ottawa reaffirmation study to address the following questions and concerns:

- *Significant concern regarding impacts associated with 120 km/h winds:* A peak wind gust reading of 120 km/h was recorded at Ottawa International Airport during the event. Wind speeds of this magnitude were included in the original climate risk assessment (Stantec 2019) but the May 21, 2022, storm generated impacts far greater than had been anticipated for winds of this magnitude.
- *The number and severity of weather-related outage events in recent years:* Several very high impact severe weather events have affected Hydro Ottawa's system since the late-2010s. This has triggered concerns that these events are increasing in frequency to such an extent that their effects may not be manageable.
    - *In particular, the southern-portion of the City has been severely affected by both the 2022 Derecho event and one of the September 2018 tornadoes:* This raised concerns that this specific region within Hydro Ottawa's service area was particularly vulnerable to severe thunderstorm-related wind events.
- *The May 21, 2022, storm indicated the need for identifying additional damage thresholds:* To help support future planning and continued efforts to increase resilience to current and future climate impacts, the risk assessment framework required the identification of additional, higher wind speed thresholds than had been previously identified in the original 2019 risk assessment (Stantec 2019).

Key **findings** from the NTP/NHP analysis are the following:

Evidence using damage-based wind speed estimates, coupled with a review of Doppler radar wind velocity information, as well as evidence from other locations

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along the derecho's path, strongly indicates that the 120 km/hr wind gust measured at Ottawa International Airport was *not* representative of the wind speeds experienced during the event in the most severely impacted portions of Hydro Ottawa's system. These pieces of evidence generally indicate much stronger winds which likely reached 180-195 km/h.

- Peak wind speed estimates obtained through damage assessment of buildings and trees using the Canadian version of the "Enhanced Fujita Scale" (EF-Scale; ECCC 2018) consistently indicated peak wind velocities in extreme south-eastern portions of the City of Ottawa were in the 180-195 km/h range – i.e., the lower-end of the "EF-2" range on the Enhanced-Fujita Scale.
- Winds of this magnitude were consistent with Doppler weather radar indicated values (Ibrahim et al., 2023), which showed winds in the area exceeding 160 km/h.
- Evidence also indicates that other locations along the storm's path that reported similar or higher instrumented wind gust measurements did *not* exhibit damage of the severity seen in the Ottawa area, either to electrical overhead systems or more broadly to buildings, infrastructure, and trees. These include:
  - Kitchener-Waterloo area – An initial peak gust of 131 km/h was recorded at Kitchener-Waterloo International Airport – while power outages and tree damage were reported in the area, damage to buildings, critical infrastructure and trees did not approach the magnitude of the impacts in the Ottawa area.
  - Toronto Pearson International Airport – A peak gust of 121 km/h was reported at Pearson International Airport, but damage to buildings and overhead systems in this region was again of much lesser magnitude then what had occurred in the Ottawa area. A ground survey of this area was conducted within hours of the event by one of the authors (S.Eng) and although notable damage to urban trees was documented, as well as the failure of a medium-voltage electrical distribution line near Lisgar GO Transit station, again damage was of much lower intensity than had been documented in the Ottawa area.
- For this reaffirmation study, *new* recommended wind gust thresholds of *130 km/h* and *180 km/h* were developed, corresponding to Environment and Climate Change Canada's (ECCC) "extreme" thunderstorm warning criteria, and the lower bound of EF2 damage, respectively.
- The direction of storm motion and damage to specific areas within the City of Ottawa should not be taken as indications that the motion and impact area of storms will be similar in future events. Historical events have shown that both the direction of storm motion and locations impacted will differ depending on specific weather conditions.
  - However, the preliminary historical assessment of derecho events indicates that storm motion will mostly likely have an eastward component, with storms approaching from the SSW through to the NNW.

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Note that the NTP conducted a thorough, multi-month study of the entire length of the derecho's track, which included numerous detailed ground surveys, satellite image review, and social and news media monitoring, documentation, and follow-up. Areas suffering similar (i.e., up to EF2 intensity) damage were indeed detected in other parts of the derecho damage path but did not include the regions near or around Kitchener-Waterloo and Toronto Pearson Airports.

Methodology and Definitions

Due to their highly localised and characteristically high intensity, specialised methods are needed to obtain wind speed estimates for severe thunderstorm winds (i.e., tornadoes, derechos, microbursts, etc.). This assessment used two methods in addition to instrumented measurements, to obtain wind speed estimates:

1) The Enhance Fujita or "EF" Scale uses damage to buildings, trees, and other infrastructure and objects to estimate wind speeds (ECCC 2018). Wind speeds are classified into 6 categories, from EF0 to EF5, of increasing intensity (Table 1). Consistency is achieved through comparing damage to adjacent objects and assets to determine if they indicated similar wind speeds. It is also achieved through careful inspection of the age, type, and quality of building construction.

Table 1 - Canadian EF-Scale and Associated Wind Speed (Gust) Ranges

EF-Scale Rating	Associated Wind Speed Range (Equivalent 3-second gust; km/h)
EF0	90 to 130
EF1	135 to 175
EF2	180 to 220
EF3	225 to 265
EF4	270 to 310
EF5	315 +

2) The EF-scale estimated wind speeds were supplemented through a Doppler weather radar analysis. The Franktown (CASFT) radar is located close to the Ottawa area and was used to assess wind speeds near the surface during the event.

3) Finally, instrumented measurements from anemometers – instruments used to measure wind speed – were also consulted. However, we note that measurements from such instruments may be missing or suppressed due to power failures, mechanical issues, debris impacts or obstructions, and other causes. The data they generate is also subject to errors in data capture and computer archiving.

The storm that produced the severe wind damage in the Ottawa area (and indeed across southern Ontario and western and southern Québec) is a special class of

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severe thunderstorm wind event referred to as a “derecho”. A derecho is defined as a long-lived “convectively” (i.e., thunderstorm) driven windstorm. “Damage must be incurred either continuously or intermittently over a swath of at least 650 km (~400 mi) and a width of approximately 100 km (~60 mi) or more.” (AMS, 2023)

Historical Derecho Climatology and Climate Change

A historical database of Canadian derechos is currently in development but is only in its infancy (see **Figure 1**). To properly assess the historical frequency and characteristics (e.g., path length, intensity, direction of motion) of derechos in Canada, the historical database needs to first be completed. Similarly, for a climate change projection of potential future changes in derecho activity, the historical baseline is first needed.

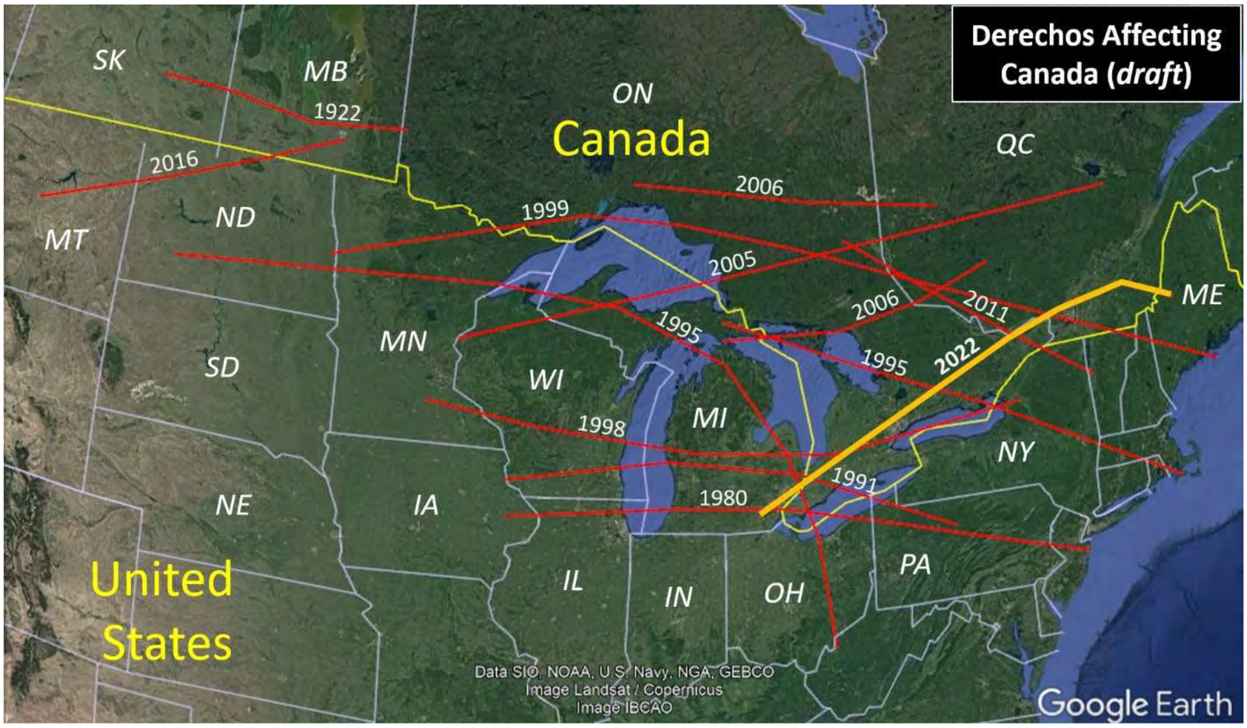

Figure 1 - Draft climatology of derechos affecting Canada (1922 to 2022).

Historical Events: July 17, 2011, Ottawa River Valley Derecho

The most recent derecho event preceding the 2022 storm affecting the Ottawa area occurred on July 17, 2011. The 2011 derecho event began at 2:45 PM in the Upper Ottawa Valley, affecting Allumette Island and Petawawa/Pembroke are before impacting the City of Ottawa at around 7:20 PM (CBC 2011). This storm resulted in four (4) injuries (including one serious) after it triggered a stage collapse at the

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Ottawa Blues Festival (CBC 2011), as well as one fatality at Ferme-Neuve, Québec. The storm continued to the southeast, affecting portions of Ontario, Québec, New York, and Vermont, ending at ~10:10 PM in Vermont. Unfortunately, no reliable wind speed estimates could be readily developed for this event in the Ottawa area. Ottawa International Airport reported a gust of “96E km/h”, with the letter “E” indicating the archived wind gust value is estimated and not an instrumented recording. No reliable wind speed estimate could be obtained from the stage collapse, either, since while the design wind speed for the stage should have been 80 km/h, subsequent investigations of the structure indicated it was not properly constructed and could easily have failed at a lower wind speed than the design requirement (CBC 2021). However, the storm did produce two instrumented measurements of gusts reaching 120 km/h, one at Pembroke, Ontario, the other at Chapeau, Québec.

Literature Assessment of Climate Change Effects on Derecho Activity

While no tailored climate change projection studies of derecho activity exist, the following considerations suggest that an increase is indeed possible:

- Climate change studies of the “storm track” – the boundary between air masses that generally represents where both the boundary between warm, moist air to the south and cooler arctic air to the north – and where large-scale low-pressure systems tend to travel, are shifting poleward (i.e., north in the northern hemisphere, e.g., Harvey et al., 2014).
  - Studies of derecho activity in the United States (e.g., Coniglio et al. 2004) have consistently indicated an area of maximum activity located immediate south of the Canadian border. Any poleward shift in this track would result in an increase in derecho events affecting southern Canada, especially in the Great Lakes basin.
- Derecho events tend to occur along the poleward side (i.e., northern fringe in the Northern Hemisphere) of so-called “heat domes”. These are features which result in extended extreme heat events for regions located underneath these domes. The frequency and intensity of heat events are projected to increase substantially, and therefore it is possible that severe thunderstorm events which favour the periphery of these extreme heat events will also increase in frequency and severity.

Engineering Risk Considerations

As is indicated on the preliminary map of historical Canadian derechos (Figure 1), the path of the May 2022 event was indeed anomalous. The 2011 storm impacted the City from the northwest, while other storms in the region resulted in paths with other directions, even changing direction in different segments. While the direction of motion will have an eastward component, this means that the *exact* direction of motion of the next event cannot be reliably anticipated.

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Summary of Findings

- Wind producing the worst impacts in southern and south-eastern portions of Hydro Ottawa's service area were due to winds in the 180-195 km/h range.
  - Indications from EF-scale damage analysis and Doppler radar derived winds strongly indicate that the wind gust measurement at Ottawa International Airport is not representative of winds which produced the most severe damage.
- A review of historical events indicates that the City of Ottawa has previously been affected by derecho events, and that the direction of motion and specific areas impacted have differed from the 2022 event. Therefore, the specific locations affected and the direction of storm motion experienced in the 2022 storm should not be explicitly relied upon as indicators of future events.
- While no derecho-specific climate change projection studies are available – for Canada or elsewhere – there are several indicators that suggest that derecho activity may increase in frequency for southern Canada under climate warming.

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Appendix C Forensic Analysis Derecho Event May 21, 2022

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
PLS-1	Pole Line System	Develop anti-cascading strategies and standards for hardening of pole line systems to protect against wind and ice accumulation events, including: •Introducing break or stress points into the distribution lines. •Anchoring. •type of pole. Complete a cost-benefit review of the strategies at critical areas and/or strategic timelines (end of life).	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Wind, ice accumulation	Monitor power outages from cascading events year over year and track by climate event.
PLS-2	Pole Line System	Consider further updates to the vegetation management plan to account for the climate impacts and risks of increased invasive species and their potential to damage infrastructure or injure personnel during wind and ice events. Noting past program augmentations made in response to past storm events, evaluate feasibility of further augmentation with: •Trimming trees more often/aggressively or include heritage trees. •Include trees in the fall zone outside of Hydro Ottawa right away if condition assessment indicates vulnerability. •Working with the City of Ottawa and the Village of Casselman to choose tree species that will be more resistant to future climate.	Forestry Asset Planning	Vegetation Management Plan	Wind, ice accumulation	Review outage report as a result of tree damage on an annual basis and adjust Vegetation Management Plan as required.
PLS-3	Pole Line System	Complete a technology review and feasibility study of technology that may use reduce ice build-up through pulsing or vibration of distribution lines to prevent ice build-up and galloping of lines.	Standards	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Ice accumulation	Line and pole damage and ice accumulation.
PLS-4	Pole Line System	Complete a study/analysis of potential methods to increase detection capabilities for downed lines to increase response time to repair damaged pole line system after damage from wind and/or ice accumulation.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Wind, ice accumulation	Monitor power restoration response time to event.
PLS-5	Pole Line System	While likely cost prohibitive, where it may be warranted, complete a cost/benefit analysis to converting overhead lines to underground infrastructure when major damage has occurred, or when the infrastructure is nearing its end of life. Underground distribution lines and infrastructure would mitigate risk from wind, ice accumulation and fog.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Wind, ice accumulation, fog	Outage reports for weather events and cost of damage estimates.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
PLS-6	Pole Line System	Consider the feasibility of further increasing the frequency of pole washing and cost/benefit based on risk level (current/future) to prevent increase risk of fires related to an increase in anticipated fog days.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Fog	Monitor pole fires and fog days on a year over year basis.
PLS-7	Pole Line System	Complete a cost/benefit analysis of expedited replacement of insulators and fused cut-outs with porcelain to prevent increase risk of fires related to an increase in anticipated fog days.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Fog	Monitor pole fires and fog days on a year over year basis.
PLS-8 [1]	Pole Line System	Complete an inventory of switches for critical equipment and consider looking at alternatives for implementing measures to prevent freezing.	Asset Planning	Asset Management Plan Pole, Fixtures and Primary Overhead Conductor	Ice accumulation	Incidents and/or inability to correct issues related to immobile switches as a result of freezing rain.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
ULS-1	Underground Line System	Complete an engineering review to identify if there are locations vulnerable to overheating (via a detailed assessment of locations that could be vulnerable to temperatures higher than 40°C) and complete a cost-benefit analysis for mitigation options, which may include: •Institute either operational constraints on how much power can be conveyed through cables to limit overheating of cables. •Cool ducts either actively or passively, for example, with thermal fill (a clay slurry).	Asset Planning Standards	Asset Management Plan UG Cable R0	Maximum Temperatures	Temperature runs within prescribed levels. Premature cable failure events and occurrences of 40°C days.
ULS-2	Underground Line System	Identify new technologies and processes through research and feasibility or pilot studies to reduce freeze thaw impacts. These may include: •Exploring the use of different materials for manholes instead of concrete that are less susceptible to freeze-thaw (e.g. fiber glass). •Redesign civil structure collars to move with the heading (e.g. telescopic collars).	Asset Planning Standards	Asset Management Plan - Civil Structures	Freeze-thaw events	Track freeze-thaw damage and annual freeze-thaw days.
SUB-1	Substations	Review additional requirements for sanding and gritting prior to site access.	Facilities	Maintenance Procedures	Ice accumulation	Delays due to inaccessibility.
SUB-2	Substations	Develop a policy to monitor and inspect substation building and structural components after an ice event to mitigate the risk of structural damage and loss of assets as a result of ice damage to substations.	Facilities Stations	Maintenance Procedures	Ice accumulation	Number of leaks or damages. Track maintenance costs.
SUB-3	Substations	Complete a cost-benefit analysis of installing protective covers on small exterior equipment, where feasible, to prevent damage/failure as a result of ice accumulation.	Facilities	Asset Management Plans	Ice accumulation	Number of failures of attached equipment due to ice.
SUB-4	Substations	Create an inventory of all critical equipment (e.g. switches) that could be impacted by ice accumulation, prioritize by criticality, and assess feasibility or practicality of covering with permanent or temporary covers without creating additional hazards [1].	System Operations Asset Planning Standards	Asset Management Plan - Station Switchgear and Breakers	Ice accumulation	Number of operational failures due to ice.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
OPS-1	Operations	Refine and establish a policy on wind conditions when a lift bucket should not be used and when work should not be completed to mitigate the risk of injury related to wind.	Distribution Operations Health and Safety	Health and Safety Policy/Practice	Wind	Monitoring of the number of wind-related events and health and safety incidents associated with wind and lift buckets.
OPS-2	Operations	Consider a review of policies surrounding heat stress on outdoor workers and revise to include projected climate changes to mitigate the impacts of heat stress. Policies to consider should including: •A policy on work redistribution (scheduling) to avoid outdoor work during peak heat hours. •Where feasible and risk assessment permits, consider a policy around the adoption and use of modified PPE to improve cooling / ventilation.	Distribution Operations Health and Safety	Health and Safety Policy/Practice	Heat events	Monitor the number of heat-related incidents and daily max temperatures in excess of 35 °C and 40°C.
OPS-3	Operations	Work with Hydro One, and provincial regulators to ensure supply design and standards are aligned with climate risks.	Asset Planning System Operations	Various	Ice accumulation, wind	Track the frequency and scale of outages resulting from Hydro One service disruption.
OPS-4	Operations	Consider the cost-benefit of the following measures to reduce the risk of employee injuries related to ice accumulation events: •Review, and consider revising policy for requiring installation of winter tires on Hydro-owned vehicles to prevent injuries to personnel rather than through a request/approval process. •Installation and use of additional automated devices to limit need to travel during inclement conditions. •Introducing policies to include heated steps or walkways on Hydro Ottawa properties versus continued salting/sanding.	Fleet & Facilities Asset Planning	Health and Safety Policy/Practice	Ice accumulation	Monitor the number of ice-related incidents (near miss, incidents).
OPS-5	Operations	Develop a policy to monitor and inspect building and roofs after an ice event.	Facilities	Maintenance Procedures	Ice accumulation	Tracking of damage by weather event (if known). Track maintenance costs.
OPS-6	Operations	Consider updating the work from home policy to eliminate or reduce commuting during extreme weather events and hazardous road conditions, particularly ice accumulation.	Human Resources	Human Resources Policy	Ice accumulation	Safety bulletin for tracking number of slips, falls, and other ice-related incidents.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

Priority Level	Asset Class	Initiative	Responsibility	Business Operation to Integrate Outcome	Climate Event Mitigated	Monitoring Strategy
OPS-7	Operations	Consider future climate projections at end of life of current system when deciding to replace or rehabilitate building HVAC systems. Integrate requirement into Procurement Policy to size and design based on climate projections (heating and cooling requirements) in conjunction with critical needs (IT server requirements). By integrating future needs into procurement, the risk that cooling is not adequate during 40°C is minimized.	Facilities	Procurement Policy	Heat event	Monitor the efficiency and service requirements of the building's HVAC system and environmental controls.

1 Initiative changed from the 2019 Hydro Ottawa Climate Change Adaptation Plan

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10/24/2024

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Subject: Hydro Ottawa Asset Condition Assessment Framework

Dear Pranav,

Hatch was engaged by Hydro Ottawa Ltd. (HOL) to review their Asset condition assessment (ACA) framework. The primary objective of this exercise is to validate the framework's calculation and methodology, providing suggestion on its alignment with HOL's broader asset management (AM) strategy and relevant standards. The ACA framework is employed by HOL to derive Asset Health Indices (HI), supporting efforts to enhance system reliability, optimize customer satisfaction, and improve operational efficiency. This approach integrates data from various maintenance programs such as visual inspections, testing and monitoring activities.

Hatch's review was structured into two aspects: 1) Examination of the provided information, including summaries of methodologies and raw data, to validate the ACA framework results for the assets in scope; 2) Evaluation of the ACA framework to ensure alignment with HOL's AM philosophy.

Hatch's review of HOL's ACA framework led to the following conclusions:

1. **Desktop Review and Validation of Framework Results**

Hatch has found HOL's ACA framework to be comprehensive, reflected by HOL's efforts to capture and utilize available data. The methodology document largely demonstrates transparency, consistency and alignment with the calculation model. Despite the volume of assets being assessed, the methodology ensures that data from different source is translated into meaningful metrics.

Hatch identified minor calculation gaps with minimal impact to the overall asset portfolio. HOL currently uses Microsoft Excel (Excel) for Health Index calculations. Some of the identified discrepancies rise from the manual handling of multiple Excel files. While Excel offers ease of use and flexibility, it is also prone to errors due to the intensive manual processes involved in managing and processing data. The reliance on manual data transfer, formula adjustments, and file imports increases the risk of human error, which can compromise the accuracy of health index calculations. Even minor mistakes, such as incorrect cell references or data misplacement, can potentially cascade into larger issues, leading to unreliable outputs. Additionally, the lack of built-in automation or advanced error-checking mechanisms within Excel makes it challenging to maintain consistency across large datasets. As data volumes grow, the effort required to validate entries and formulas manually becomes more time-consuming and error-prone. This increases the potential for inconsistencies, especially when multiple users are involved in updating and modifying asset data.

When Hatch identified this minor gap, HOL, acknowledges the challenges associated with Excel's manual processes and their impact on data accuracy. In response, HOL shared that they are actively exploring more streamlined solutions to address this limitation. Their goal is to implement a system that minimizes reliance on manual processes, offers analytics and dashboard capabilities, and has the potential to integrate with other enterprise solutions.

Hatch worked with HOL to identify the gaps and to find mitigation solutions, ultimately resulting in addressing all the calculation gaps a result of the project.

2. Assessment of Alignment with AM Philosophy and Relevant Standards:

Hatch has found HOL's ACA framework as overall comprehensive giving the limitation with available data. The framework also shows HOL's effort to balance complexity with practicality.

A key strength of HOL's ACA framework lies in its HI validation step, which ensures the integrity and robustness of all results. This step assesses if a sufficient number of parameters is available for each asset before proceeding with the ACA calculation, ensuring that the analysis is not only thorough but also meaningful. By setting this threshold, the framework prevents incomplete or unreliable assessments, maintaining consistency and precision across all evaluated assets.

Hatch proposed that additional criteria be incorporated for certain asset classes to provide a more comprehensive representation of the overall Health Index. HOL acknowledged the value of this suggestion and expressed agreement, noting that they are already in the process of gathering more data to support this enhancement. HOL confirmed that with this expanded dataset, they plan to implement some of the suggested criteria in the near future, further enhancing their ACA framework.

Hatch further recommended adopting a non-linear approach that can be closer aligned with HOL's Asset Management principles, emphasizing a shift from traditional linear models to more dynamic, data-driven methodologies. HOL has acknowledged the value of this suggestion and confirmed that they are actively exploring solutions to enhance their capabilities in advanced analytics. Their objective is to adopt a platform that offers better scalability, reduces reliance on manual processes, and minimizes the potential for human error inherent in Excel-based management. By moving toward a more automated and integrated system, HOL aims to streamline operations, improve data accuracy and ensure consistency across asset condition assessment as the framework evolves.

These efforts reflect HOL's commitment to continuous improvement, balancing the need for immediate enhancements with long-term strategies for operational efficiency. Their dual focus on expanding data collection and upgrading technology ensures that future phases will not only incorporate more robust criteria but also benefit from more reliable and scalable processes.

Key Takeaway

Hatch has reviewed HOL's Asset Condition Assessment calculations and methodologies. Hatch confirmed that the calculations are aligned with the methodologies and that the methodologies are generally aligned with industry best practices. Minor gaps were identified in the calculations, which HOL has acknowledged and addressed. Hatch also provided suggestions for enhancing the methodologies, which HOL recognized as valuable. HOL confirmed that they are in the process of gathering additional data and exploring solutions to support advanced analytics and meet evolving data requirements.

Yours faithfully,

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Distribution Asset Failure Curves

August 15, 2024

Hydro Ottawa Failure Curves

HydroOttawa

HATCH

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Agenda

Confidential

Resilience Investment Business Case Report

Hydro Ottawa

Hydro Ottawa Resilience Investment Business Case Assessment
Project No. 156002

3/27/2024

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
ANL	Argonne National Laboratory
BCR	Benefit Cost Ratio
C&I	Commercial & Industrial
CIS	Customer Information System
CMI	Customer Minutes Interrupted
COF	Consequence of Failure
Con Ed	Consolidated Edison
DC	District of Columbia
DOE	Department of Energy
Dominion	Dominion Energy
FPL	Florida Power & Light
FPSC	Florida Public Service Commission
GHG	Green House Gas
GIS	Geographic Information System
HILP	High impact lower probability
ICE	Interruption Cost Estimator
IEEE	Institute of Electrical and Electronics Engineers
LOF	Likelihood of Failure
MED	Major Event Day
NARUC	National Association of Regulatory Commissioners
NASEO	National Association of State Energy Officials
NIAC	National Infrastructure Advisory Council
NOAA	National Oceanic and Atmospheric Administration
OH	Overhead
OMS	Outage Management System

Abbreviation	Term/Phrase/Name
PC44	Public Conference 44
Pepco	Potomac Electric Power Company
PNNL	Pacific Northwest National Laboratory
PSEG	Public Service Electric and Gas
ROW	Right-of-Way
SQ	Status Quo
T&D	Transmission and Distribution
TECO	Tampa Electric Company
UG	Underground

1.0 EXECUTIVE SUMMARY

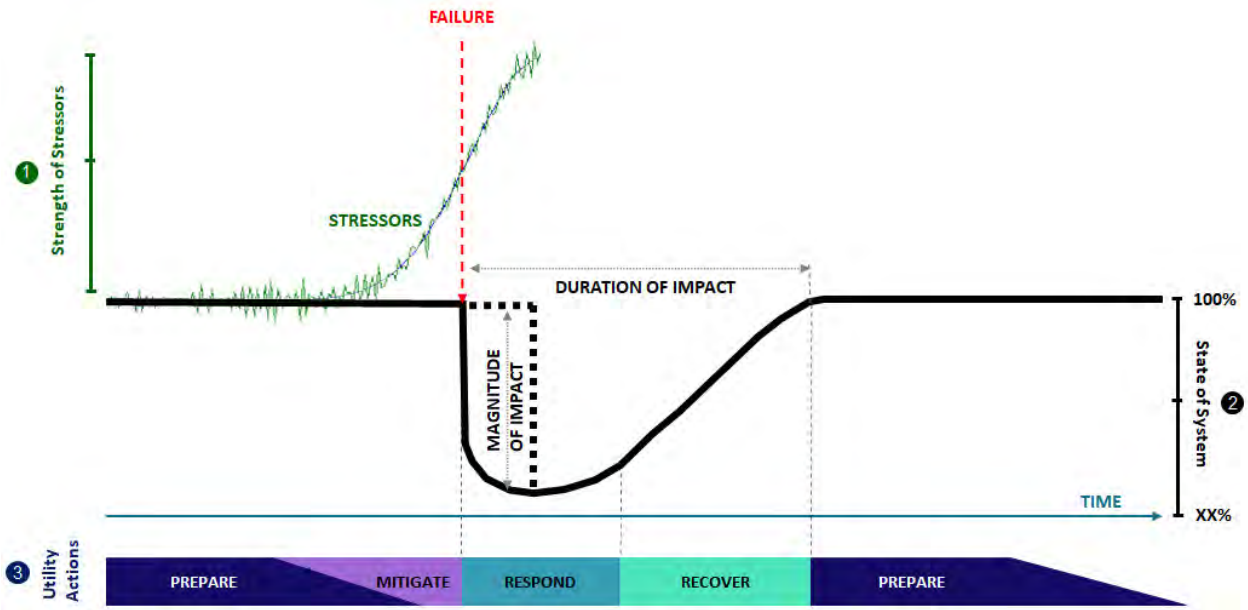
Resilience and its quantification within the utility industry, amongst others, is increasingly the topic of conversation for many electric grid stakeholders from commissions to planning engineers, from boardrooms to utility operations and beyond.

A utility's system resilience is a function of many factors but the two main functions are the frequency and types of events to impact the system, and the characteristics of the infrastructure. Obviously, more frequent and more intense events make grid resilience challenging. Second, the unique characteristics of a utility's system will change the overall outcome of the major events. The following are examples of key characteristics or vulnerabilities that will impact the resilience of the grid:

- Vegetation density
- Quantity of exposed infrastructure (Overhead vs Underground)
- Age and condition of exposed infrastructure
- Level of system sectionalization (Size of circuits, i.e. no. of customers fed off of each circuit)
- Mix of downstream customers

The combination of events and vulnerabilities provides additional challenges for grid resilience. 1898 & Co. utilizes a conceptual resilience framework to understand both of these factors (events and vulnerabilities) and how improvements to the grid can be executed to improve system resilience. Figure 1-1 represents this conceptual view of resilience. The framework is broken up into three components (stressor, state of the system, and utility actions). These three components of the framework are discussed in more detail in Section 2 of the report.

Figure 1-1: Conceptual Resilience Framework



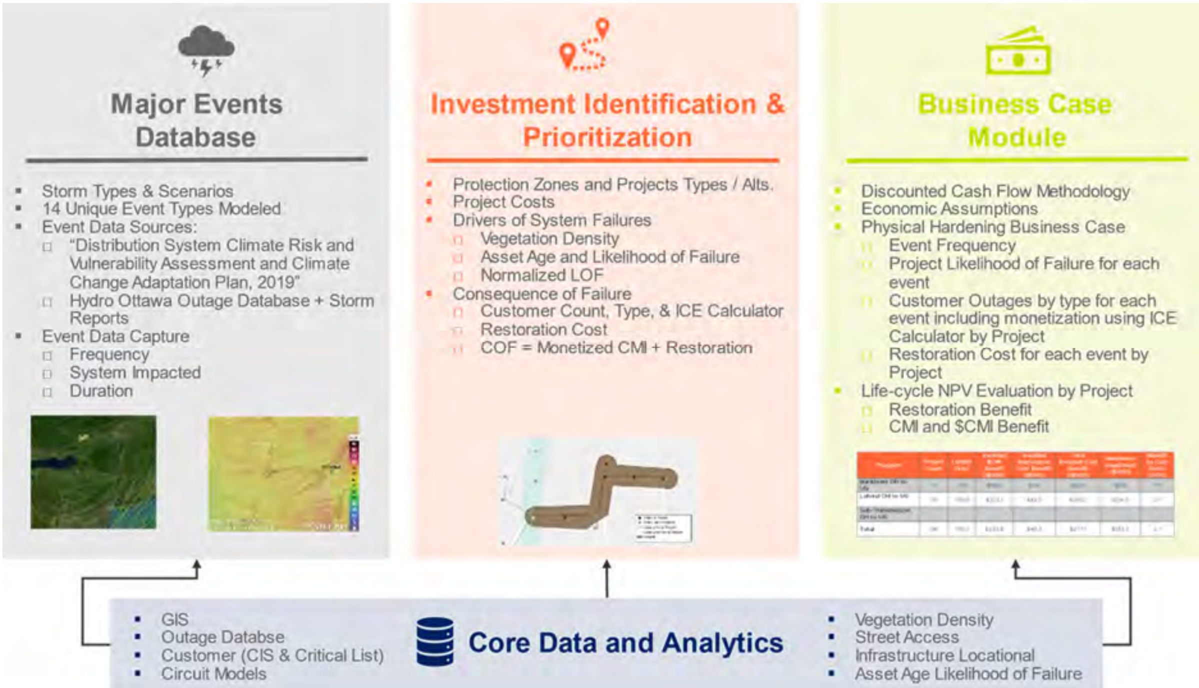
The conceptual frameworks are used throughout this report to:

- Make the case for how resilience investments benefit Hydro Ottawa's customers.
  - Impact to Customers: Outages - Section 3.2
  - Stressors - Section 3.3
  - Impact to Customers: Restoration Costs - Section 3.4
  - Elevated Safety Risks – Section 3.5
- Understand the benefits resilience investments have in avoiding or mitigating disruptive events.
- Anchor the resilience investment business case providing 'line-of-sight' from the theory to practice.

1.1 Resilience Investment Model Overview

Figure 1-2 provides an overview of the Resilience Investment Model to identify and prioritize hardening investments and calculate their customer centric business case.

Figure 1-2: Resilience Investment Model Overview



The Resilience Investment Model is foundationally data centric. It utilizes Hydro Ottawa enterprise data sources as well as external sources. From an internal enterprise perspective, the model utilizes Hydro Ottawa's Geospatial Information System (GIS) for the collection of assets and their attributes (age, type, etc.). This allows the resilience-based planning approach to be asset-centric. The model also utilizes Hydro Ottawa's Outage Database to understand the relationships between protection devices and the types of outage events, particularly larger events. The third core enterprise data set includes information from the Customer Information System (CIS). The fourth core dataset includes Hydro Ottawa distribution circuit models. 1898 & Co. linked these datasets to create the relationship between assets and customers and customer types. This allows the resilience-based planning approach to be customer-centric.

1898 & Co. also leveraged external data sources for the evaluation linking them to the internal data sources. The external data sources included satellite tree canopy for vegetation density analysis, and age deterioration analytics from 1898 & Co. own proprietary modeling. These external sources provided valuable information in identifying infrastructure that would more likely fail during events. Full details of the Resilience model are provided in Section 6.0

1.2 Resilience Investment Results

Hydro Ottawa and 1898 & Co. utilized a resilience-based planning approach to identify, prioritize, and justify o verhead to underground resilience investments in Hydro Ottawa's distribution system. Project benefits are shown in terms of the:

1. Decrease in the Storm Restoration Costs

2. Decrease in the customers impacted and the duration of the overall outage, calculated as CMI.

Additionally, the results are presented assuming monetization of the CMI using the DOE ICE Calculator, modified for resilience. The ICE Calculator is discussed in Section 6.2. The monetization of the CMI in conjunction with the storm restoration costs allows for the calculation of a benefit cost ratio for each potential overhead to underground project.

The resilience projects are prioritized based on the benefit cost ratio of each potential project. Figure 1-3 shows the resulting project resilience ranking, BCR per project cost, for all potential projects included in the evaluation with a historical baseline storm forecast.

Figure 1-3: **Project Resilience Ranking by BCR for Historical Baseline Storm Forecast**

As the figure shows approximately 1 percent of the overhead to underground projects evaluated show a resilience benefit cost ratio value of more than one (28 million dollars). This metric is used to identify the most vulnerable parts of the system that yield the greatest return per dollar spent.

Figure 1-4 shows the resulting project resilience ranking, BCR per project cost, for all potential projects included in the evaluation with climate change storm forecast.

Figure 1-4: **Project Resilience Ranking by BCR for Climate Change Forecast**

As the figure shows approximately 1 percent of the projects evaluated show a resilience benefit cost ratio value of more than one (57 million dollars). This metric is used to identify the most vulnerable parts of the system that yield the greatest return per dollar spent.

1.3 Conclusions

The following include the conclusions of this resilience evaluation for Hydro Ottawa:

- The resilience of the grid is becoming increasingly important. The case for selective overhead to underground resilience investment is sound for Hydro Ottawa; resilience is at the cross section of major events, the modern customer and integrated society. The impact of major events to today's customer and society are much greater than in the past.
- There is opportunity to improve the resilience of Hydro Ottawa's grid for the benefit of customers over the long-term with strategic overhead to underground projects that have quantified benefits that outweigh the costs.
  - Approximately fifty million in total investment that will benefit customers depending on the event forecast assumed.
  - Over Twelve km of resilience circuit investment.
  - 17-26 of potential beneficial overhead to underground projects.
- The development of a Resilience Investment Strategy using the Resilience Investment Model results provides confidence to Hydro Ottawa grid stakeholders. The model provides confidence for the following reasons:
  - **Event-Based –** each project is evaluated against its event performance for 14 different weather events types that are based in the historical record and also climate forecasts with similar conclusions.
  - **Asset and Root-Caused Focused –** each project includes the relationship to their underlying assets. Asset likelihood of failures are based on the assets age and surrounding vegetation.
  - **Data-Centric –** the model utilizes Hydro Ottawa's GIS, OMS, CIS, distribution circuit models, and critical customer information.
  - **Customer-Centric –** the model links each asset to the impacted customer count and type.

- Granular - the granularity at the asset and project levels allows Hydro Ottawa to invest in portions of the system that provide the most value to customers from both a restoration cost reduction and avoided CMI perspective.
- Comprehensive - The approach is comprehensive and evaluates nearly all of the assets on Hydro Ottawa's overhead distribution systems.
- Business Case Foundations - The output of the model is the life-cycle resilience benefit and benefit cost ratio in financial terms.
- Consistency: The model calculates benefits consistently for all potential projects.

The assessment and modeling approach drives prudency for the comprehensive overhead to underground hardening evaluation on two main levels. First, the granularity of potential resilience projects allows Hydro Ottawa to target investment in the portions of the system that provide the most value to customers. Secondly, the customer-centric financial justification of project investments allows Hydro Ottawa to prioritize investments that provide significant customer 'bang for buck'.

The focus of this study was underground of overhead infrastructure, that is not the only resilience investment strategy available to mitigate the impact of future events. As Hydro Ottawa finalizes their resilience plan, other resilience investments could supplement the investment identified in this study.

2.0 RESILIENCE FRAMEWORK

Resilience and its quantification within the utility industry, amongst others, is increasingly the topic of conversation for many electric grid stakeholders from commissions to planning engineers, from boardrooms to utility operations and beyond. Following this industry movement, the Institute of Electrical Electronics Engineers (IEEE) has a working group committee focused on supporting the utility industry to develop metrics for measuring and normalizing resilience. These stakeholders recognize that major events are impacting critical infrastructure and disrupting our interconnected society with increasing consequences and devastation. Stakeholders also recognize that the impact of major events cannot be fully mitigated, but efforts can be made to decrease the overall impact and time for the grid to return to normal operations. Currently, measuring resilience for grid stakeholders is still evolving, as it is not a simple concept, and has many factors to consider. Section 2.0 of the report discusses the following resilience topics:

- Provides various definitions as a foundation for understanding resilience
- Offers a framework to understand resilience, the various factors related to it, and how it will be measured within this evaluation and report

2.1 Resilience Definition

The Merriam-Webster dictionary defines resilience as

> "1 : the capability of a strained body to recover its size and shape after deformation caused especially by compressive stress.
> 2 : an ability to recover from or adjust easily to misfortune or change."

Merriam-Webster elaborates on the definition, taking it from a "physics" definition and applying it more personally. It says:

> "In physics, resilience is the ability of an elastic material (such as rubber or animal tissue) to absorb energy (such as from a blow) and release that energy as it springs back to its original shape. The recovery that occurs in this phenomenon can be viewed as analogous to a person's ability to bounce back from a jarring setback."

Merriam-Webster also provides an etymology for resilience:

> "The word *resilience* derives from the present participle of the Latin verb *resilire,* meaning to "to jump back" or "to recoil". The base of *resilire* is *salire*, a verb meaning "to leap" that also pops up in the etymologies of such sprightly words as sally and somersault."

The definitions from Merriam-Webster provide a baseline for understanding resilience from a "physics" and "person" perspective, but additional exploration is needed for its application to infrastructure and electric grids specifically. While there is general agreement within the industry around the major elements of resilience, the definitions are not identical. Other definitions of resilience from grid stakeholders are:

- IEEE PES PES-TR83 Report—Resilience Framework, Methods, and Metrics for the Electricity Sector: "The ability to protect against and recover from any event that would significantly impact the grid."
- CIGRE WG C4.47: "Power system resilience is the ability to limit the extent, severity, and duration of system degradation following an extreme event."
- FERC: "The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such event."
- DOE: "The ability of a power system and its components to withstand and adapt to disruptions and rapidly recover from them."

In a 2013 paper, the National Association of Regulatory Utility Commissioners (NARUC) offered its own definition of resilience in a manner that is simple and easy to understand.

> *"Robustness and recovery characteristics of utility infrastructure operations, which avoid or minimize interruptions of service during an extraordinary and hazardous event. In other words, it's the gear, the people and the way the people operate the gear immediately before, during and after a bad day that keeps everything going and minimizes the scale and duration of any interruptions."*

Before that, the National Infrastructure Advisory Council (NIAC) provided a definition that is often quoted, and which includes elements used in many other definitions. It states that resilience is the following:

> *"The ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event."*

The NIAC definition includes a system's ability to absorb and adapt. These important characteristics were also used by Argonne National Laboratory (ANL) in its work on state and social resilience and were incorporated into Pacific Northwest National Laboratory's (PNNL) work on the resilience impacts of transactive energy systems. The ANL approach can be used to break resilience into four phases that also align with NARUC's elegantly simple description – the difference being that ANL explicitly includes the ability of the system to recognize and mitigate potential failures before they happen. These four phases are described below:

- Prepare (Before)
  The grid is running normally but the system and its operators are preparing for potential disruptions.
- Mitigate (Before)
  The grid resists and absorbs the event until, if unsuccessful, the event causes a disruption.
- Respond (During)
  The grid responds to the immediate and cascading impacts of the event. The system is in a state of flux, and fixes are being made while new impacts are felt. This stage is largely reactionary (even if using prepared actions).
- Recover (After)
  The state of flux is over, and the grid is stabilized at low functionality. Enough is known about the current and desired (normal) states to create and initiate a plan to restore normal operations.

Sub-definitions include:

- *Vulnerability analysis*
  - *Lessons learned*
  - *Continued improvement*
- *Adaptability*
  - *To grid stresses*
  - *Switching flexibility/design*
  - *Robustness to absorb shocks and keep stable*
- *Changing conditions*
  - *Customer expectations*
  - *Climate change*
  - *Heavy distributed energy resources (DER) penetration*
- *Recovery*
  - *Includes preparedness like mutual assistance, SRP, spare inventory, etc.*
- *Extreme event*
  - *System Average Interruption Frequency Index (SAIFI) and Customer Average Interruption Duration Index (CAIDI) exclusions*
  - *Recordable storm*
- *Deliberate attacks*
  - *Cyber*
  - *Physical*
- *Accidents*
  - *Human performance*
  - *External*

Comparison of definitions to each other show significant alignment with respect to 1) disruptive events, 2) minimizing events, and 3) prepare, adapt, and recover.

For 1898 & Co. these definitions of resilience above can be used to form a conceptual framework in which to better understand and evaluate initiatives to improve grid resilience. This is discussed in the following sub-section.

2.2 Resilience Conceptual Framework

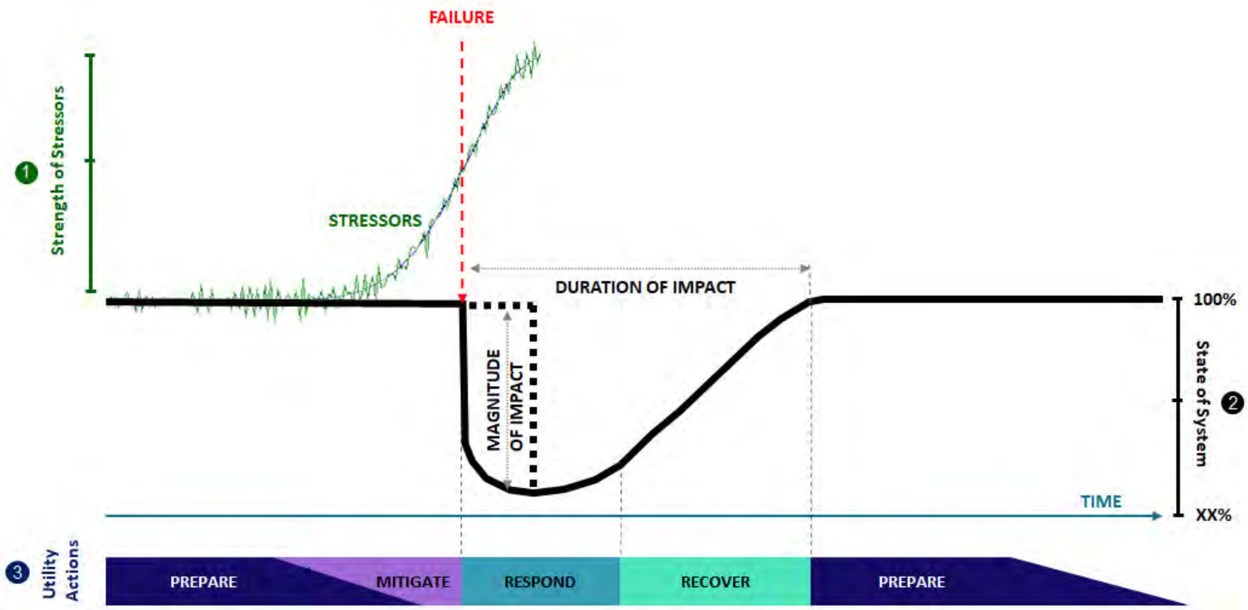
A utility's system resilience is a function of many factors but the two main functions are the frequency and types of events to impact the system, and the characteristics of the infrastructure. Obviously, more frequent and more intense events make grid resilience challenging. Second, the unique characteristics of a utility's system will change the overall outcome of the major events. The following are examples of key characteristics or vulnerabilities that will impact the resilience of the grid:

- Vegetation density
- Quantity of exposed infrastructure (Overhead vs Underground)
- Age and condition of exposed infrastructure
- Level of system sectionalization (Size of circuits, i.e. no. of customers fed off of each circuit)
- Mix of downstream customers

The combination of events and vulnerabilities provides additional challenges for grid resilience. Weather events by their nature are chaotic and do not impact an area evenly. Grid stakeholders could be 'lucky' or 'unlucky' depending on how weather events impact the grid. The power system will have a different resilience response to a thunderstorm with pockets of high winds in older, vegetation dense neighborhoods as opposed to newer neighborhoods which are typically underground (more likely in the suburbs). If a major event is more localized to the suburban area the grid may 'show' to be resilient, but should the event move 10 miles in a different direction it could cause significant outages in the older, vegetation dense neighborhood. The combination of these two factors - events and vulnerabilities - have profound impacts on a grid's measured resilience.

1898 & Co. utilizes a conceptual resilience framework to understand both of these factors (events and vulnerabilities) and how improvements to the grid can be executed to improve system resilience. Figure 2-1 represents this conceptual view of resilience. The framework is broken up into three components.

Figure 2-1: Conceptual Resilience Framework



The first component is the relative strength of a ‘Stressor’ or major event. The green line represents the underlying issue that is stressing the grid, which increases in magnitude until it reaches a point where it impacts the operation of the grid and causes an outage. The origin of the stress may be due to a failing component, or external due to storms or other events. Section 3.3 includes additional discussion on ‘Stressors’ and why investment is needed. Section 8.0 provides the application of ‘Stressors’ within this resilience framework for modeling resilience investment benefits. Each ‘stressor’ has a different expected frequency of occurrence and relative strength.

The second component is the ‘State of System’, represented by the black line. The line shows the status of the entire system or parts of the system (e.g., distribution circuits or substations). The “pit” depicted after the event occurs represents the impact on a system in terms of the magnitude of impact (vertical) and the duration (horizontal). For utilities this should be measured from a customer-centric perspective, mainly in the number of customer outages and the cost to restore the system to ‘steady state’. The ‘State of System’ is driven by grid characteristics or vulnerabilities as outlined above. For utility overhead circuit infrastructure, the more aged and vegetation exposed assets with high downstream customer counts will cause a system to be less resilient against events.

The third component of the resilience framework is the utility actions as they prepare, mitigate, respond, and recover from the stressors that caused major disruptions to the grid. Within this third component, the utility has the ability to minimize the disruptions to the state of the system. The 'prepare' phase can be immediately before an event or well in advance of an event. In the case of immediately before an event, grid owners and operators may mobilize foreign utility crews and stage equipment to enable faster response during the event. Well before an event, grid owners and operators may invest in grid hardening initiatives to mitigate events. The focus of this report is on this prepare phase and the hardening investments that could be made to mitigate the impact of events. However, it should be noted that additional operation focused activities also impact major disruptions minimization but are not discussed as part of this evaluation. Additionally, technologies could be implemented to better understand the strain on the system to point grid operators to where failures could occur. For instance, utilizing enhanced weather prediction models against the system could identify likely areas of failure on the system. This would enable grid operators to reduce the time to respond. In the 'respond' phase grid operators are assessing damage and prioritizing response. This phase is often unpredictable, as efforts to assess the full impact can be delayed for safety reasons. In the 'recover' phase, grid operators understand the state of the system and how to restore it to normal operations. Section 8.0 outlines the resilience investment in the 'prepare' phase to decrease the impact of grid disruptions on customers.

Note that whether this is a specific or overall depiction of resilience, there is no quantification of time. Events may be measured in hours, or days, depending on the duration of the event.

The conceptual framework can be used to depict a specific distribution circuit, the whole distribution system, or the entire grid. If the figure is used to represent a specific distribution circuit, it represents the impact of the event on only that circuit. If the figure is used to represent the impact on the whole Hydro Ottawa system, it represents the aggregated impacts of the event (storm) and the outages that result from it.

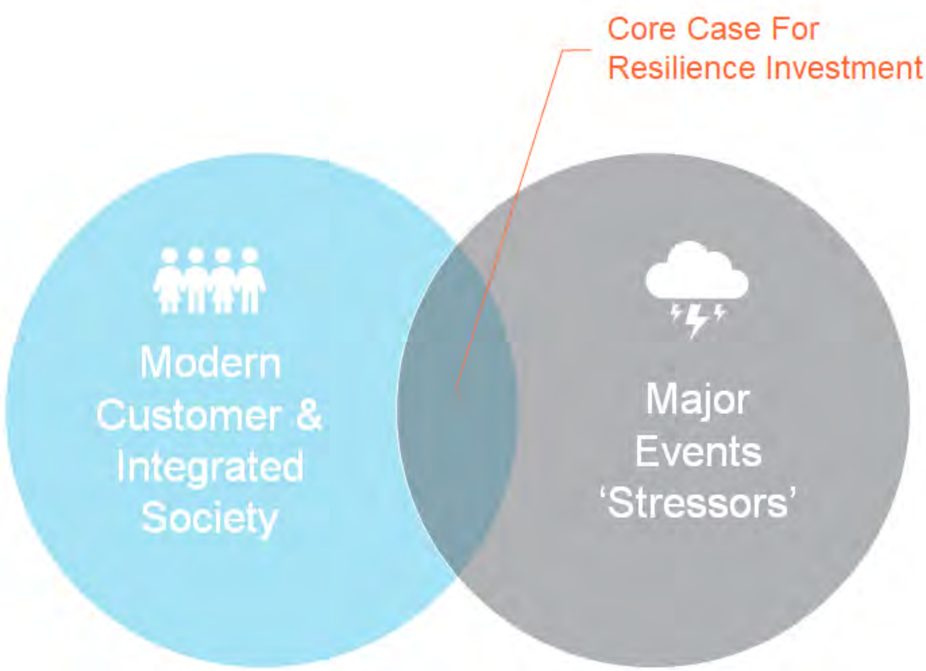
The conceptual frameworks are used throughout this report to:

- Make the case for how resilience investments benefit Hydro Ottawa's customers.
  - Impact to Customers: Outages - Section 3.2
  - Stressors - Section 3.3
  - Impact to Customers: Restoration Costs - Section 3.4
  - Elevated Safety Risks – Section 3.5
- Understand the benefits resilience investments have in avoiding or mitigating disruptive events.
- Anchor the resilience investment business case providing 'line-of-sight' from the theory to practice.

3.0 CASE FOR RESILIENCE

The case for resilience infrastructure improvements is where the modern customer and integrated society intersect with major events. This is depicted in Figure 3-1. While there are many factors, these two are the core case for improving grid resilience.

Figure 3-1: Core Case for Resilience Investment



The customer of today is much different than the customer of 25 years ago. Decades ago, grid outages were seen as inconveniences for customers. Today, these outages can cause real economic harm and stress, especially on society's most vulnerable. Additionally, today's society is far more integrated than in the past. The recent supply chain disruptions following the global pandemic have revealed to us just how interconnected our society and global economy has become.

The customer of today depends on the electric grid being consistently available for these reasons. Compounding the challenge is the expected trend toward more dependence on the grid with the acceleration of electrification such as home heating, commercial fleet electrification, transportation, electric vehicle adoption, to name a few. Additionally, distributed energy resources (DERs) are being contemplated by the customer base. The Canadian Net-Zero Emissions Accountability Act, which became law on June 29, 2021, enshrines in legislation Canada's commitment to achieve net-zero emissions by 2050. Electrification is seen as a key tool to achieve this goal. The acceleration of society's grid reliance due to electrification further establishes the need for the grid to be resilient. Delaying resilience investment will cause additional grid vulnerabilities as electrification accelerates to meet GHG targets.

History often shows that the catalyst for action is a major event that causes significant economic harm and/or stress for customers and society, while also placing societies most vulnerable at risk. A resilience focused and proactive organization considers these potential major events and the impact to customers and invests to mitigate their impact. As the modern customer and integrated society continue to rely more and more on the grid, it is important that grid stakeholders take proactive action to mitigate the impact of more regular events, as well as the major 1 in 100 year or 1 in 50-year type events.

The case for resilience starts by first exploring recent historical events that have impacted Hydro Ottawa customers, including memorable events, historical restoration costs, and historical customer outages. Second, the case for resilience provides additional context about the modern customer and expectations for grid reliance. The third element for the case for resilience is exploring major events outside recent memory to include the '1 in 100 hundred' year type events. As described above, the second and third items are the core case for resilience. While not always the primary focus of resilience investment, the high costs of system restoration and the increased levels of safety risk to society and crews of failed infrastructure during these events are also reasons to improve system resilience. These are also discussed in the following sub-sections. The sub-sections also show how these components fit into the resilience conceptual framework.

3.1 Historical Events Impacting Hydro Ottawa Customers

3.1.1 Recent Events of Note

The following are notable events that have impacted Hydro Ottawa's territory and left an impact on Hydro Ottawa and stakeholders. The review will include storms of note in 2022 and also recap some high impact storms over the last 25 years.

3.1.1.1 May 2022 Derecho

On May 21, 2022 a historic derecho swept through Hydro Ottawa's service territory. This derecho was one of the most destructive storms in Canadian history with winds up to 190 km/h.[1] The storm resulted in over 400 poles that needed to be replaced. In addition, approximately 180,000 customers lost power. Approximately 50 percent of these customers were without power for multiple days. Some customers were without power for over two weeks. The restoration efforts included utilization of 335 contractors[2]. The storm impacted the entire service territory with wind equivalent to either an EF1 (138-177 km/h) or EF2 (178-217 km/h)winds.

[1] Northern Tornadoes Project: https://ntpopendata-westernu.opendata.arcgis.com/apps/westernu::on-qc-derecho-may-21-2022-event-summary-map/about

[2] Derecho: Our biggest storm yet | Hydro Ottawa

Figure 3-2: May 2022 Derecho[3,4]

Storm Name:
May 2022 Derecho

Year: 2022

Top Wind Speed:
190 km/h

Outage Duration:
7+ days

Customers Impacted:
~180,000

Time to restore 50% of Customers: 48 hours

System Damage:
Poles Replaced – 400

3.1.1.2 December 23, 2022 Winter Storm

Before the storm hit Ottawa, the northeastern United States faced down wild weather with blizzards, damaging winds and freezing temperatures causing havoc for holiday travelers. Thousands of flights were cancelled and highways were closed with stranded motorists and multi-vehicle pile-ups.

Customers with email addresses on file received Weather Watch notification in their inbox the afternoon of Wednesday, December 21, warning them that fierce winds and power outages were expected due to the severity of the incoming storm. As predicted, the storm arrived late Thursday evening.

The storm impacted Hydro Ottawa's distribution system starting on December 23 with the first outage taking place at 1:01 a.m. A total of 67,710 customers sustained interruptions. Ninety percent of the customers were restored within 12.5 hours.[5]

[3] https://www.uwo.ca/ntp/blog/2022/ntp_extends_may_21st_ottawaarea_ef2_downburst_eastward.html
[4] https://hydroottawa.com/en/blog/what-year-top-five-outages-2022
[5] https://hydroottawa.com/en/about-us/regulatory-affairs/major-events/december-23-2022

Figure 3-3: December 23, 2022 Winter Storm[6]

Storm Name:
Dec 23, 2022 Winter Storm

Year: 2022

Outage Duration:
2 days

Customers Impacted:
~67,710

Time to restore 90% of Customers: 12.5 hours

3.1.1.3 Sept 2018 Tornados

On Sept 21, 2018 multiple tornados impacted Hydro Ottawa's service territory. These tornados were destructive with winds at 265 km/h. The storm resulted in 88 poles that needed to be replaced as well as 4 km of powerlines that needed to be replaced. In addition, approximately 165,000 customers were without power. Approximately 95 percent of these customers were restored within 72 hours. The restoration efforts included utilization of 86 contractors[7].

[6] https://hydroottawa.com/en/blog/what-year-top-five-outages-2022
[7] https://hydroottawa.com/en/blog/weathering-storm-look-back-september-2018-tornadoes

Figure 3-4: Sept 2018 Tornadoes[8]

Storm Name:
Sept 2018 Tornadoes

Year: 2018

Top Wind Speed:
265 km/h

Outage Duration:
7+ days

Customers Impacted:
~165,000

Time to restore 50% of Customers: 36 hours

System Damage:
Poles Replaced – 88
Powerlines – 4km

Several poles collapsed along Greenbank Road and Hunt Club Road after a tornado hit Ottawa on Sept. 22, 2018. (Leah Hansen/CBC)

3.1.1.4 Great Ice Storm of 1998

While this was approximately 25 years ago, it give insights into resiliency planning. On January 5, 1998, ice started forming and ice thickness up to 85 mm were measured with unofficial report of up to 100 mm were reported. The storm was very large in extent with considerable damage throughout Ontario and Quebec. Employees from Gloucester Hydro, Goulbourn Hydro, Kanata Hydro, Nepean Hydro and Ottawa Hydro come together as one team to repair the extensive damage. Overall, Environment Canada estimates "the storm claims as many as 35 lives, downs millions of trees, 1,000 transmission towers, 30,000 utility poles and enough wires and cable to stretch around the world three times.[9]

[8] https://www.cbc.ca/news/canada/ottawa/tornadoes-one-year-anniversary-city-response-1.5291134
[9] https://hydroottawa.com/en/about-us/our-company/our-history

Figure 3-5: Great Ice Storm of 1998[10,11,12]

Storm Name:
Great Ice Storm of 1998

Year: 1998

Maximum Ice Thickness:
85 mm

Customers Impacted (Ontario):
~1,500,000

Time to restore 95% of Customers: ~48 hours

Last Customer Restored:
33 days

Total Storm Damage (Ontario):
Poles Replaced – 300,000
Powerlines – >100,000km

Ice storm in Ottawa. Postmedia

3.1.1.5 Other Major Events

The following table summarizes other weather Events:

Table 3-1: Other Major Weather Event Summary[13]

Start Date	Storm Description	Total Customers Interrupted	Time to restore 90% of Customers
July 1, 2016	Thunderstorm	32,934	2 hours
January 4, 2017	Freezing Rain	19,130	11.3 hours
September 27, 2017	Thunderstorm	14,051	24 hours
April 16, 2018	Freezing Rain/Wind	56,146	36 hours
May 4, 2018	High Wind	60,811	12 hours
July 5, 2019	Thunderstorm	70,069	6.5 hours
November 1, 2019	High Winds	14,228	6 hours
June 14, 2021	Thunderstorm	17,441	8.5 hours
April 5, 2023	Freezing Rain	163,448	40.5 hours

10 https://www.cbc.ca/news/canada/ottawa/ice-storm-ottawa-20-years-later-1.4470067
11 https://ottawacitizen.com/news/local-news/the-great-ice-storm-of-1998-by-the-numbers
12 https://hydroottawa.com/en/about-us/our-company/our-history
13 https://hydroottawa.com/en/about-us/regulatory-affairs/major-events

3.1.2 Historical Restoration Costs

Table 3-2 shows the historical Hydro Ottawa storm costs for major storms. The table shows the costs in the dollars of the day (nominal) and then escalated to 2023. The values were provided by Hydro Ottawa. The average major storm cost is approximately $7.6 million per storm in 2023 dollars. These costs are eventually passed on to customers.

Table 3-2: Hydro Ottawa Historical Storm Costs

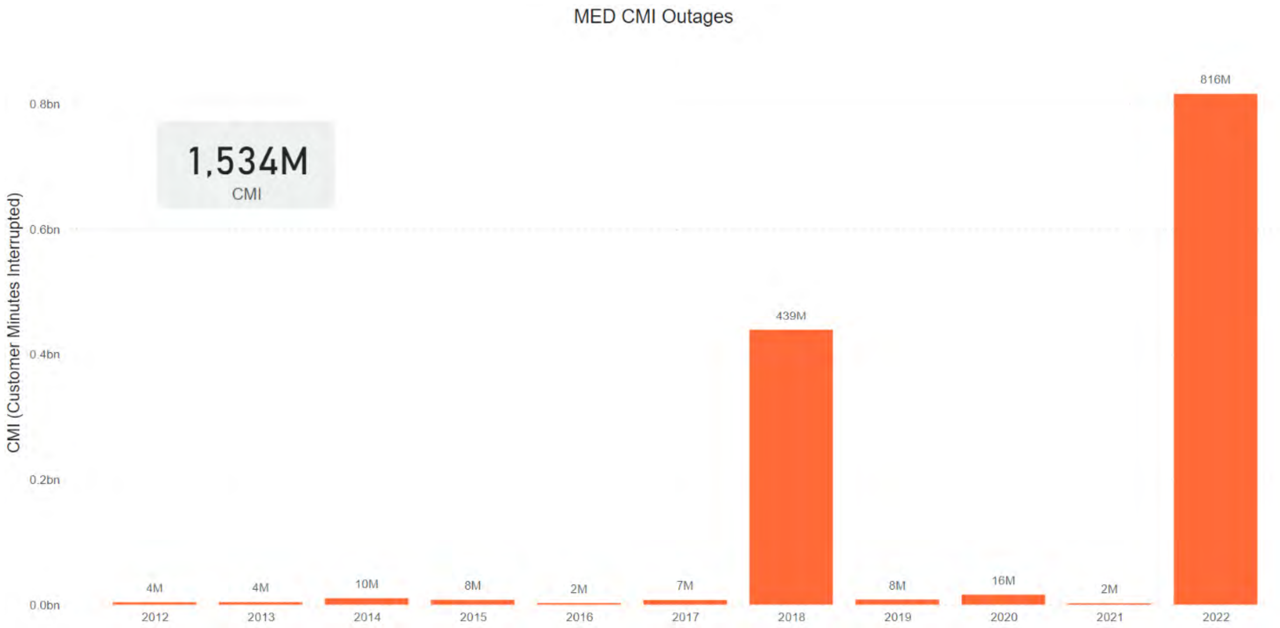
Date	Strom Type	O&M (Nominal$)	Capital (Nominal$)	Total (Nominal$)	Total (2023$)[14]
2018-04-15	Ice Storm	$400,000	$900,000	$1,300,000	$1,579,572
2018-05-04	Wind Storm	$100,000	$800,000	$900,000	$993,673
2018-09-21	Tornado	$800,000	$2,300,000	$3,100,000	$3,422,650
2022-05-21	Derecho	$8,700,000	$15,300,000	$24,000,000	$24,480,000

3.1.3 Historical Major Event Day Customer Outages

Figure 3-6 shows the historical Hydro Ottawa major event (Major Event Day)[15] customer minutes interrupted (CMI) from July 2012 through February 2023. This information was captured from Hydro Ottawa outage database. The figure shows a total 11-year CMI of 1.53 billion, with an annual average of 128 million CMI. This means each customer was without electrical service an average of 366 minutes per year over the 11-year time horizon. The figure also shows that a single event can impact an 11-year time horizon significantly as the May 2022 Derecho 816 million CMI comprise a significant portion of the 11-year total CMI.

[14] Inflation Calculator | Find US Dollar's Value from 1913-2022 (usinflationcalculator.com)
[15] A Major Event Day (MED) is a day where the impacts on system reliability have exceeded a threshold which is no longer considered business as usual. Definitions vary by jurisdiction, but typically adhere to some variation of the 2.5-β method defined in IEEE 1366-2022. MED outages are typically excluded from reporting to help compare reliability performance between utilities.

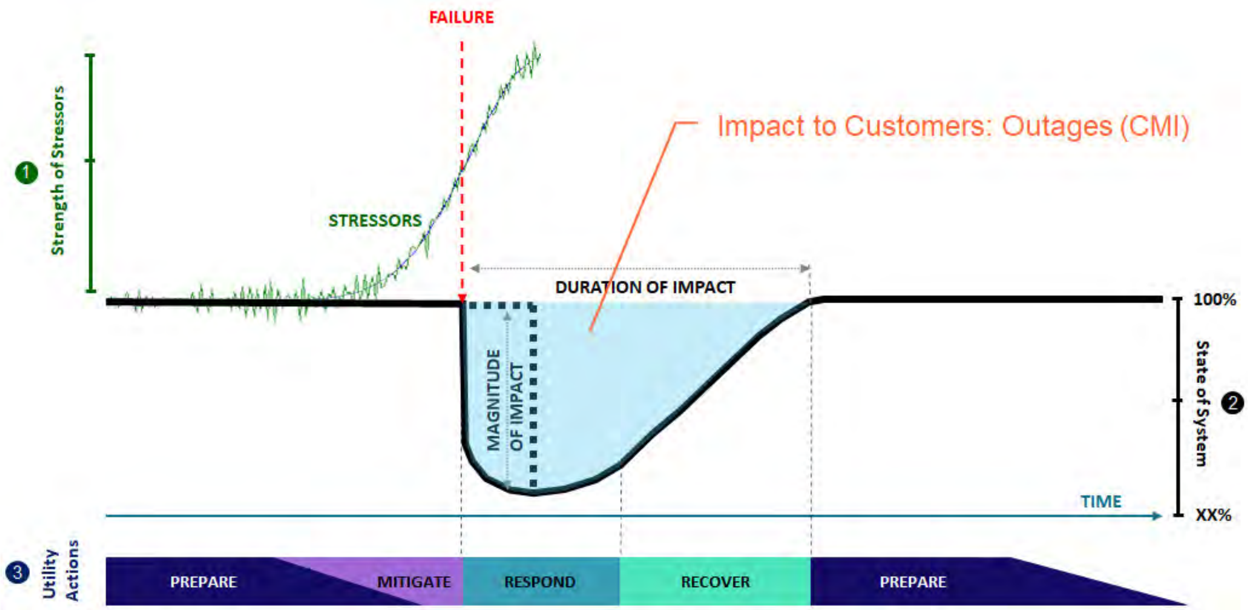
Figure 3-6: Hydro Ottawa Historical CMI



3.2 The Impact of Customer Outages

The core case for resilience starts with the impact to customers and grid stakeholders. Figure 3-7 demonstrates the impact to customers from an outage perspective, within the Resilience Conceptual Framework. The area in blue represents the overall customer outage time. Within the utility industry, this is quantified by CMI. Within the blue-shaded portion of Figure 3-7, CMI is the impact of magnitude in terms of customers without service at each minute of time summed together.

Figure 3-7: Resilience Framework & Customer Outages



The CMI outage metric is not new for utilities. It has been used for several decades to understand utility performance and calculate the impact of grid outages. What has changed over the decades is the impact to customers and society of grid outages. Twenty-five years ago, grid outages used to be seen as an inconvenience or nuisance to life; today grid outages cause serious stress and economic harm for customers depending on the duration and time of the event. Extended outages caused by major events are a real concern for the health and safety of society's most vulnerable.

Several factors have caused the outages of today to be more impactful than the outages of decades past. These changes for customers and society are a key reason for why resilience investment in the electric grid is needed. The following sub-sections outline many of these customer and societal changes.

3.2.1 Critical Customers

Hydro Ottawa serves many different customer types, including some customers that are highly dependent on an uninterrupted, infrequent, and resilient power supply as possible. This includes customers with life sustaining medical devices, critical function customers (such as nursing homes, hospitals, and police stations), and warming centers.

Critical customers who serve the community in a service or healthcare role, among other necessary functions. There is a total of 1,061 critical customer facilities served by Hydro Ottawa, including but not limited to the following customer types:

- Ambulance Depot
- Ambulance Facility
- Child-care Center
- Community Police Center
- Fire Station
- Hospital
- Long Term Care Facility
- Police Station
- Public Works Garage/Community Police Station
- Recreational Facility
- School
- Veterinary Facility

Investing in grid resilience has a crucial impact on customers whose health is tied to power dependent medical devices, and critical customers whose purpose is to provide public, or healthcare services rely on resilient power to serve the community effectively and efficiently. Disrupted power interferes with their ability to provide care and assistance, especially during critical times.

3.2.2 Work from Home

Today, the largest number of the workforce is working from home than in history. Ottawa has the nation's highest percentage of the workforce who work from home (40% in December 2022)[16]. The catalyst for increased work from home was spurred by the COVID-19 pandemic. This compares to a Canadian national average of approximately 4% in 2016[17].

For this population, insulating against outages and fluctuations in power supply directly impacts a customer's bottom line. When power is interrupted from the home

[16] https://www.thestar.com/business/opinion/2023/05/10/working-from-home-10-surprising-facts-that-complicate-everything.html
[17] https://www.statista.com/topics/7816/remote-work-in-canada/#topicOverview

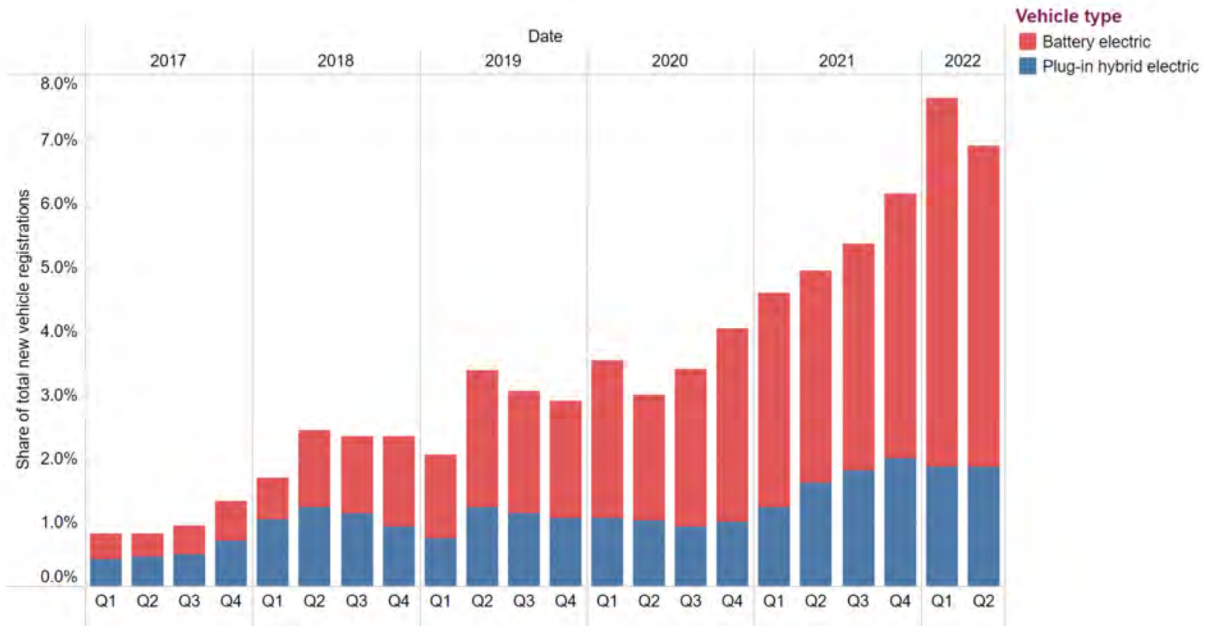
working space, this may cause an employee to use paid or unpaid leave, or incur additional costs to outsourced support in the form of additional childcare, commuting costs, etc. For the modern employee and business, power resilience is critical to maintain operations and lower business risk.

3.2.3 Electrification and Decarbonization

As mentioned in Section 3.0, Canada has very aggressive decarbonization plans which center around electrification of traditionally fossil fuel intensive activities. As the country plans to move the majority of activities that require power to electric power, the reliability and resiliency of the electric grid become critical. While this shift will affect many industries and activities, this section focuses on transportation electrification as an example, but the plan to decarbonize includes electrification of residences, commercial locations, industrial equipment, industrial processes, and agriculture to name a few.

This shift to electrification will cause growth in demand on the distribution system as an increased number of systems and services become electrified. Customers will expect the distribution grid to handle the new technology and subsequent increased load in real time. To illustrate this concept, EV adoption in Canada is a prime example. As customers continue to adopt electric vehicles, demand for decreased grid instability is at the forefront of customer's minds. For the customers that commute or otherwise rely on vehicles to perform daily tasks, it is expected that they are able to drive after a night of charging. Figure 3-8 shows the adoption of EVs within Canada as a percentage of total sales through mid 2022.

Figure 3-8: EV Vehicle Adoption in Canada[18]



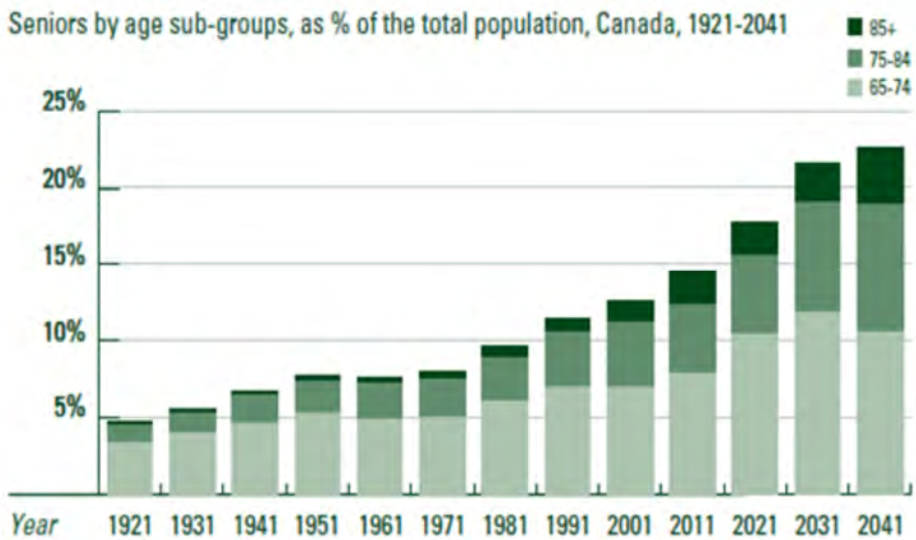
Residential customers are not the only customers affected by this change. Since residential customers work at industrial and commercial customers, these larger customers will see reduced productivity and revenue when their employees can't commute to work (for those that can't work virtually). Additionally, those with commercial vehicles for shipping or local delivery would be heavily impacted by a significant disruption in power.

3.2.4 Aging in Place

Nearly 90 percent of Canadians state their preference is to remain in their current homes as they age.[19] The number of Canadian residents that are over 65 are trending up, as shown in Figure 3-9.

[18] https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2022/market-snapshot-record-high-electric-vehicle-sales-canada.html
[19] https://www.readersdigest.ca/health/healthy-living/aging-in-place/

Figure 3-9: Population of Canadian Over 65 from 1921-2041[20]



For seniors who plan to age in their current homes, the decreasing of long-lasting and widespread power outages, and increased time to power restoration are critical to independence and their overall health and safety. During the Texas blackouts of February 2021, 246 people died when power was lost to large portions of the state in freezing weather. Of those deaths, 67% were due to hypothermia and the rest were due to pre-existing illness, vehicle accidents, carbon monoxide poisoning, fires, and falls[21]. Of these fatalities, approximately 60% were over the age of 60.[22]

3.2.5 Integrated Society

Decade over decade society is evolving and becoming more and more reliant on electrical power. Consider just 25 years ago when the personal computers were starting to emerge as a business necessity, but widespread adoption in homes had not begun yet. The internet was a fascination, but not central to how customers lived life. On-line shopping for essentials was not yet a mainstream concept. Networking was by telephone landlines or in-person, with "virtual" mediums of communication, such as video calling, not yet possible. Modern electrical vehicles with practical

[20] https://www.elections.ca/content.aspx?section=res&dir=rec/part/sen&document=index&lang=e
[21] https://www.texastribune.org/2022/01/02/texas-winter-storm-final-death-toll-246/
[22] https://www.courthousenews.com/wp-content/uploads/2022/02/texas-state-health-services-department-report-on-winter-storm-uri-death-toll.pdf

ranges were not at the prototype stage. Productivity was not as intertwined with electric power availability as it is today, since work and personal functions were still done in person.

Energy resilience is now business-critical and is having a higher impact on people's lives as society continues to become more integrated. Our society today is highly intertwined on both the macro and micro scale. We have grown to understand this integration from the supply-chain disruption following the global pandemic, and personal experience with productivity interruptions in daily life. A real-life example helps prove the point – a utility consulting engineer recently had to take a day off unexpectedly because of a power outage at his child's daycare in Austin, TX. This engineer was part of a larger group, based in Kansas City. The Kansas City team had to re-arrange their day to cover for this engineer's time out, causing decreased productivity and efficiency for the team as a whole. In an efficient society with 'just-in-time everything' and families where all heads of households are employed, minor disruptions in the utility grid can cause economic harm and stress.

Industries, large and small, work cohesively to allow society to function at the level of productivity and financial success currently achieved. If one of these falls due to unavailable power, the ripple effect is not contained to just one employee, business, or industry.

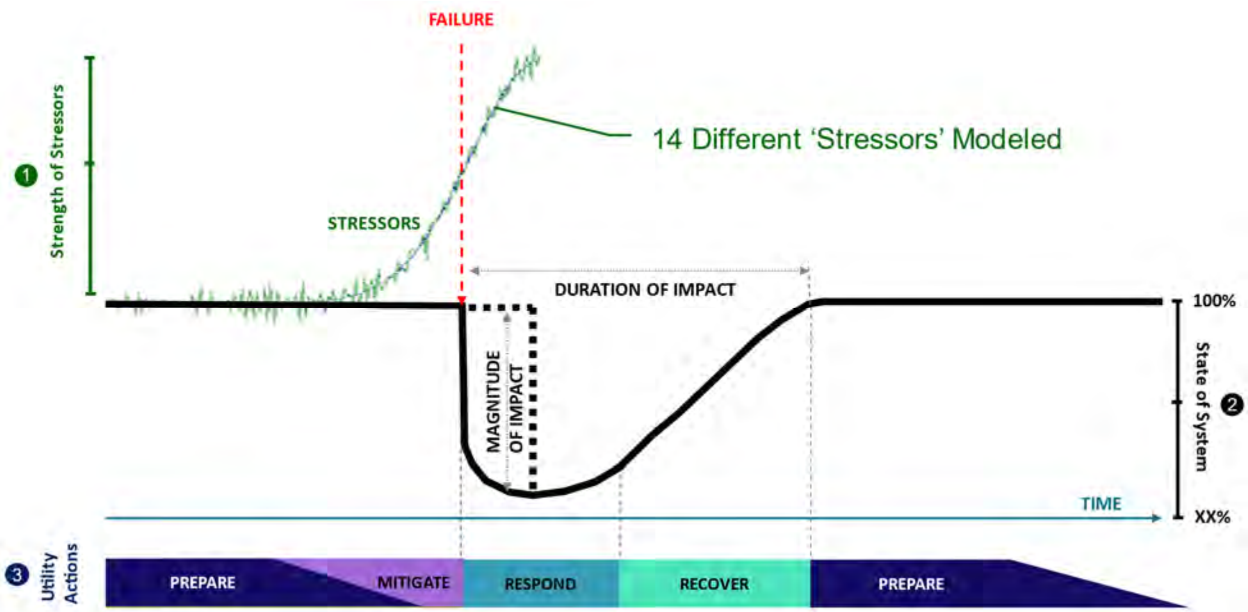
3.3 Major Events 'Stressors'

The case for resilience continues with disruptive events or 'stressors'. The types of events and their frequency is key to understanding the grid's resilience, measuring it, and performing the business case for investments.

Because of this, measuring a grid's current resilience is forward looking. This forward-looking nature causes challenges in measuring resilience since the future needs to be modeled and the future is uncertain. While it may be tempting and much easier to measure resilience from a historical perspective, this leaves grid stakeholders, especially customers, at high risk. For instance, grid stakeholders may have a false sense that their grid is resilient by comparing their customer outages to their peers. However, this may only be because the stakeholder's grid did not experience many events in the last 5 or 10 years as their peers. Section 8.0 shows that Hydro Ottawa's service territory has had periods of very low major events and periods of high major events. A historical focus provides a misleading measure for grid resilience and leaves grid stakeholders exposed to disruptive events.

As discussed above, the level of grid resilience is firstly based on the number and type of events. Within the resilience conceptual framework, Figure 3-10 shows that this evaluation includes 14 different stressors or major events. Section 8.0 outlines each of these 'stressors' in more detail and the approach to estimating their future frequency.

Figure 3-10: Resilience Framework 'Stressors'



Since grid resilience is foundationally based on potential future stressors, it is critical to formulate the 'universe' of events that could impact the grid. Several factors need to be considered. Firstly, the type of events, such as natural disasters (e.g. tornados, ice storms) or human driven disruptions (e.g. cyber/physical infrastructure attacks). This evaluation covers the range of weather-based natural disaster events in the modeling of resilience. Second is the level of impact. This evaluation includes a wide range of events, from the upper bound impact events (strong thunderstorm/derecho) to the lower bound impact events (regional weather events). The type of events included in measuring resilience is based on the goals grid stakeholders have for mitigating disruption. This evaluation mainly leverages historical events as a guide for the future as a conservative assumption.

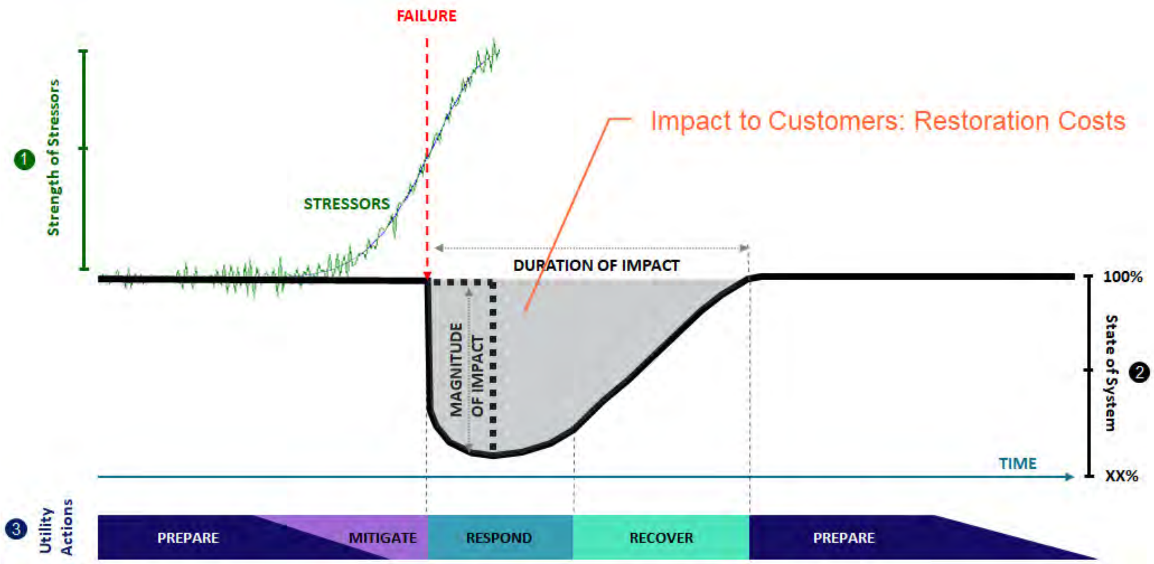
Within this evaluation, system resilience is a sum of all the events weighted by their expected future probability. Specifically, the resilience measurement is done for each of the 14 identified event types multiplied by their expected future probability, then totaled together. The entire system worth of assets do not fail, so the resilience impact is a double failure calculation, 1. Probability of an event 2. Probability an asset fails.

The range and type of 'stressors' outlined in Section 8.0 is the key driver for the case for resilience investment. The historical record shows a wide range of event types to impact the Hydro Ottawa service territory. As the effects of climate change are expected to increase over time, these types of events could increase in relative frequency in the future.

3.4 Restoration Costs

While the foundation of the case for resilience is the overlap of the modern customer and integrated society with the range of major events, restoration costs are a further driver. Figure 3-11 shows this customer impact within the Resilience Conceptual Framework. It should be noted that the cost represented in the 'grey' area includes both the immediate cost to restore the system during the event and the costs to rebuild the grid to standard following the event.

Figure 3-11: Resilience Framework & Restoration Costs



Over time, the cost to replace infrastructure has increased. This is especially the case during major events. Replacing infrastructure during a failure event typically requires overtime and more resources than for a proactive approach. It also includes 'patches' during the respond and recover phases, which are followed on by rebuilds to appropriate standards after the event, sometimes weeks or months later. This causes reactive infrastructure rebuilds for a disruptive event to be 1.5 to 2.0 times higher than for similar planned activities. Depending on the size of the event, utilities may leverage mutual assistance from other outside utilities in the restoration effort. These costs can be 3.0 to 5.0 times higher than using local crews. These higher multipliers are due to the double time, per diems, mobilization and de-mobilization, equipment fees, and general higher inefficiencies in managing a high level of resources all at one time. The urgency to speed up recovery times results in a premium price for services, and these costs eventually get passed on to the customer.

Proactive resilience investment can mitigate some of these costs. If enough resilience investment is completed, a utility will have less infrastructure failures during events, therefore will use less resources and crews in the restoration process.

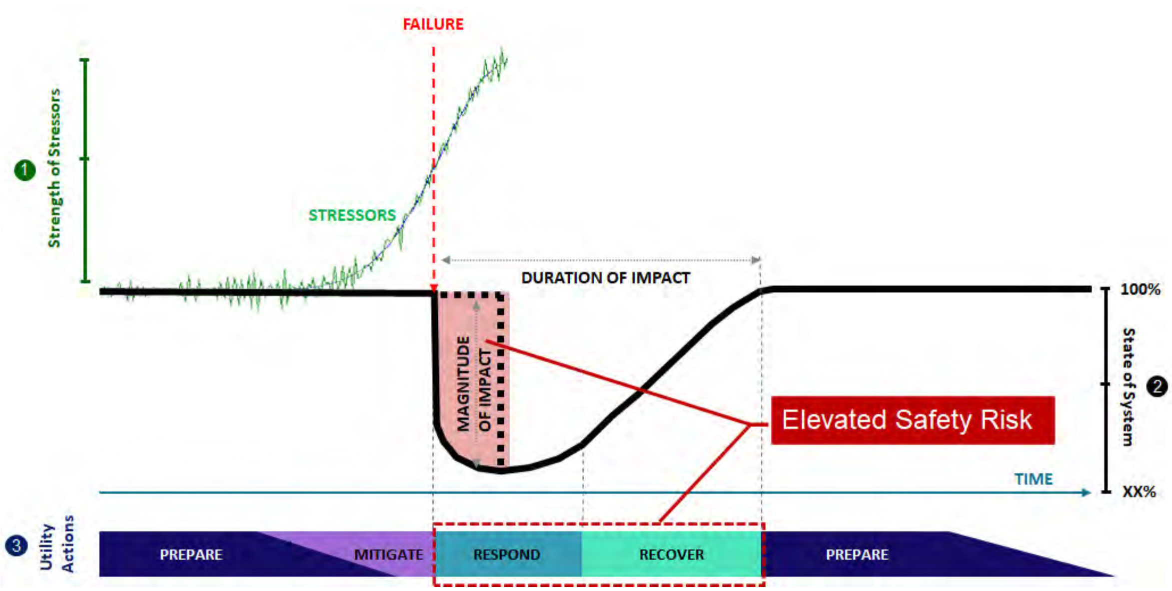
With smart resilience investment, the grid can be rebuilt to not only withstand major events but also enable the customer of the future's demand for electrification and

DER penetration. Given the current expectations for the future customer, a fully reactive approach could cause infrastructure rebuilds to be 2.5 to 4.0 times more than a proactive approach. To date, the level of infrastructure rebuilds at this higher life-cycle cost has been low, but with the increasing age of the system the percentage of the system that would be rebuilt at these levels will be much higher.

3.5 Safety Risks

Similar to restoration costs, mitigating safety risks is another additional driver of resilience. This is done on two fronts. Firstly, during an event, infrastructure failures expose the general public to elevated levels of safety risks. Additionally, utilities crews during the respond and recover phases are rebuilding the grid in a more unpredictable situation. Often times, the rebuilding efforts can be late into the evening, in the dark, and in conditions that are potentially hazardous. The long hours and maneuvering around debris, broken infrastructure, and hard to reach places increases safety risks. These elevated levels of safety risk are shown within the Resilience Conceptual Framework in Figure 3-12.

Figure 3-12: Resilience Framework & Elevated Safety Risk



Rebuilding resilient infrastructure will help to mitigate the safety risks. As discussed in more detail below, this benefit stream is not overtly quantified in this evaluation.

However, this benefit stream should not be ignored within the resilience business case framework.

4.0 RESILIENCE OBJECTIVE

As the utility industry has yet to develop an agreed upon definition for resilience, establishing an ultimate objective for resilience and measuring how to achieve it are further behind. Nevertheless, electric utilities are taking action to harden the grid (see Section 5.0) while the industry evolves on defining resilience, setting an objective for it, and establishing metrics to grade progress and achieving the objective of resilience.

4.1 Measuring Resilience Conceptual Framework

Resilience metrics are in their infancy and relatively immature within the utility industry. Some utilities are exploring resilience metrics through derivations from reliability metrics. In developing metrics for resilience, 1898 & Co. has leveraged the conceptual resilience framework from Section 2.2, to measure resilience for electric utilities. This framework provides the underlying design philosophy and basis for the Resilience Investment Model (see Section 6.0). 1898 & Co.'s guiding principles for measuring resilience are:

- **Customer-Centric –** Since the case for resilience is founded on the impact to customers, metrics need to have direct 'line-of-sight' to customer impacts. Where possible, metrics should take into account differences in customer and community types. 1898 & Co. has included an initial recommendation for the value of customer outages in this report (see Section 6.2).
- **Incorporate the 'universe' of events –** The other foundation for the case for resilience is the range of events. This includes the typical events that occur several times a year through High Impact Low Probability (HILP) events that may have a frequency of '1 in 100' years or even '1 in 500' years. This may mean including events that are not part of the historical record. Similar to the value of various customer types and communities, the process of identifying the 'universe' of events should include various grid stakeholders. Additionally, the unknown unknowns of climate change make it vital to collaborate with a larger stakeholder group. 1898 & Co.'s evaluation for this resilience investment evaluation included both forecast based on historical information as well as a climate change forecast.

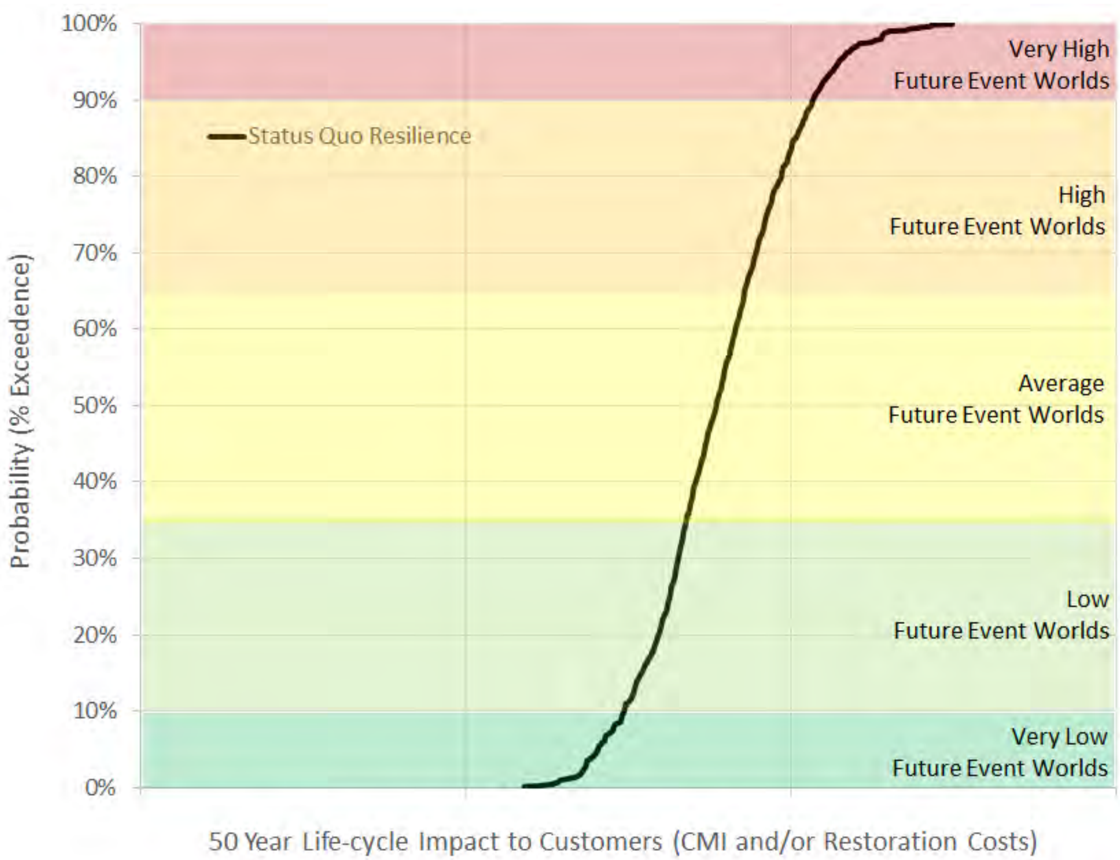
- **Future-focused –** Since resilience is about mitigating future disruptive events, metrics should aim to focus on potential future events. While capturing historical performance is objective and rooted in data, solely focusing on them may provide a false sense of actual resilience depending on the time horizon. Future-focused allows for the inclusion into a resilience metric the HILP events, historical only metrics may exclude HILP events since they have not occurred in the recent past. If only historical metrics are used to evaluate a grids resilience, it may leave stakeholders with a false sense of system resilience. This is often why a major event 'catalyst' occurs before real change happens. For this reason, it is vital that metrics include a future focus to understand the real risks exposed to grid stakeholders.
- **Encompass the arc of time –** Recency bias is a real concern for resilience metrics. The historical records show periods of time with few events and periods of time with higher-than-average number of events. If resilience metrics only include a short time horizon, it may provide a false sense of a system's actual resilience. Metrics should strive to include decades long time horizons if possible.
- **Integrate system characteristics / vulnerabilities –** Disruptive events, especially weather, are unpredictable. For instance, major wind events can have gusts of 50 mph winds in one part of the service territory, and only 15 mph winds 5 miles away. Focusing only on event-based metrics would exclude the fact that all parts of the system are not the same in age, vegetation density, etc. For example, the infrastructure impacted by the 15 mph winds may be much older, with high vegetation density compared to the infrastructure hit with 50 mph winds. For this reason, it is critical that resilience metrics focus on the vulnerable parts of the system agnostics of events.
- **Range of potential outcomes (stochastic modeling) –** While there is uncertainty around future events, this uncertainty is not unbounded. Bounds or confidence bands can be developed through stochastic modeling (generally Monte Carlo techniques). Time horizons of interest can be modeled and better understood by utilizing the historical record to statistically characterize and forecast the range of future system outcomes.

- **Data-Driven with Industry Experience Insights-** Data availability and quality are continually improving. As data availability grows, more effective and insightful indicators can be developed and explored. This will not happen in a vacuum as both the frontier of data science and industry insights are continuing to evolve.
- **Simplicity –** Resilience is a multifaceted and complex topic as outlined above. In measuring resilience, there is balance between metrics that are simple and easy to communicate, and metrics that are complex and include all necessary details.
- **Enables Effective Prudency Evaluation-** The cost of mitigation measures is often considerable. Metrics and investment evaluations need to ensure limited resources are being deployed effectively and providing value to the utility's customers. Metrics that produce financial justification results provide more direct alignment for stakeholders in evaluating investment prudency.

The conceptual framework, discussed above in Section 2.2, is useful as a starting point to develop a framework for measuring resilience. The conceptual framework for resilience is for a specific event and shows the customer impacts in terms of CMI (see Section 3.2) and restoration costs (see Section 3.4). A whole system resilience metric can be estimated by summing the impacts of all events weighted by their expected frequency over the arc of time. In other words, sum the conceptual framework figures for the 'universe' of events multiplying each by their expected future frequency.

The result of this approach produces the life-cycle customer impact for the 'universe' of events as represented in Figure 4-1. The figure shows the range of potential impacts to customers for all events and their range of frequencies over the next 50 years. The figure shows several potential event 'worlds' from very high to very low. It also incorporates the range of events permutations that could occur over the time horizon. The 50-year time horizon is recommended as it is the minimum of a '1 in 100' year type of event and the average expected life of utility infrastructure, 50 years. This conceptual approach to measuring resilience meets many of the guiding principles outlined above with the exception of complexity in understanding and enabling effective prudency evaluation. It is also the foundation for understanding the goal of resilience.

Figure 4-1: Measuring Resilience Framework



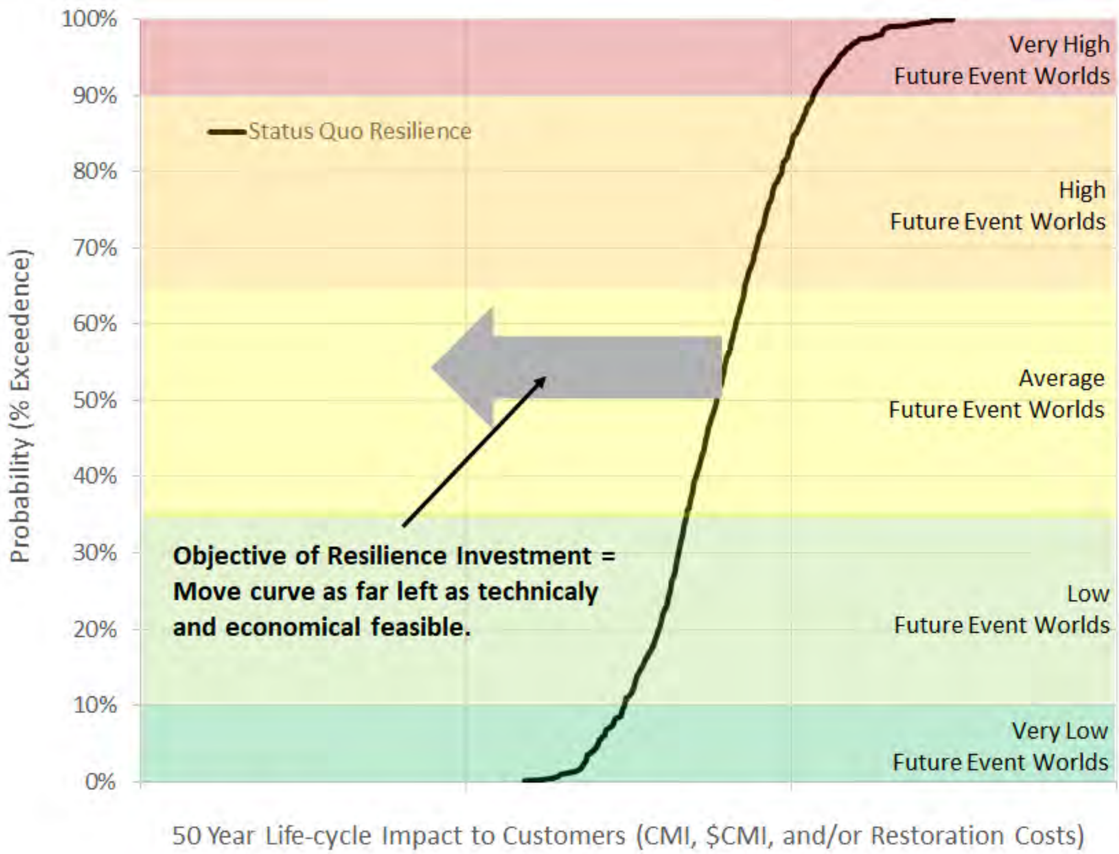
4.2 The Objective for Grid Resilience

The objective for grid resilience investment is two-fold:

1. Minimize to the extent technically feasible the impact of disruptive events to customers over the life-cycle of infrastructure
2. Invest in resilience upgrades with a positive business case, benefit to cost ratio >= 1

This is depicted within the resilience measuring framework in Figure 4-2.

Figure 4-2: Resilience Investment Objective



This two-fold objective for resilience investment seems simplistic enough on the surface but a deeper evaluation is needed to fully understand its implications.

- **Minimize to extent feasible –** Investments over time should be made to a level that they provide meaningful change in event impact. Since events impact all over a utility service territory, resilience investments will need to be substantial over the long term to provide meaningful change. Meaningful change being decreasing all system major event outages and restoration costs by over 30 to 40 percent. This approach allows for all customers to benefit through significantly shorter event's durations and restoration costs. For example, 4 day events before a long-term resilience plan could be a 2.5 day event after a resilience plan is implemented on the system. This also means that the impact of events cannot be fully mitigated. There will always be residual risk.
- **Investments with a positive business case –** The substantial level of investment is balanced or constrained by only including investments with a

positive business case. Over investment is also a risk with achieving a goal of resilience. Because customers ultimately pay for both proactive and reactive system costs, it is important that over investment risk be managed. Limiting investments to those with a positive business case helps utilities to not overinvest in resilience measures.

- **Measuring the impact to customer** – Customers are impacted in terms of restoration costs which eventually get passed along through rates and outages. Minimizing outages and restoration costs should be included in the objective for resilience. In fact, the Florida legislature outlined this two-fold objective for evaluating investments of decreasing customer outages and restoration costs as the focus for Florida electric utilities in developing their 10-year Storm Protection Plans. It should be noted that a specific metric was not proposed, rather utilities metrics need to be aligned to this two-fold objective. The impact of customer outages is complex in that different customers and communities have significantly different impacts to them based on the type of event and duration of the event. Measuring resilience will require grid stakeholders to place a value on different customer and community types and the duration of events. This is critical to identifying direct investments for customers and building the business case for investments. While restoration savings is part of the business case, the main component is the value of avoided outages. For this reason, 1898 & Co. shows CMI, monetized CMI ($CMI), and restoration cost for measuring resilience investments. The valuing of societal costs for different event durations is currently a gap for electric utilities stakeholders. In other words, what is the societal cost of a 4-day outage for a residential customer versus a 2 day outage. 1898 & Co. has included its baseline approach for the value of outages, sometimes referred to as the value of lost load, in Section 6.2.

Before exploring specific metrics to evaluate resilience and improving it, it is important to understand how it can be improved through infrastructure upgrades. The following section discusses this topic.

4.3 Improving System Resilience

There are several approaches to mitigating the impacts of major disruptive events and improving the overall resilience of the system. From an infrastructure enhancement perspective, there are three main approach types to improving system resilience:

1. **Resistance** – the ability of the system to retain its service, to completely or partially fend off the effects of a major event.
2. **Absorptive Capacity** – the ability of the system to mitigate the effects of a major event by implementing contingency measures that restore all or part of the system.
3. **Recoverability** – the ability of the system to more quickly return to full service.

Each of these three approaches is targeted at the 'prepare' phase. The following sub-sections describe each of these approaches in relation to the Resilience Conceptual Framework. The sections use example infrastructure improvements for each of the three approaches. The focus of this evaluation is undergrounding, but other resilience investment alternatives will be discussed for completeness. Undergrounding is expected to be part of a larger Resilience Investment Plan. In developing a resilience investment plan, it is important to use all three of these approaches for a multi-prong approach to improve resilience, prioritizing those investments that provide the most resilience 'bang-for-buck'. This is discussed in Section 6.0.

4.3.1 Resistance Investments and Resilience Impact

Resistance investments aim to strengthen the system so that major events do not impact the system or have minimal impact on the system. Examples of these types of grid investments include:

- Stronger Structures / Poles
  - Wood to Steel (or other manufactured) Conversions
  - Wood Pole Upgrades (e.g. Class 3 conversion to Class 1 or Class C or B construction to Class B+ or A)
- Rebuild with Tree-wire
- Overhead to Underground Conversions

- Substation Elevation

The focus of this evaluation is undergrounding, but other resilience investment alternatives will be discussed for completeness. The level of improvement in system resilience for each of these investment types is dependent on the level of penetration of the investment across the system and the types of stressors to impact the system. Figure 4-3 shows the impact of resilience improvement assuming weaker stressors with the entire system having been rebuilt with much stronger structures or poles. For the weaker stressors, the figure shows that this type of investment can nearly fully mitigate the impact of events.

Figure 4-3: Resilience Improvement and Hardening All Infrastructure (Weaker Event)

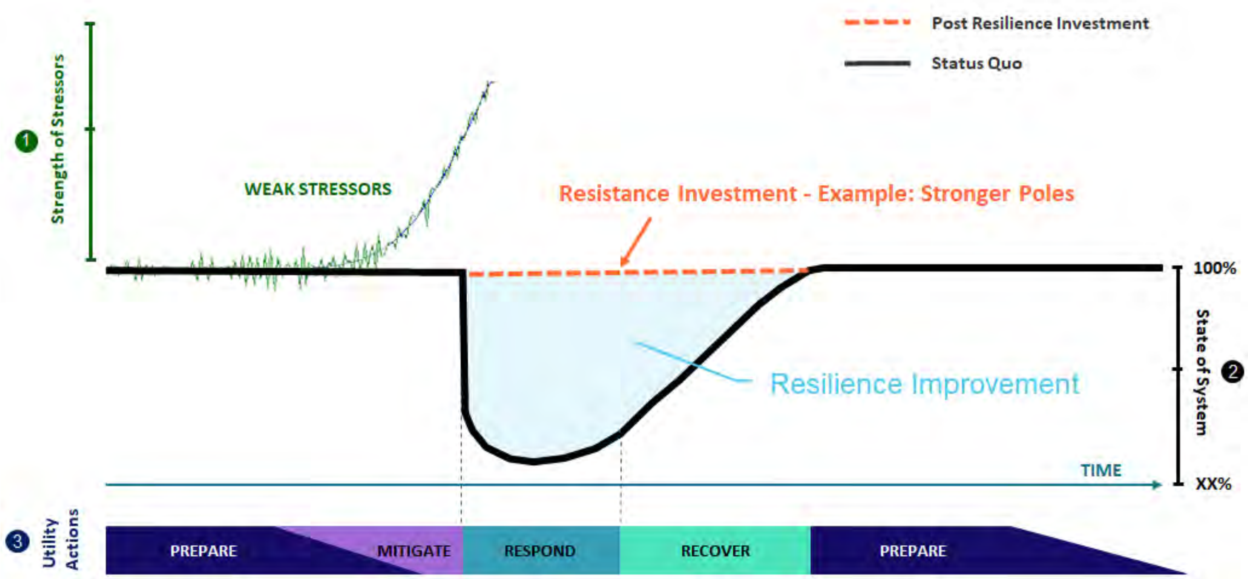


Figure 4-4 shows the resilience improvement for this same investment strategy, stronger poles across the entire system, for the stronger stressors. With the stronger infrastructure, it now takes a stronger or more intense stressor to cause asset failures. This is represented in the figure by failure now occurring at point 'B' as opposed to point 'A' without the infrastructure upgrade. The hardening did not prevent failures but delayed it and shortened the outage duration. While it might take more work to erect the stronger, and bigger, poles, fewer structures fail in this scenario. Fewer asset failures means that more crews will be able to work on the assets that do fail, which can have a beneficial multiplying effect on outage reduction time. Of course, if only a small fraction of the structures are hardened the overall resilience improvement is small.

Figure 4-4: Resilience Improvement and Hardening All Infrastructure (Stronger Event)

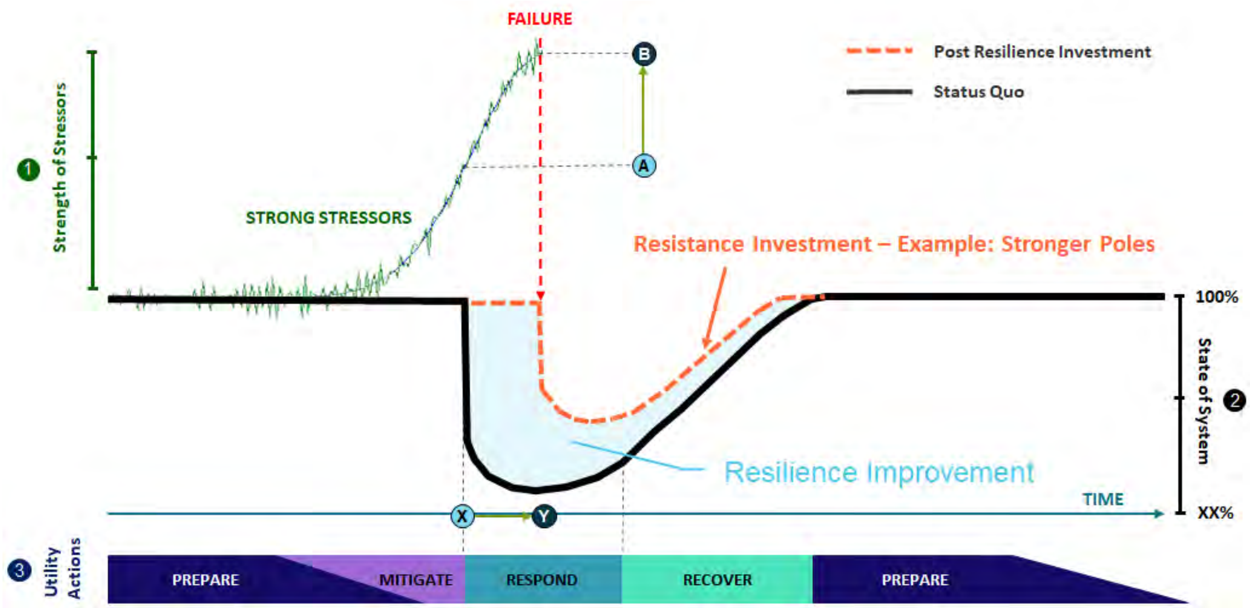


Figure 4-3 and Figure 4-4 show the range of resilience improvement for utilizing stronger structures or poles for the resistance investment approach. The cost effectiveness of this strategy is dependent on the relative mix of weaker and stronger stressors. Undergrounding infrastructure, while expensive, does provide maximum resilience benefit, nearly fully mitigating the impact of the range of stressors. Figure 4-5 visualizes the resilience benefit within the Resilience Conceptual Framework. The figure is based on a fictitious scenario where the entire system is undergrounded. Figure 4-6 provides a more realistic resilience improvement scenario with partial system undergrounding.

Figure 4-5: Resilience Improvement and Undergrounding All Infrastructure

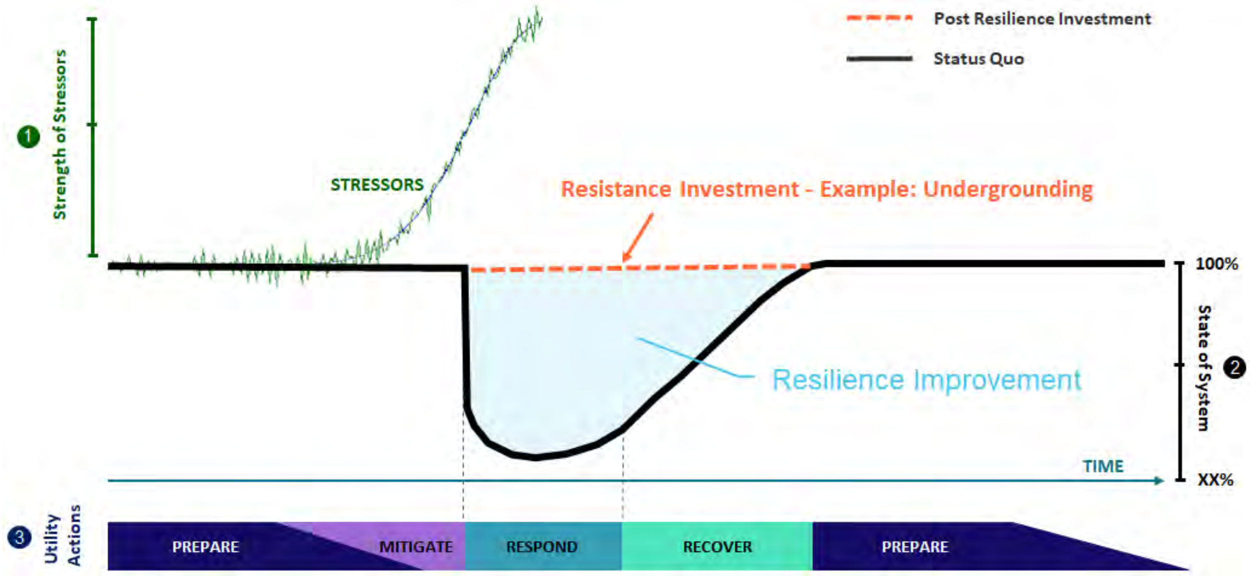
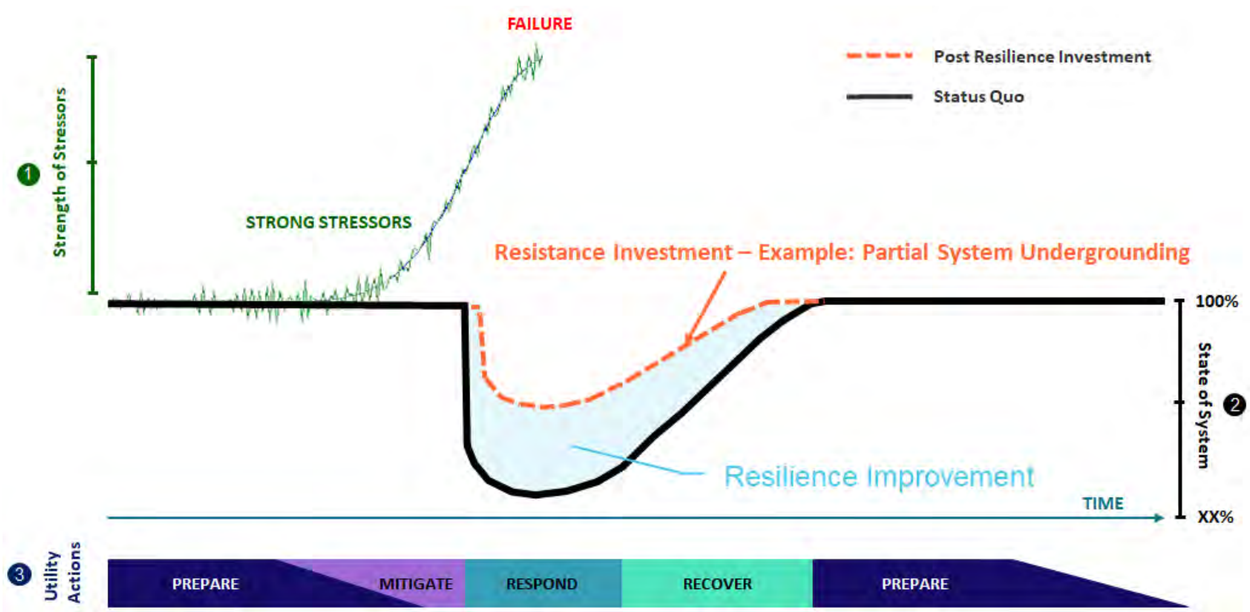


Figure 4-6: Resilience Improvement and Partial System Undergrounding



The resistance investment approach can provide significant benefits for all grid customers. Firstly, directly for the customers whose infrastructure has been hardened or undergrounded. These customers directly benefit from the hardening activities. Secondly, even customers whose upstream infrastructure was not hardened achieve benefits from this strategy. As Figure 4-4 and Figure 4-6 both show, the overall duration of the major disruptive stressors are less than a status quo approach. With less infrastructure to rebuild after a major event, crews can rebuild the failed infrastructure much faster. Additionally, depending on the severity of the storm, there could be additional benefits of needing less costly foreign crews to restore the system.

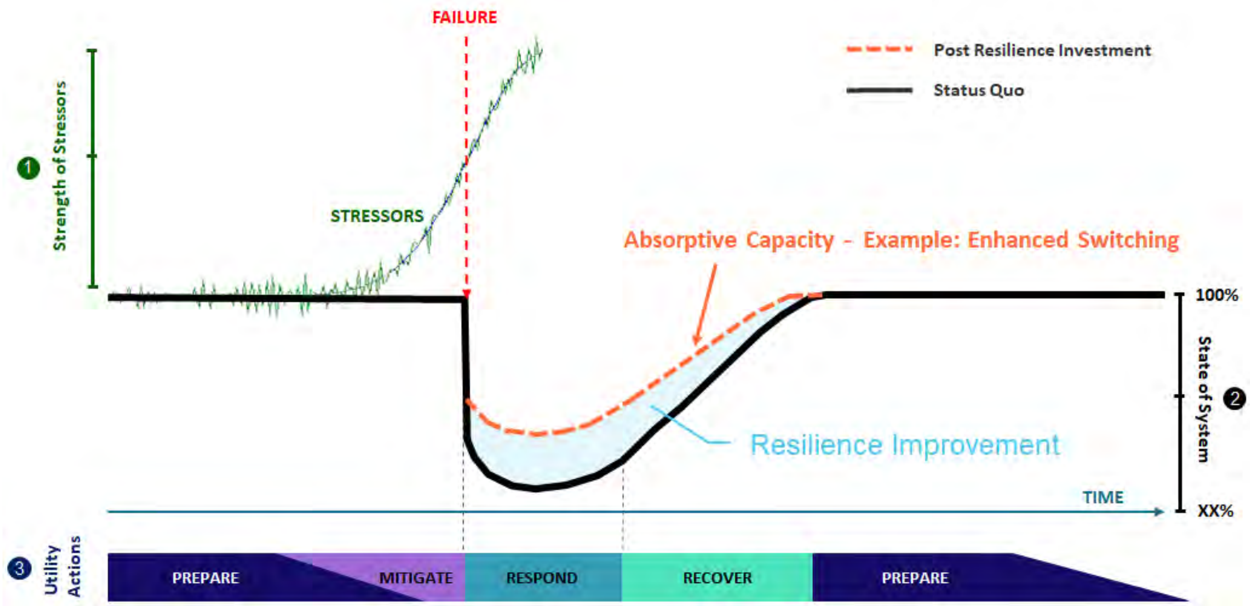
4.3.2 Absorptive Capacity Investment and Resilience Impact

Absorptive capacity investments aim to mitigate the impact of the event by implementing contingency measures that restore part of the system. Examples of these types of grid investments include:

- Enhanced Switching
  - Distribution Automation
  - Adding more circuit ties
- Looping and diverse paths

The focus of this evaluation is undergrounding, but other resilience investment alternatives will be discussed for completeness. Figure 4-7 shows the impact of resilience improvement from absorptive investment strategies, specifically enhanced switching capabilities. While this type of investment does not mitigate asset failures, it does mitigate the impact to customers. In the case of enhanced switching, customers can be swapped over to parts of the system that have not failed, decreasing the number of customers impacted. For enhanced switching, the overall duration of the event is not mitigated making the overall resilience improvement less than a resistance strategy. However, the cost of these approaches relative to resistance investment approaches can be significantly less.

Figure 4-7: Resilience Improvement and Enhanced Switching



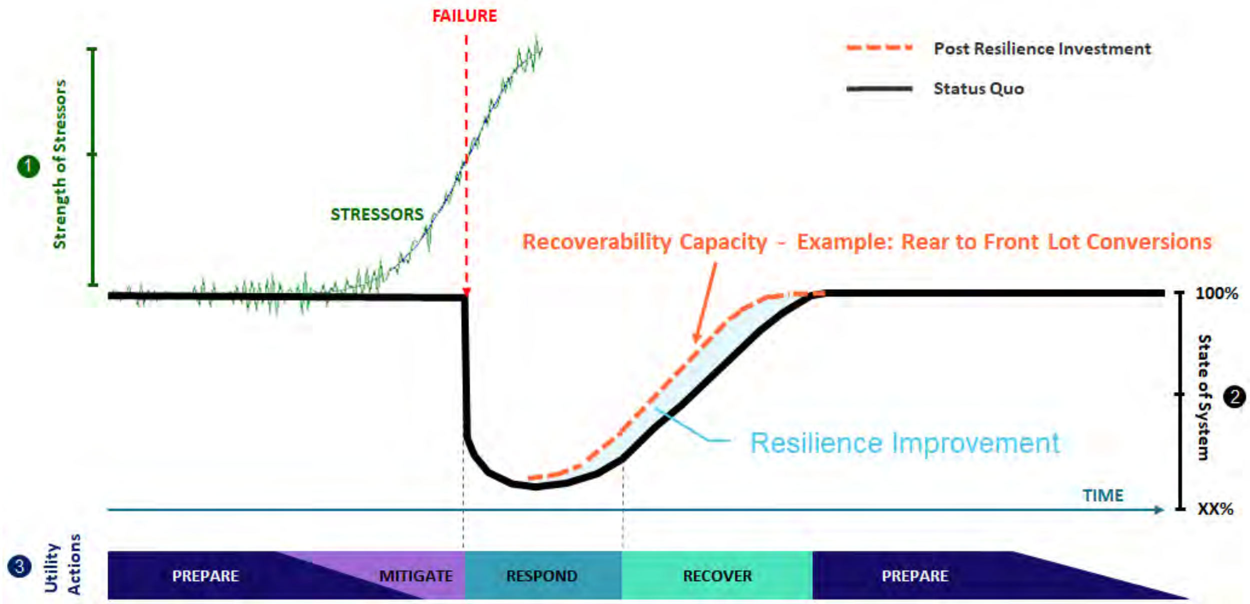
4.3.3 Recoverability Capacity Investment and Resilience Impact

Recoverability is the ability of the system to quickly return to full service. Typically, recoverability for major events is achieved through operational strategies like number of crews, staging of equipment, and optimization of crew development to name a few. From an infrastructure investment perspective, a main approach to improving recoverability is to enhance access to the infrastructure. Assets in deep right-of-way are far more challenging to rebuild as access for crews and trucks is challenging. Examples of these types of grid investments include:

- Improving Access to Right-of-ways
- Bridge and Road Access
- Rear lot to Front Lot Conversions (all else equal)

The focus of this evaluation is undergrounding, but other resilience investment alternatives will be discussed for completeness. Figure 4-8 shows the impact of resilience improvement from recoverability investment strategies, specifically rear lot to front lot conversions. As the figure shows, the absolute impact on the system is not mitigated, rather the overall duration is decreased to improve the overall resilience. In the long-term, this investment strategy does not mitigate asset failures, unless the infrastructure is built to a stronger standard with the conversion, it does allow crews to get access to and fix the infrastructure much faster. Recoverability only based investment strategies are not typically done at scale since the cost can be significant. Rather, this strategy is more on an opportunistic basis or done at the same time with cost efficiencies with a resistance or absorptive investment strategy.

Figure 4-8: Resilience Improvement and Rear to Front Lot Conversions



5.0 RESILIENCE INVESTMENT PLANS WITHIN THE INDUSTRY

Across the United States, Canada, and around the world, utilities are pursuing resilience investment plan filings in response to the greater impact major events have on the electrical system. While some states have strong stances on resilience requirements (Florida, New York), others have chosen to provide recommendations for utilities to consider. As seen with New York's recent move from resilience recommendations to codified filing requirements, resilience investment requirement levels are in a state of flux. Many Public Service Commissions (PSC) are recognizing the importance of resilience but there are still a wide range of regulatory environments out there. The following section is an initial review of resilience investment across the United States and Canada.

5.1 Maryland & Virginia

In 2012, a derecho storm impacted Maryland during a sustained heat wave, and together resulted in the 47 fatalities according to NOAA[23]. In response, Executive Order 01.01.2012.15 directed the State Energy Advisor, in conjunction with other agencies including the Maryland Energy Administration (MEA), to solicit recommendations from industry experts on how to improve the resilience and reliability of the distribution system – resulting in the formation of the Grid Resiliency Task Force. This group included almost 50 experts who evaluated the effectiveness and feasibility of undergrounding power lines, options for improving grid resilience infrastructure investments, and alternative financing and cost recovery for capital investments. The resulting *Weathering the Storm* report included 11 recommendations, including to implement a ratemaking structure that aligns customers and utility incentives by rewarding reliability that exceeds established reliability metric and penalizes failure to meet those metrics.

In 2016, MDPSC initiated a proceeding titled Public Conference 44 (PC44)[24] to review electric distribution systems in Maryland, aiming to explore issues that will

[23] National Oceanic and Atmospheric Administration (NOAA). (2013 January). *The Historic Derecho of June 29, 2012*. U. S. Department of Commerce

[24] https://www.psc.state.md.us/transforming-marylands-electric-grid-pc44/

maximize benefits and choice to Maryland electric customers and assess how the evolving grid impacts low- and moderate-income ratepayers. In the first notice, seven topics were considered for the proceeding, including the following:

- Rate design
- Electric Vehicles
- Competitive Markets and Customer Choice
- Interconnection Process
- Energy Storage
- Distribution Planning

Building on the information from the Task Force on Comprehensive Electricity Planning (compromising of the NARUC and NASEO), MDPSC created the Distribution System Planning Work Group in 2021 with the goal of aligning planning processes with state goals and proliferation of distributed energy resources through comprehensive examination of distribution system planning in Maryland[25].

In 2019, the MEA sponsored an incentive program called Resilient Maryland, aimed at growing the adoption of microgrid and other distributed generation systems. This pilot program provides competitive grants to stakeholders in the development of microgrids, combined cycle heat and power, and resilience hubs in the state. The program disbursed $297,000 in 2019, $1.03 million in 2020, $1.59 million in 2021, and $1.58 million in 2022. Applications for 2023 are currently open[26].

The MDPSC approved a request from Potomac Electric Power Company (Pepco) to include a “Grid Resilience Charge” on customer’s monthly bills in Montgomery and Prince George countries. This charge allowed Pepco to secure $24 million from ratepayers in Case No. 9311, in order to replace priority distribution feeders in 2014. In 2016, Pepco requested approval under Case No. 9418 for an additional $31.6 million under the same program.

[25] https://news.maryland.gov/mea/2021/02/11/maryland-announces-plan-for-electric-grid-of-the-future/
[26] https://energy.maryland.gov/business/Pages/ResilientMaryland.aspx

Pepco and Dominion Energy (Dominion) are utilities with similarities to Hydro Ottawa. A summary of efforts by these utilities is summarized Table 5-1 below:

Table 5-1: Pepco and Dominion Resilience Efforts to Date

Utility	Resilience Program	Area	Projects	Time Horizon	Budget
Pepco	DC Plug Projects	District of Columbia (DC)	Undergrounding distribution feeders – Wards 3, 4, 5, 7, and 8.	2012-Present	$500M*
	Capital Grid Projects	DC & Maryland	Substation upgrades, new substations, 10 miles of undergrounding transmission lines	2020-2028	$1.1B
Dominion	Strategic Underground Program	Virginia & North Carolina	Undergrounding tap lines most prone to outages over the last 10-years	2019-2026	$179M per year
	Grid Improvement Programs	Virginia	Hardening main feeders, vegetation management for ash tree mortality due to invasive insects.	2018-2030	$3B

*This program is funded by Pepco, and the District of Columbia.

Additionally, MEA (along with 12 other states), declared commitment to a more efficient and resilient energy future in February of 2011, following the conclusion of the two-year initiative hosted by the NARUC and the National Association of State Energy Officials (NASEO).

5.2 Florida

In 2006, the Florida Public Service Commission (FPSC) passed a requirement for electric utilities to develop storm protection plans. In 2019, this became codified by the Florida legislature, also allowing utilities to recover the costs of approved plans through a charge separate and apart from base rates. Each utility must file a petition with the Commission for approval of a T&D Storm Protection Plan (SPP) that covers the utility's immediate 3-year planning period and their longer 10-year planning horizon. Per the legislation and SPP rule, each utility is required to provide an updated SPP at least every 3 years. The SPP rule following the legislation lays out requirements for plans. From a benefits perspectives, the plans are required to show benefits in terms of avoided customer outages and avoided storm restoration costs.

In November 2022, FPSC approved 4 plans submitted by power company utilities for efforts to harden the state's power grid over the next 3 years. The FPSC approved nearly all of the investments over the next 3 years for each of the four electric utilities; Florida Power and Light (FPL), Duke, Florida Public Utilities and Tampa Electric Company (TECO).

5.2.1 Florida Power & Light

FPL requested approval for plan totaling $13.77B. The commission approved nearly all of the requested funding for programs for the first 3 years of the 10-year plans. Table 5-2 provides an overview of their SPP filing.

Table 5-2: FPL Storm Hardening Estimated Categories and Spends

Program	Annual Cost	Timeframe (Years)
Distribution Inspection	$66.9M	10
Transmission Inspection	$67.2M	10
Distribution Feeder Hardening	$270.8M	9
Distribution Lateral Hardening	$939M	10
Transmission Hardening	$50.4M	10
Distribution Vegetation Management	$76.6M	10
Transmission Vegetation Management	$14.4M	10
Substation Storm Surge/Flood Mitigation	$16M	2
Distribution Winterization (withdrawn)	$22.3M	2
Transmission Winterization (withdrawn)	$22.3M	2
Transmission Access Enhancement	$11.70	10
Total	**$1.54B**	

5.2.2 Duke Florida

Duke Florida requested approval for plan totaling $7.17B. Table 5-3 provides an overview of their SPP filing. Duke Florida's Plan programs include the following:

Table 5-3: Duke Storm Hardening Estimated Categories and Spends

Program	Annual Cost	O&M Cost	Timeframe (Years)
Feeder Hardening	$2.0B	$49M	10
Lateral Hardening	$2.9B	$74M	10
Underground Flood Mitigation	$15M		10
Distribution Vegetation Management	$23M	$517M	10
Transmission Structure Hardening	$1.6B	$34M	10
Substation Flood Mitigation	$38M		10
Loop Radially-Fed Substation	$82M		10
Substation Hardening	$133M		10
Transmission Vegetation Management	$126M	$127M	10
Self-Optimizing Grid (3yrs)	$340M	$11M	10
Total	**$7.257B**	**$812M**	

5.2.3 Florida Public Utilities

Florida Public Utilities requested approval for plan totaling $243.1M. The plan includes Distribution Overhead Feeder Hardening, Distribution Overhead Lateral hardening, Distribution Overhead Lateral Undergrounding, T&D Vegetation Management, Future T&D Enhancements, Transmission/Substation Resiliency, Transmission Inspection and Hardening, and SPP Program Management. Table 5-4 provides an overview of their SPP filing. Florida Public Utilities Plan programs include the following:

Table 5-4: Florida Public Utilities Storm Hardening Estimated Categories and Spends

Program	2022 Cost	2023 Cost	2024 Cost
Overhead Feeder Hardening	$300,000	$3.01M	$3.07M
Lateral Feeder Hardening	$60,000	$580,000	$1.01M
Lateral Undergrounding	$110,000	$1.12M	$1.67M
Distribution Inspection and Replacement	$1.2M	$1.52M	$1.62M

Transmission System Inspection and Hardening	$620,000	$620,000	$620,000
Transmission & Substation Resiliency	-	-	$9.35M
Transmission & Distribution Vegetation Management	$9.5M	$11.5M	$14M
Future Transmission & Distribution Enhancements	-	-	-
Total	**$11.81**	**$18.35M**	**$31.34M**

5.2.4 TECO

TECO requested approval for a plan totaling $1.45B for Distribution lateral Undergrounding, Substation Extreme Weather (Distribution & Transmission), Distribution Overhead Feeder Hardening, Transmission Access Enhancement, along with things like environmental management and future maintenance. Table 5-5 provides an overview of their SPP Filing.

Table 5-5: TECO Storm Hardening Estimated Categories and Spends

Program	Annual Cost	Timeframe (Years)
Distribution Lateral Undergrounding	$105M	3
Supplemental Distribution Circuit Vegetation Management	$60,200	10
Mid-Cycle Distribution Vegetation Management	$58,100	10
69kV Vegetation Management Reclamation	$2,185	1
Transmission Asset Upgrades	$53.1M	3
Substation Extreme Weather Hardening	$5M	3
Distribution Overhead Feeder Hardening	$94.8M	3
Transmission Access Enhancements	$3M	3
Wood Pole Inspections	$1.1M	10
Transmission Inspections	$430,000	10
Groundline Inspections, ground Patrol, Aerial Infrared Patrol, Above Ground Inspections, Substation Inspections	$150,000	10
Disaster Preparedness & Recovery Plan	$300,000	Annually
Distribution Pole Replacements	$82.9M	10
Total	**$345.9M**	

5.3 Louisiana

The state of Louisiana saw two storm resilience plans filed in 2022, both from Entergy. The filings were the results of two major category 4 hurricanes impacting the Entergy service territory in 2020 and 2021 (Laura and Ida, respectively). First, Entergy New Orleans enacted a grid hardening and resilience filing with the New Orleans City Council (their applicable regulator). The plan detailed nearly $1.3 billion in spending over 10 years and asserted 890 grid resilience projects were identified in the plan. These projects include distribution and transmission projects involving over 33,000 structures and 650 line-miles. The annual plan costs are shown in Table 5-6.

Table 5-6: Entergy New Orleans Resiliency Estimated Spends by Year

Year	Approx. Investment
2023	$0
2024	$20M
2025	$36M
2026	$47M
2027	$197M
2028	$200M
2029	$205M
2030	$188M
2031	$230M
2032	$154M
Total	**$1.276B**

The second filing in Louisiana was done by Entergy Louisiana, with a proposed plan capital investment for approval by the commission of approximately $5 billion for the first five years of the 10-year plan. The total 10-year plan investment level is nearly $9 billion. This plan proposes the following resilience programs, as shown in Table 5-7.

Table 5-7: Entergy Louisiana Resiliency Estimated Spends by Year and Category[27]

Year	Distribution Feeder Hardening (Rebuild)	Distribution Feeder OH to UG Conversion	Lateral Hardening (Rebuild)	Lateral OH to UG Conversion	Transmission Rebuild	Substation Control House Remediation	Substation Storm Surge Mitigation	Total
2023	$0	$0	$54,700	$0	$0	$700	$3,800	**$59,200**
2024	$48,000	$0	$252,700	$26,648	$11,800	$3,100	$16,900	**$359,148**
2025	$382,100	$0	$281,900	$68,260	$80,500	$5,000	$40,900	**$858,660**
2026	$556,200	$25,800	$257,600	$61,062	$258,400	$3,400	$51,200	**$1,213,662**
2027	$364,000	$5,800	$241,300	$29,273	$271,300	$0	$27,800	**$939,473**
2028	$532,200	$0	$269,100	$49,533	$326,900	$0	$5,000	**$1,182,733**
2029	$555,300	$0	$319,900	$42,690	$217,500	$0	$5,600	**$1,140,990**
2030	$513,300	$0	$250,000	$58,223	$226,200	$0	$5,300	**$1,053,023**
2031	$419,700	$0	$166,000	$50,045	$133,100	$0	$3,600	**$772,445**
2032	$222,100	$0	$261,900	$25,311	$12,200	$0	$0	**$521,511**
2033	$441,100	$0	$74,800	$20,403	$0	$0	$0	**$536,303**
2034	$183,900	$7,800	$15,900	$1,210	$0	$0	$0	**$208,810**
Total	**$4,217,900**	**$39,400**	**$2,445,800**	**$432,659**	**$1,537,900**	**$12,200**	**$160,100**	**$8,845,959**

Both Entergy filings proposed to recover costs through a resiliency and storm hardening cost recovery rider, to permit timely recovery of the Resilience Plan's revenue requirements due to the level and pace of spending through the plan.

5.4 New York

The state of New York has seen multiple named events in recent years, most notably Hurricane Sandy. In response, the Columbia Center for Climate Change Law filed a formal petition with the New York PSC requesting all utilities under its jurisdiction be required to develop climate change adaptation plans, which in turn led Consolidated Edison (Con Ed) to file a plan of the same name in 2014. The initial plan

[27] **Source:** Application of Entergy Louisiana, LLC For Approval of the Entergy Future Ready Resilience Plan (Phase 1), Table 8-1

investment level was $1 billion and was recoverable through its own recovery rider. This same year, a group of NGOs and academic centers were ordered by the PSC to continue the Storm Hardening and Resiliency Collaborative in the form of four working groups with the scope of addressing storm hardening design standards, alternative resiliency strategies, natural gas system resiliency and risk assessment/cost benefit analysis. Additionally, the PSC required Con Ed's commitment to conduct a Climate Change Vulnerability Study, which was performed in 2013, and again in 2019.

The New York State Senate passed Bill S4824A in 2021, which requires electrical corporations to submit a storm hardening system resiliency plan to the PSC, authorizes utility companies to petition the PSC for a waiver of reimbursement requirements, requires utility companies to reimburse customers for certain widespread prolonged outages, and prohibits utility companies from recovering costs incurred due to power outages from customers. The bill, named the Soil Health and Climate Resilience Act, went into effect in 2022 and requires utilities to perform climate change vulnerability studies by 2023. An updated plan must be filed five years after the approval of an original plan, and utilities can make an annual filing to recover costs associated with the preparation of the plan. Additionally, each utility must establish a climate resilience working group no later than 2023, and include in the group representatives from the PSC, municipalities, customer advocacy groups, and energy and environmental advocacy groups.

5.5 New Jersey

Public Service Electric and Gas (PSEG) was granted approval of the $550 million "Energy Strong" infrastructure hardening and resiliency plan in 2014 and $207 million in 2019. The cost recovery for this plan was a new recovery rider, for both gas and electric investments. The program spends by phase are detailed in Table 5-8.

Table 5-8: PSEG Energy Strong Program Investment Levels by Phase

Program	Approx. Investment
Phase 1	
Substation Flood Hardening	$400M
Grid Modernization	$150M
Phase 2	
Distribution Circuit Hardening	$100M
Communication and ADMS Upgrades	$107M
Total	**$757M**

5.6 California

California is currently executing plans to mitigate the impact of wildfires in the state. California's investor-owned utilities plan to spend over $10 billion to mitigate the risk. The investments are aimed at reducing the risk of wildfires in their service territories. These programs employ several strategies, including inspecting and repairing equipment, trimming back trees and other vegetation that could fall into power lines, and investing in grid technologies and system hardening.

5.7 Texas

In response to very disruptive natural disaster events that cause disruption throughout the midwestern portion of the United States, Texas has passed House bill 2555 that creates a new cost recovery mechanism to allow transmission and distribution investments to harden those systems. Specific rules to implement House Bill 2555 are expected from the Texas Public Utility Commission by the end of 2023.

5.8 IEEE Resilience Working Group

The Institute of Electrical and Electronic Engineers (IEEE) created a working group in 2019 dedicated to the discussion, defining, and quantification of resiliency in the electric distribution system. The group's scope includes capturing common methods and applications utilities may use prior to and following extreme natural events and/or environmental conditions to improve distribution system resiliency. The topics covered by the group include but are not limited to the following:

- System design and implementation
- Hardening Efforts
- Inspections and maintenance activities
- Response consideration
- Quantitative measurements

This group does not consider events surrounding cybersecurity or deliberate physical security attacks. The work group is comprised of 27 industry professionals, contributing to seven different chapters, with each chapter's scope as follows:

- Chapter 1: Literature Review
- Chapter 2: Resilience Goal/Objectives
- Chapter 3: High Impact Weather/Storm Event Risk Identification
- Chapter 4: Quantification of Resiliency
- Chapter 5: System Modeling and Storm Simulation
- Chapter 6: Guide for Infrastructure and Operational Improvements
- Chapter 7: Use Cases and Resiliency Study

Currently, the work group's goals through 2023 include building a consensus on resilience metrics between the following factors: common tools among utilities, common tools among research, and bringing a consensus among available data to utilities, data infrastructure, and research methods. Through 2024, the group aims to create a common framework for quantitative metrics of resilience with a focus on available data by starting a risk-benefit analysis of investments on both new infrastructure and grid hardening.

5.9 Ontario Energy Board Resilience Policy Analysis[28]

[28] https://engagewithus.oeb.ca/sectorresilience

In 2023, the Ontario Energy Board engaged London Economics International LLC to analyze and define resilience and explore related policy questions as they apply to electric distributors in Ontario. The result was a comprehensive report "Resilience in the electricity distribution sector and related policy questions" that outlined an initial road map that could be used to guide strategy and tactics related to resilience initiatives aimed at mitigating threats to the electrical distribution system. While the report concludes that resilience investment are warranted to best serve the needs of electrical customers and financial justification should be required before specific investments are funded, it leaves some key elements unresolved around the areas of the appropriate evaluation framework, the funding mechanism to support resilience investment, and how to measure the effectiveness of the investments after implemented.

6.0 RESILIENCE INVESTMENT MODEL

Hydro Ottawa and 1898 & Co. utilized a resilience-based planning approach to identify, prioritize, and perform a business case for resilience investment in the distribution system. The resilience-based planning approach utilizes 1898 & Co.'s Resilience Investment Model. The Resilience Investment Model leverages the Conceptual Resilience Framework outlined in Section 2.0 and was designed based on the guiding principles outlined in Section 4.1. The model takes the "theory" of the frameworks and develops an actional investment plan that prioritizes resilience investments based on available data, analytics models, and a business case methodology. The approach calculates the resilience improvement at the asset, project, and program level. For the purposes of this evaluation, resilience benefits for projects are estimated from a customer centric perspective. The customer benefits are shown in terms of the:

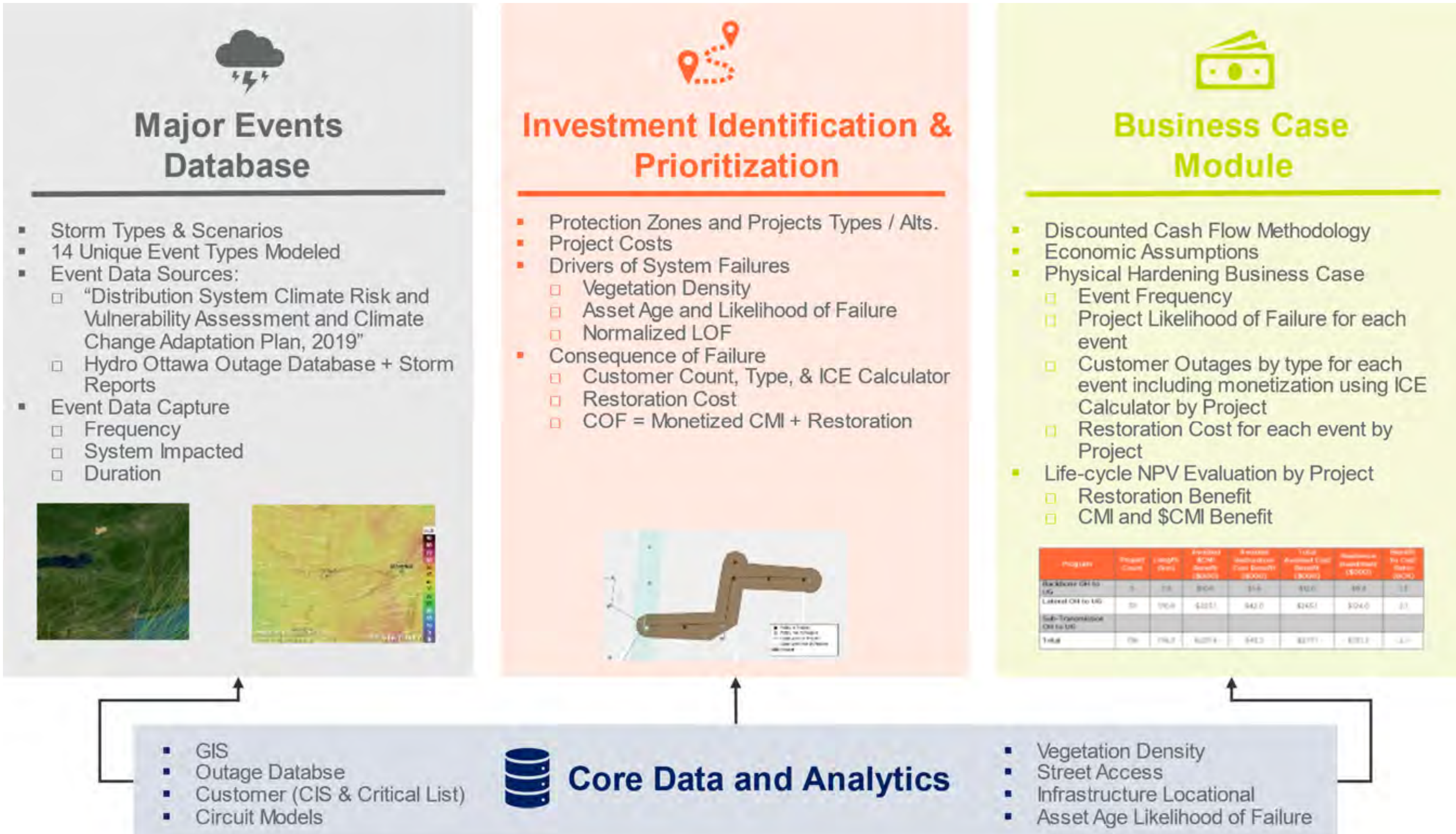
1. Decrease in the Event Restoration Costs
2. Decrease in the customers impacted and the duration of the overall outage, calculated as CMI and monetizing the CMI (discussed in Section 6.2)

The Resilience Investment Model employs a data-driven, decision-making methodology using robust and sophisticated algorithms to calculate the resilience benefits. The following sections provide an overview of the model, the approach to monetizing customer outages, and why modeling using this approach is important and necessary.

6.1 Resilience Investment Model Overview

Figure 6-1 provides an overview of the Resilience Investment Model to identify and prioritize hardening investments and calculate their customer centric business case.

Figure 6-1: Resilience Investment Model Overview



6.1.1 Core Data and Analytics

The Resilience Investment Model is foundationally data centric. It utilizes Hydro Ottawa enterprise data sources as well as external sources. From an internal enterprise perspective, the model utilizes Hydro Ottawa's Geospatial Information System (GIS) for the collection of assets and their attributes (age, type, etc.). This allows the resilience-based planning approach to be asset-centric. The model also utilizes Hydro Ottawa's Outage Database to understand the relationships between protection devices and the types of outage events, particularly larger events. The third core enterprise data set includes information from the Customer Information System (CIS). The fourth core dataset includes Hydro Ottawa distribution circuit models. 1898 & Co. linked these datasets to create the relationship between assets and customers and customer types. This allows the resilience-based planning approach to be customer-centric.

1898 & Co. also leveraged external data sources for the evaluation linking them to the internal data sources. The external data sources included satellite tree canopy for vegetation density analysis, and age deterioration analytics from 1898 & Co. own proprietary modeling. These external sources provided valuable information in identifying infrastructure that would more likely fail during events.

6.1.2 Major Event Database

Since the magnitude of the restoration cost decrease and CMI decrease is dependent on the frequency and magnitude of future major events that may impact the Hydro Ottawa service area, the Resilience Investment Model starts with the 'universe' of major weather events that could impact Hydro Ottawa's service area. The Major Event Database provides the high-level impact to the system of the storm stressor. The major events database includes the following:

- Event Type
- Frequency of an event occurring
- Percentage of the system impacted
    - Sub-Transmission Protection Devices
    - Backbone Protection Devices
    - Lateral Protection Devices

- Duration of the event
- Restoration Cost

6.1.3 Investment Identification

The Investment Identification develops the list of potential underground hardening projects and their costs. The evaluation is comprehensive in evaluating nearly the entire system. Underground hardening investments are defined based on a customer-centric perspective at the protection zone level for distribution circuits. The module also estimates the costs for each of the projects.

6.1.4 Resilience Business Case Module

The Resilience Business Case Module calculates the business case for each project with total benefit per dollar invested from the Investment Identification Module. The business case is based on a discounted cash flow methodology over a 50-year time horizon. The business case for each project is a sum of the avoided reactive costs and avoided monetized customer outages for each of the events within the Major Events Database.

The output of the Resilience Business Case Module is:

- Resilience Business Case for highest resilience improvement projects
  - Project Cost and High Level Scope
  - Life-Cycle Net Present Value (NPV) Benefits
  - Benefit to Cost Ratio (BCR)

6.2 Societal Impacts & Monetizing Outages

Society's reliance on electricity continues to expand from one decade to the next. This includes the increasing number of connected devices, aging in place, working from home, and electrification to highlight some of the more obvious drivers of an increased reliance on the grid. Section 3.2 provides further discussion of the many societal impacts tied to the loss of electrical power. From a customer's perspective, there is a real impact to their lives, and these impacts should be considered and factored into the development of a business case for each proposed resiliency project. .

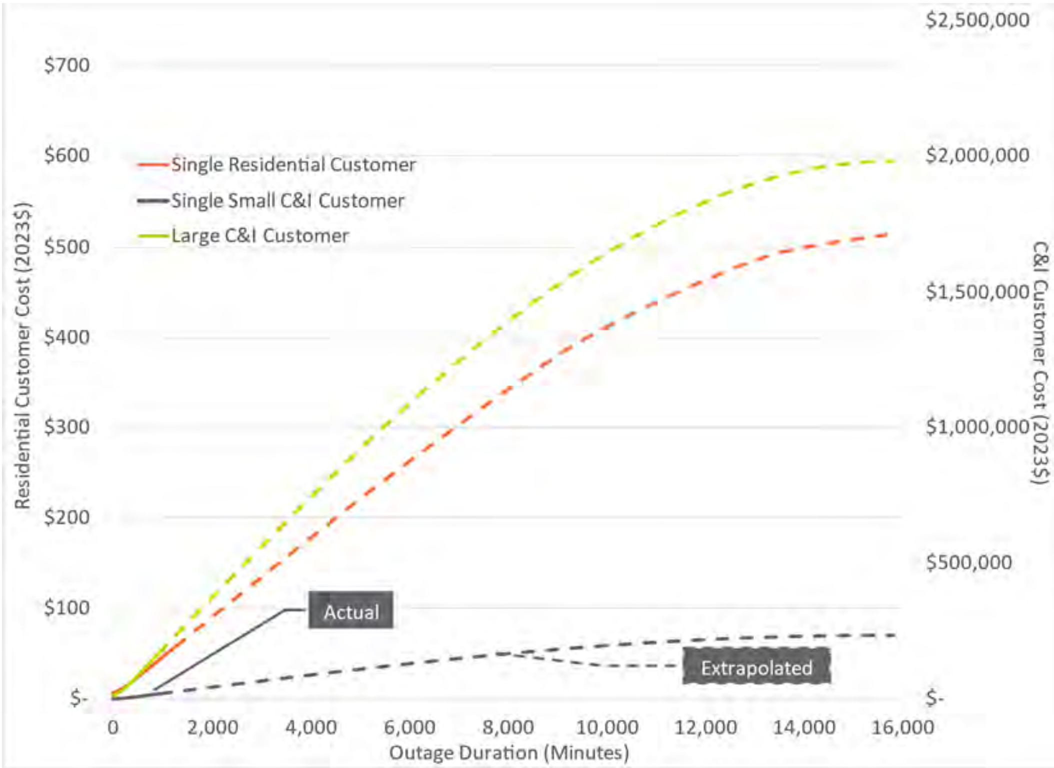
The DOE ICE calculator provides a third-party independent estimate of the value of eliminating or partially mitigating an outage. While there are some known deficiencies that generally result in underestimating the monetized customer impact, it is still the most recognized and utilized approach for the monetization of customer outages.

The ICE Calculator is an electric reliability planning tool developed by Freeman, Sullivan & Co. and Lawrence Berkeley National Laboratory. This tool is designed for electric reliability planners at utilities, government organizations, or other entities interested in interruption costs and/or the benefits associated with reliability improvements in the United States. The ICE Calculator was funded by the Office of Electricity Delivery and Energy Reliability at the DOE.

The value of interruption costs within the calculator are based on customer surveys from 15 research efforts conducted by 10 utility companies resulting in 34 different data sets totaling over 105,000 observations from 1989 to 2012. Greater than 44 thousand Medium to Large C&I customers, greater than 27 thousand small C&I customers, and over 34 thousand residential customers. The developers of the ICE calculator have also noted significant advancements in societal use of devices and other technologies including a higher number of people working from home. With most of the surveys being done before these advancements in the last 10 to 15 years, the developers of the ICE Calculator consider the current cost of interruptions to be conservative. The developers of the calculator have received additional funding to update the surveys which would reflect these key changes, especially the value of interruptions in a post-pandemic society. As this update will not be reflected until 2024, this business case evaluation does not attempt to normalize the ICE Calculator for these factors, rather the evaluation utilizes the result directly from the current calculator to be conservative.

The calculator includes the estimated interruption costs for residential, small commercial and industrial (C&I), and large C&I customers for a range of durations. The calculator was extrapolated for the longer outage durations for storm-based outages. Figure 6-2 shows the cost of interruptions for New York (closest US state to Ottawa) customers for each customer class in Canadian dollars. The figure also shows the extrapolation for longer outages. Hence a customer interruption monetized value can be derived for an outage of any duration for each of the listed customer classes.

Figure 6-2: ICE Calculator Monetized Cost of Outage Summary



6.3 Resilience Investment Model – 'The Why'

The Resilience Investment Model was designed and developed for the purpose of identifying and ranking T&D resilience investments to provide the most benefit for customers. For Hydro Ottawa, it was utilized only for the distribution system. The resilience-based planning approach described within this report are appropriate to model resilience investment for the following reasons:

- **Event-Based -** The benefits of resilience projects are wholly dependent on the number, type, and overall impact of future events to impact the region served by Hydro Ottawa. Different events have dramatically different impacts to Hydro Ottawa's distribution system. For this reason, the resilience-based planning approach includes 14 different potential major events that could impact Hydro Ottawa over the next 50 years capturing event forecasts provided within the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan" produced by Stantec Consulting Ltd. (additional details in Section 8.0) and Hydro Ottawa's outage records. The evaluation is not limited to only recent events to minimize recency bias, but rather includes data going back 170 years.

- **Asset and Root-Caused Focused -** Major events cause assets to fail, and assets collectively serve customers. Moreover, it only takes one asset failure to cause customer outages. The cost to restore the failed assets is dependent on the extent of the damage and resources used to fix the system. The duration to restore affected customers is dependent on the extent of the asset damage and the extent of the damage on the rest of the system. It may only take 4 hours to fix the failed equipment, but customers could be without service for 4 days if crews are busy fixing other parts of the system for 3 days and 20 hours. All of this is dependent on the type of storm to impact the system. Modeling this series of events for the entire system at the asset and project level for both a "Status Quo" and "Hardened" scenarios is needed to accurately model resilience project benefits. Therefore, the resilience-based planning approach calculates the phases of asset and project resilience for each of the 14 storm events for both scenarios.
- **Data-Centric -** By breaking down the entire distribution system by protection zone, the resilience-based planning approach is foundationally data centric and links the appropriate assets to each possible resiliency project. The model utilizes Hydro Ottawa's GIS, outage database, CIS, distribution circuit models, and critical customer information. It also utilizes satellite tree canopy data and road layers.
- **Customer-Centric -** By breaking down the entire distribution system by protection zone, the resilience-based planning approach is foundationally customer centric. Each protection zone has a known number of customers and type of customers such as residential, small or large commercial and industrial, and critical customers. The objective is to harden each asset that has a higher risk of failing, which would result in a customer outage. Since only one asset needs to fail downstream of a protection device to cause a customer outage in that zone, failure to harden all the necessary assets still leaves vulnerable

components that could potentially fail in an event. Rolling assets into projects at the protection device level allows for hardening of all vulnerable components in the project zone and for capturing the full benefit for customers.

- Granular - The granularity at the asset and project levels allows Hydro Ottawa to invest in portions of the system that provide the most value to customers from both a restoration cost reduction and avoided CMI perspective. For example, a circuit may have 10 laterals that come off a feeder, and the resiliency investment model may determine that only 3 out of the 10 should be hardened. Without this granularity, a suboptimal or inefficient level of investment could occur. The adopted approach provides confidence that the final overall plan is investing in parts of the system that provide the most value for customers.
- Comprehensive - The approach is comprehensive and evaluates nearly all of the assets on Hydro Ottawa's distribution systems. By considering and evaluating those systems on a consistent basis, the results of the final underground hardening plan provide confidence that portions of Hydro Ottawa's distribution assets are not overlooked for potential resilience benefit.
- Business Case Foundations - The output of the model is the resilience benefit of each project for each of the 14 storm types. The life-cycle resilience benefit for each resilience project is dependent on the probability of each storm and the mix of storm events to occur over the life of the resilience projects. A project's resilience value comes from mitigating outages and associated restoration costs not just for one storm event, but from several over the life-cycle of the assets. For this evaluation, the future of major storm events is assumed to be equal to the historical frequency based on 170 years of weather data. The number of storm scenarios is significant given there are 14 unique types of storm events that could impact grid infrastructure.
- Consistency: The model calculates benefits consistently for all projects. The model carefully normalizes for more accurate benefits comparison between asset types. For example, the model can compare an overhead rebuild resilience project to a lateral undergrounding project to a distribution

automation project. This is a significant achievement allowing the assessment to accurately compare a wide range of investment types.

- Drives Prudency: The assessment and modeling approach drives prudency for the final comprehensive hardening plan on two main levels. First, the granularity of potential resilience projects allows Hydro Ottawa to invest in the portions of the system that provide the most value to customers. Without granularity, there is risk that parts of the system "ride the coat-tails" of needed investment causing inefficient allocation of limited capital resources. Secondly, the customer-centric financial justification of project investments allows Hydro Ottawa to prioritize investments that provide significant customer 'bang for buck'.

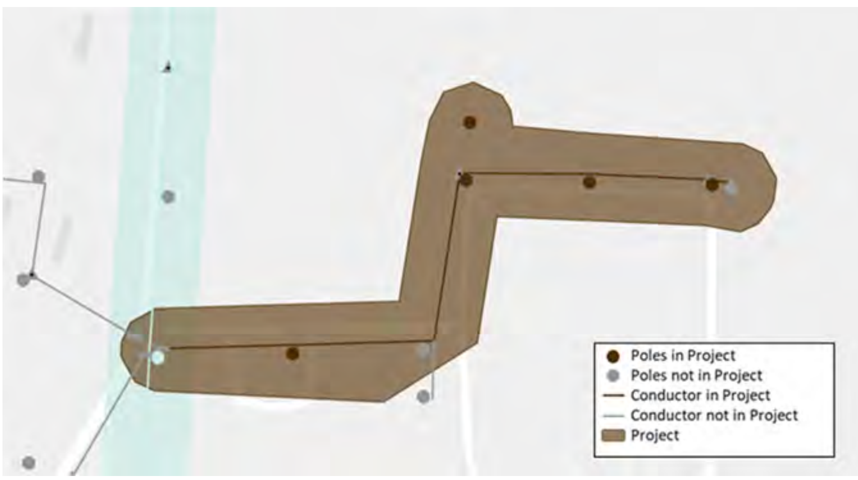
7.0 CORE DATA AND ANALYTICS

The resilience-based approach and methodology is data driven. This section outlines the core data sets and base algorithms employed within the Resilience Investment Model. This section includes both data from Hydro Ottawa's systems and external data sources.

7.1 Geographical Information System

The GIS provides the list of assets in Hydro Ottawa's system and how they are connected to each other. Since the resilience-based approach is fundamentally an asset management bottom-up based methodology, it starts with the asset data, then rolls all the assets up to projects, and all projects up to programs, and finally the programs up to the Resilience Investment Plan. The relationship between assets and projects is illustrated in the geospatial figure below.

Figure 7-1: Asset to Project Relationship



The Resilience Investment Plan created by 1898 & Co. only modeled overhead to underground projects, therefore all underground assets were removed from the evaluation. The existing underground system makes up 56% (3,463 km) of the total length of primary conductor. In addition to removing underground assets 22% (600 km) of overhead conductor was excluded from review for being 4 kV conductor which was outside the scope of this project.

In alignment with this methodology, 1898 & Co. utilized the connectivity within Hydro Ottawa's GIS to link each distribution voltage asset up to a lateral (fuse protection device) or feeder (breaker or recloser protection device). This linkage of assets to protection zones provides a granular evaluation of the distribution system that allows projects to be created to target only portions of a circuit for resilience investment. Through this approach, 1898 & Co. was able to use the asset level information from Table 7-1 and convert it to the project level summaries in Table 7-2. It is important to note that each asset in Table 7-1 is tied to one of the projects listed in Table 7-2, which provides a bottom-up analysis.

Table 7-1: Hydro Ottawa Asset Base

Asset Type	Units	Value
Sub-Transmission Circuits	[count]	72
Poles / Structures	[count]	3,387
Conductor Length	[kilometers]	312.5
Distribution Circuits (OH)	[count]	203
Feeder Poles	[count]	20,916
Lateral Poles	[count]	14,577
Feeder OH Primary	[kilometers]	1,178
Lateral OH Primary	[kilometers]	644

Table 7-2: Projects Created from Hydro Ottawa Data Systems

Count	Program	Project Count
1	Backbone OH to UG	324
2	Lateral OH to UG	1,338
3	Sub-Transmission OH to UG	81
	Total	1,743

7.2 Outage Database

The outage database includes detailed outage information by cause code for each circuit and protection device over the last 11 years. The Storm Resilience Model utilized this information to understand the historical storm related outages for the various distribution laterals and feeders on the system.

7.3 Customer Type Data

Hydro Ottawa provided customer count and type information with database relationships to the GIS and OMS. Using connectivity from the distribution circuit to the breaker, the customer relationship to the substation was also established. This data allowed the Resilience Investment Model to directly link the number and type of customers impacted to each protection device. Types of customers include residential, small C&I, and large commercial and industrial. This customer information is used in concert with the estimated event duration to estimate the CMI for each project which is monetized using the DOE ICE Calculator. This is foundational for the customer-centric business case approach. Figure 7-2, Figure 7-3, and Figure 7-3 show the customer counts for trunk backbone, lateral and subtransmission protection zones.

Figure 7-2: Customers by Backbone Protection Device

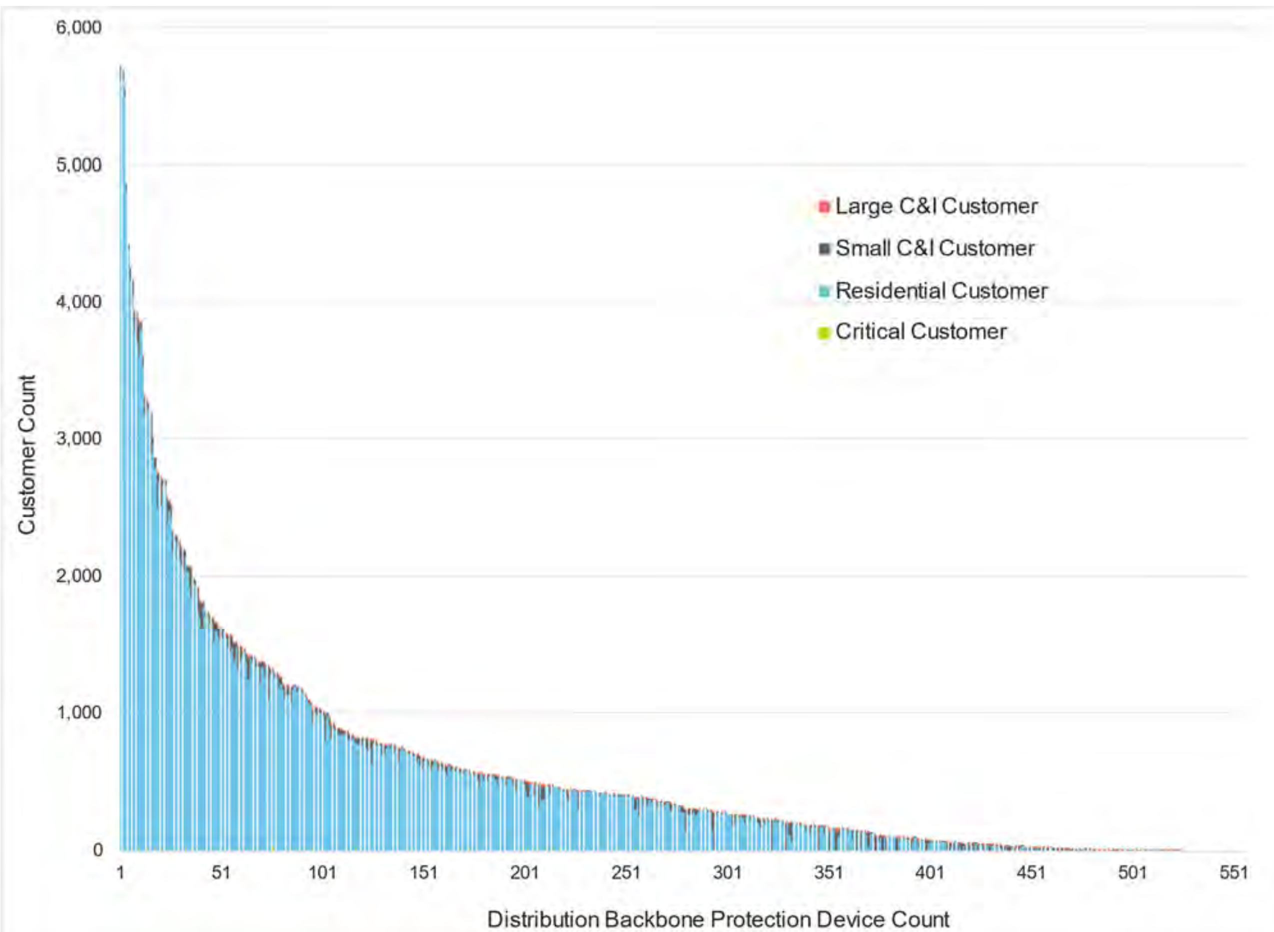


Figure 7-3: Customers by Lateral Protection Device

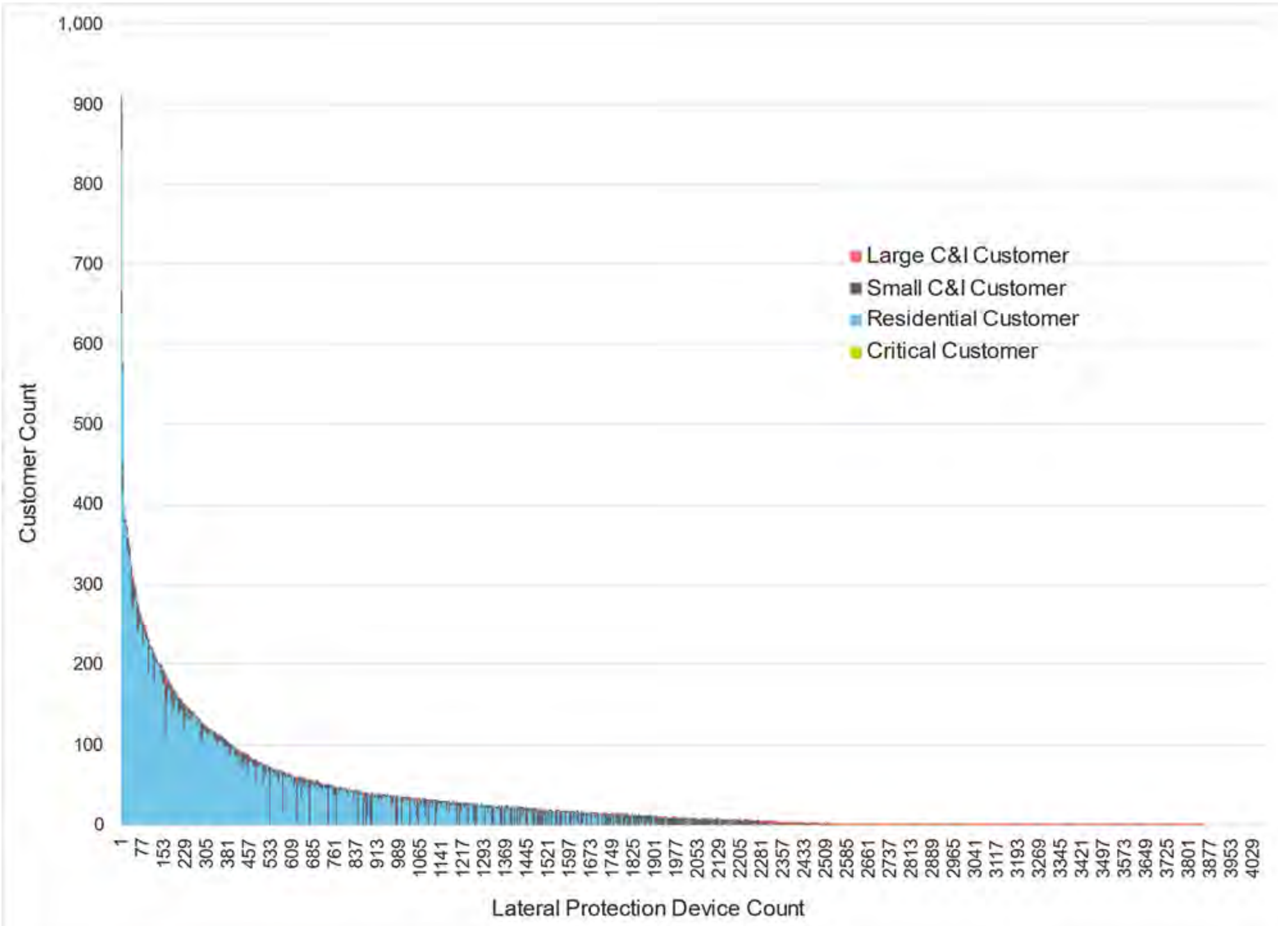
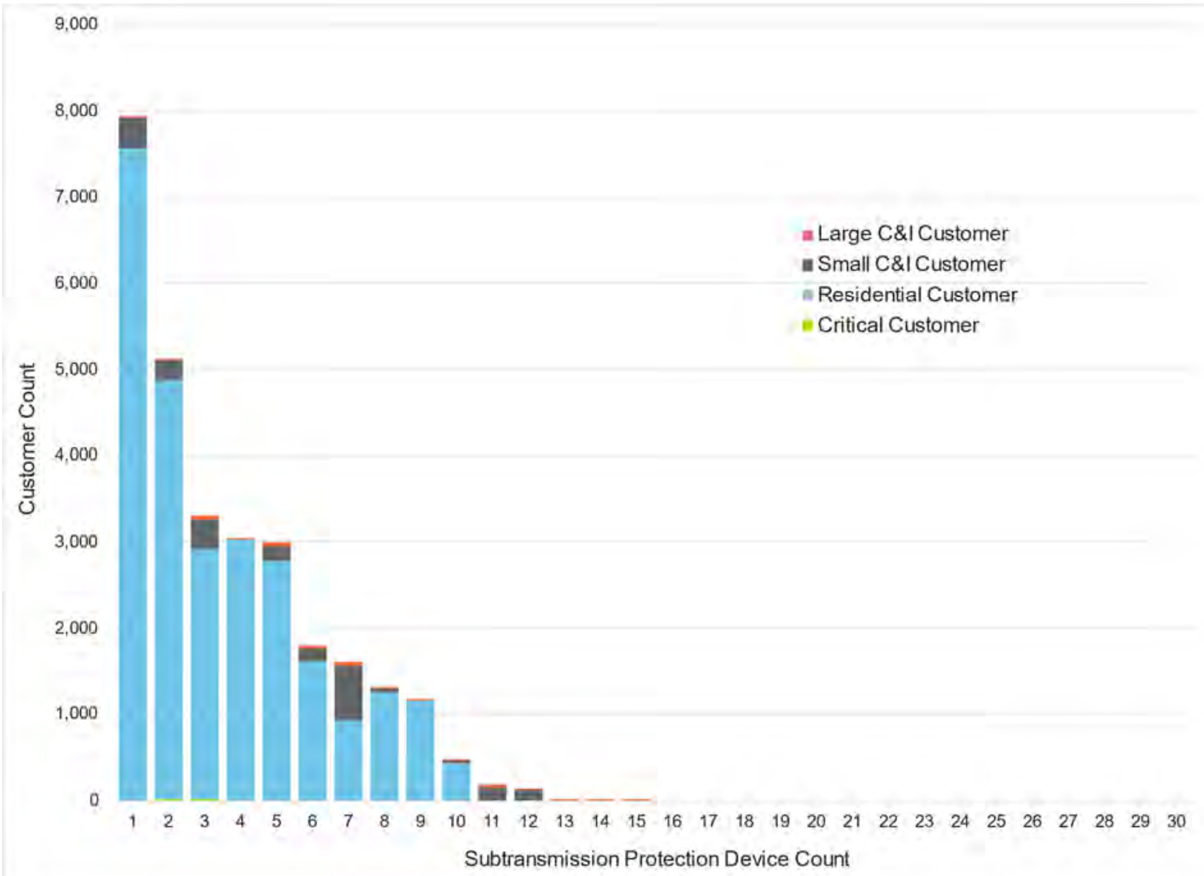


Figure 7-4: Customers by Subtransmission Protection Device



7.4 Vegetation Density Algorithm

The vegetation density for each overhead conductor is a core data set for identifying and prioritizing resilience investment for the circuit assets because vegetation, both inside and outside of the trim zone, blowing into conductor is a significant cause of outages during major storm events. The Resilience Investment Model calculates the vegetation density around each distribution overhead conductor. The model utilizes satellite tree canopy data to calculate the percentage of vegetation within the entire Hydro Ottawa system. The ± 6 meters on either side of the conductor is indicative of the vegetation density on the system from a major storm perspective. For each span of conductor (approximately 54,466) a vegetation density is assigned based on the vegetation density surrounding the conductor. This information is used to identify the portions of the system most likely to have an outage for each type of storm.

Figure 7-5 shows the range of vegetation density for OH Primary. The figure ranks the conductors from highest to lowest level of vegetation density. As shown in the figure, approximately 20 percent of the conductor spans (not weighted by length) for OH Primary have near zero tree canopy coverage, while approximately 60 to 70 percent have some level of coverage all the way up to 90 percent coverage.

Figure 7-5: Vegetation Density on Hydro Ottawa Primary Conductor

7.5 Age

As poles age, they lose some of their original design strength. Therefore, aged poles (all else equal) will fail at lower dynamic load levels than poles with their original design strength. The Resilience Investment Model utilizes 1898 & Co.'s asset management solution, AssetLens Solutions, to estimate the age based LOF for each wood pole and structure. 1898 & Co.'s AssetLens Solutions utilizes industry standard survivor curves with an asset class expected average service life and the asset's age to estimate the age based LOF over the next 10 years.

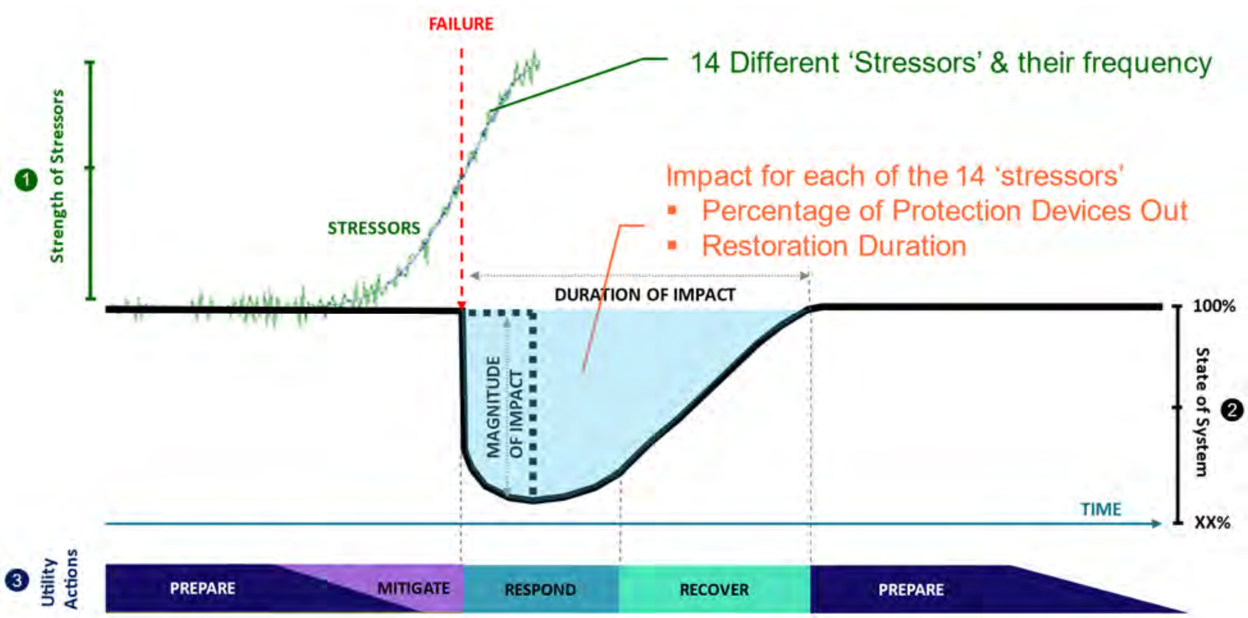
7.6 Accessibility

The accessibility of an asset has an impact on the duration of the outage and the cost to restore that part of the system. Rear lot structures take much longer to restore and cost more to restore than front lot structures. To take differences in accessibility into account, the Resilience Investment Model performs a geospatial analysis of each structure against a data set of roads. Structures within a certain distance of the road were designated as having roadside access; others were designated as in the deep right-of-way (ROW). This designation was used when calculating restoration and resilience project costs in the Resilience Investment Model. Approximately 73 percent of the Hydro Ottawa structures have road access while 27 percent are in the deep right-of-way.

8.0 MAJOR EVENT ('STRESSORS') DATABASE

The first component of the Resilience Investment Model is the Major Storms Event Database. The database includes the probabilities for each of the events as well as range of impacts to the distribution system while also outlining the duration and customers impacted. Figure 8-1 shows the Major Event Database within the Resilience Framework. The database outlines from a top-down perspective the type of events that impact the grid, their frequency, and high-level impact.

Figure 8-1: Resilience Framework & Major Events Database



This section describes the data sources and approach used to develop the database. Since the benefits of resilience projects are directly related to the frequency and impact of major storm events, the resilience-based planning approach starts with developing the range and frequency of storm types that could impact Hydro Ottawa's service area.

8.1 Event Database Evaluation

1898 & Co. reviewed several event data sources to determine the range of major events and the future frequency of events to impact the Hydro Ottawa service territory.

8.1.1 Event Database Review

The National Oceanic and Atmospheric Administration (NOAA) includes a database of major named-storm events over the past 170 years, beginning in 1852. The database includes Category 1 through 5 hurricanes, Tropical Storms, and Tropical Depressions. This database was mined to evaluate the different types and frequency of major storms to impact the Hydro Ottawa service area.

NOAA also includes a database of non-named major storm events over the past 26 years, beginning in 1996. The database includes the rain, wind and winter types of storm types organized by high-level and low-level types. Unlike the hurricane data that reports storm paths, these events are recorded at the county or sub-county level. 1898 & Co. mined this data for Saint Lawrence County in New York which was very close to the Hydro Ottawa service territory.

Additional relevant information is an update to the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019". Hydro Ottawa retained Stantec Consulting Ltd. (Stantec) to provide an independent third party assessment to better understand system risk posed by weather events. Within the report forecasts were developed based on both historical frequencies and also proposed climate change forecasts. This provides a basis for helping to develop a resilience strategy for two different risk tolerance levels. One with a 50 year forecast based on historical frequencies and one based on an independent climate change forecast. This can be helpful information to discern the appropriate level of investment as part of a resilience plan to appropriately mitigate resilience risks associated with weather events. 1898 & Co. utilized the study forecasts to understand storm types and frequencies that have the largest impact on the Hydro Ottawa service territory.

Hydro Ottawa's Outage database characterizes some outages as a Major Event Day (MED). The database also includes the duration, cause, date, and customer impact for each outage listed. 1898 & Co. mined this data for frequency and impact of major event days that impacted the Hydro Ottawa service territory.

8.1.2 Event Database Considerations and Selection

1898 & Co reviewed multiple weather event data sources as part of the evaluation. Each data set contained unique information pertaining to the frequency and strength of various weather events. However, after reviewing NOAA major named storms, non-named events, and the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan", 1898 & Co. determined the weather forecasts contained in the study provided the best basis for evaluating the business case for converting overhead sub-transmission and distribution lines to underground. While NOAA provided some regional insights, the data was not specific for Ottawa as the focus is generally contained to the United States. In contrast the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan" was commissioned by Hydro Ottawa and specific to Hydro Ottawa' service territory. Therefore, the alignment to the Hydro Ottawa outage data was better than other event data sources.

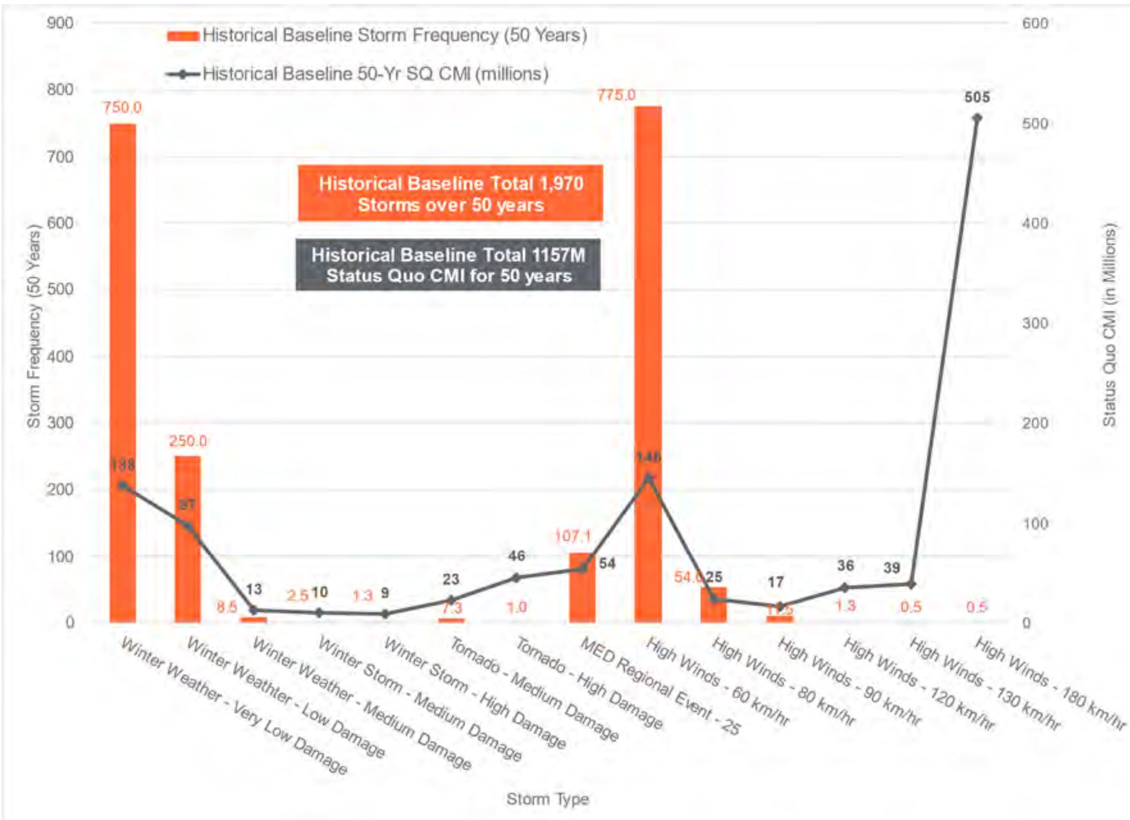
8.2 Major Event Forecast

One of the critical elements of the Major Event Database is the frequency and severity of the storms' impact on the system. As outlined in Section 8.1 the basis for frequency and severity comes from the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019". 1898 & Co. then did analysis for both the baseline historical and climate change forecasted frequencies in the evaluation.

8.2.1 Baseline Historical

Historical frequencies were put together by Stantec using external data sources as outlined in the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019". Figure 8-2 shows the frequency forecasted for each storm type over the next 50 years in orange and the status quo (SQ) CMI value for each storm type over the next 50 years in grey that was used in the Resilience Investment Model. The figure shows the storm with the highest CMI impact, High Winds – 180 km/hr, has some of the lowest frequencies in the next 50 years with a 50% chance of that size storm hitting in the next 50 years. While this is a high impact low probability event, 2022 demonstrated that the threat is credible and real.

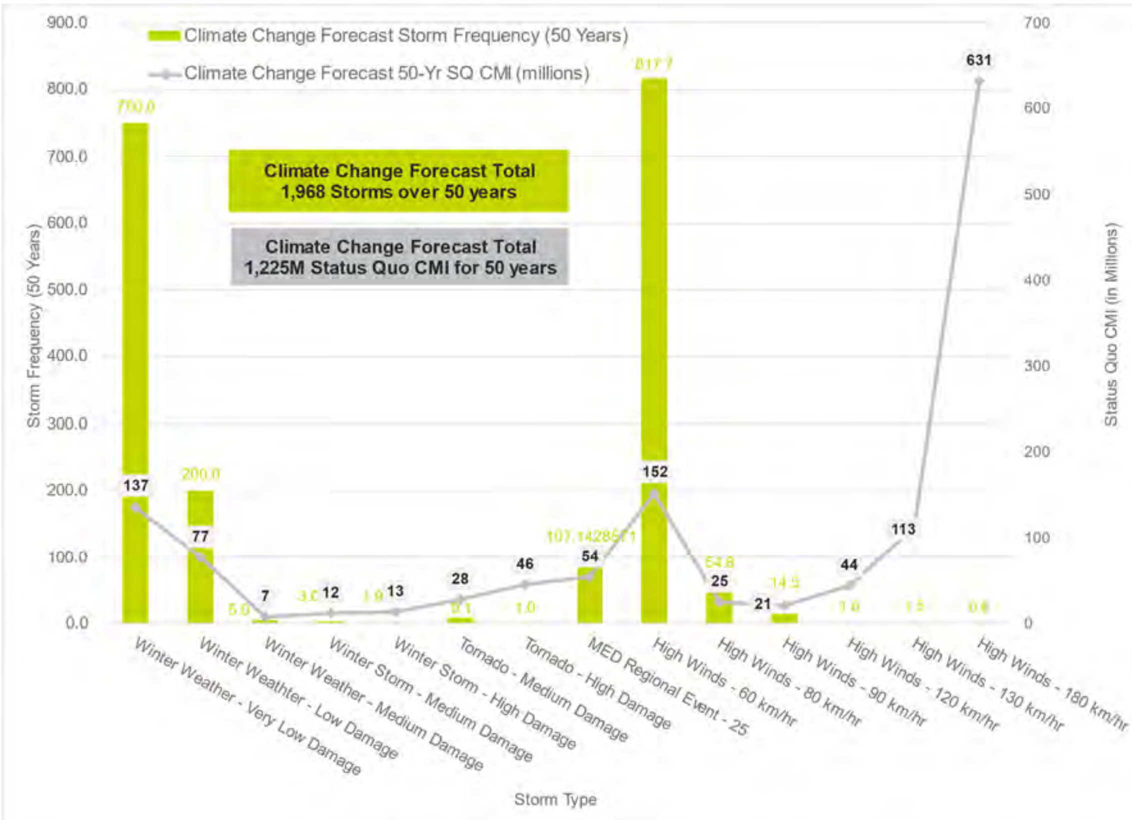
Figure 8-2: Baseline Historical 50 Year Storm Frequency and SQ CMI



8.2.2 Climate Change Forecast

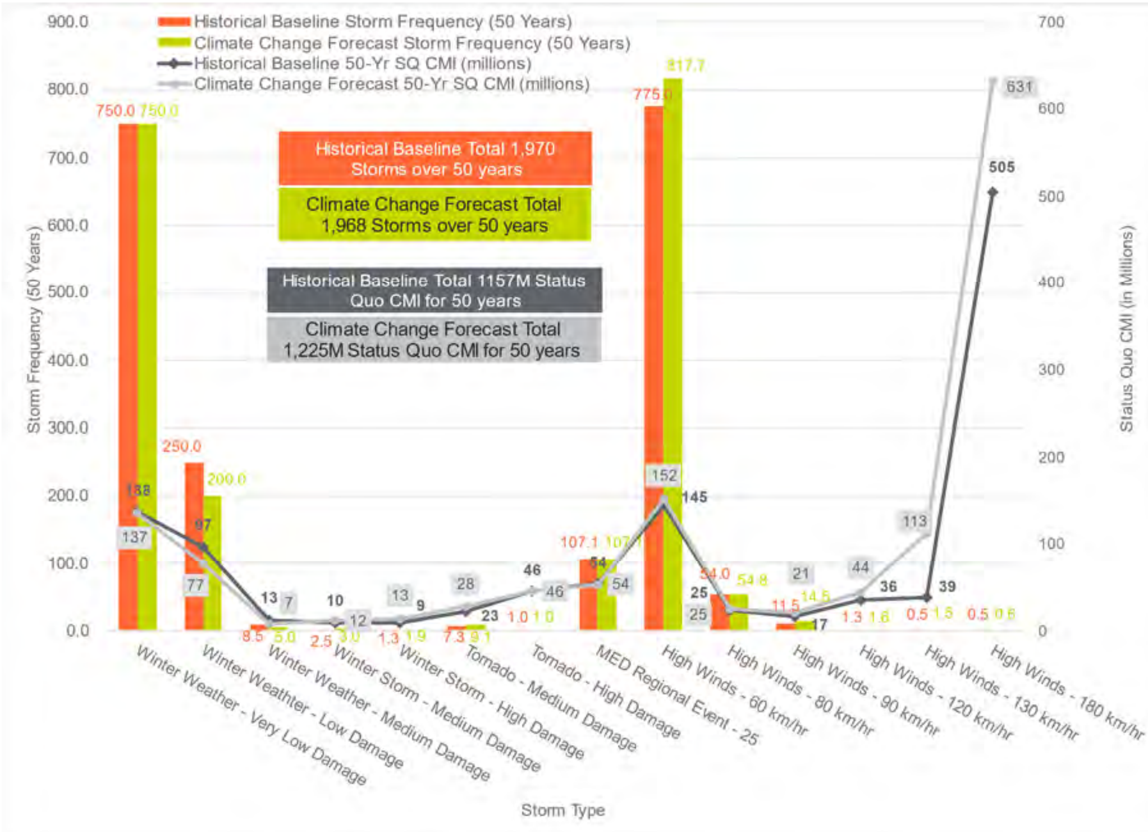
Climate change forecasted frequencies were put together by Stantec using external data sources as outlined in the "Distribution System Climate Risk and Vulnerability Assessment and Climate Change Adaptation Plan, 2019". Figure 8-3, similar to Figure 8-2 for the baseline historical frequencies, shows the frequency of each storm type over the next 50 years in green and the status quo CMI value for each storm type over the next 50 years in light grey that was used in the Resilience Investment Model.

Figure 8-3: Climate Forecast 50 Year Storm Frequency and SQ CMI



The figure shows a very similar trend and outcome as seen in Figure 8-2 with the historical data. A comparison of the two forecasts is shown in Figure 8-4. In Figure 8-4 the estimated storms to hit in the next 50 years according to historical baseline is 1,970. According to the climate change forecast storm frequency, it is estimated to be less with 1,968 as the winter weather storms are on a slight downward trend. However, there is an estimated 68M CMI increase in the climate change forecast as higher impact storms are forecasted to be more frequent.

Figure 8-4: Baseline Historical 50 Year Storm Frequency and SQ CMI



8.3 Hardening Investment Types

In developing the types of hardening and resilience investments to include in the evaluation, 1898 & Co. leveraged the following:

- Current state of the Hydro Ottawa system and types of impact to customers based on operational experience.
- Balance of investment strategies to improve system resilience: resistance, absorptive capacity, and recoverability (see Section 4.3). Additionally, how various investment types would provide benefits on 'blue-sky' days.
- Types of events to impact the Hydro Ottawa service territory (see Section 8.0).
- Types of resilience investments other utilities within North America are making (see Section 5.0).
- Feedback from utilities on recent evaluation of recent major events.

Based on these items, Hydro Ottawa and 1898 & Co. identified the following investment types to include in the evaluation:

- Trunk / Backbone Hardening - converting overhead to underground. OH undergrounding for each protection zone is based on the level of vegetation density around the infrastructure.
- Lateral or Tap – converting overhead to underground. OH rebuilding or undergrounding for each protection zone is based on the level of vegetation density around the infrastructure and if the infrastructure has street access.
- Sub-Transmission Hardening - converting overhead to underground.

8.4 Major Events Database Overview

Table 8-1 shows the Major Events Database included within the Resilience Investment Model. The database includes 14 event types, the expected future annual frequency, and the impact of the event. The impact of the event is characterized by the percent of the sub-transmission, backbone, and lateral protection devices out and the duration to restore those devices. The database is sorted by the highest percentage of laterals protection devices out. It is based on the data sources and assessment described above.

Table 8-1: Major Events Database

Even t No.	Major Event Type (Impact Level & Distance)	Annual Future Frequency (Historical Baseline)	Annual Future Frequency (Climate Forecast)	Percent of Protection Devices Out		Outage Duration (Minutes)	
				Backbone / Sub-T	Lateral	Backbone / Sub-T	Lateral
1	High Winds - 180 km/hr	0.01	0.01	28.39%	49.69%	13,500	17,190
2	High Winds - 130 km/hr	0.01	0.03	4.87%	9.30%	1,600	3,300
3	Tornado - High Damage	0.02	0.02	3.04%	5.17%	1,350	2,750
4	High Winds - 120 km/hr	0.03	0.03	1.81%	3.88%	1,350	2,750
5	Winter Storm - High Damage	0.03	0.04	0.23%	1.94%	1,350	2,750
6	Winter Storm - Medium Damage	0.05	0.06	0.13%	1.29%	1,400	3,000
7	High Winds - 90 km/hr	0.23	0.29	0.13%	1.29%	750	1,200
8	Winter Weather - Medium Damage	0.17	0.10	0.13%	1.29%	830	1,190
9	Tornado - Medium Damage	0.15	0.18	0.13%	1.29%	1,200	1,700
10	MED Regional Event - 25	2.00	2.00	0.06%	0.32%	830	1,190
11	High Winds - 80 km/hr	1.08	1.10	0.06%	0.26%	830	1,190
12	Winter Weather - Low Damage	5.00	4.00	0.06%	0.19%	500	1,400
13	High Winds - 60 km/hr	15.50	16.35	0.03%	0.13%	207	1,350
14	Winter Weather - Very Low Damage	15.00	15.00	0.03%	0.13%	165	1,315

9.0 INVESTMENT IDENTIFICATION & PRIORITIZATION MODULE

The Investment Identification and Prioritization Module develops the list of potential resilience projects, their costs, then prioritizes them based on the benefit cost ratio. The evaluation is comprehensive in evaluating nearly the entire system. Hardening investments are defined based on a customer-centric perspective at the protection zone level. The module also estimates the costs for each of the projects. The prioritization of each project is based on their benefit cost ratio. The results of the module are:

- Project scope and cost
  - Original pole count
  - Length of under grounding (km)
  - Estimated overhead to underground project cost (Can 2023$)
- Project Benefits
  - 50 year CMI reduction
  - Monetized CMI (50 year PV)
  - Restoration savings (50 year PV)

9.1 Evaluated System for Resilience Investment

The Resilience Investment Model is comprehensive in that it evaluates nearly all of Hydro Ottawa's overhead distribution system. Table 9-1 shows the asset types and counts included in the Resilience Investment Model.

Table 9-1: Hydro Ottawa Asset Base Modeled

Asset Type	Units	Value
Sub-Transmission Circuits	[count]	72
Poles / Structures	[count]	3,387
Conductor Length	[kilometers]	312.5
Distribution Circuits (OH)	[count]	203
Feeder Poles	[count]	20,916
Lateral Poles	[count]	14,577
Feeder OH Primary	[kilometers]	1,178
Lateral OH Primary	[kilometers]	644

9.1.1 Distribution Projects Identification

For distribution projects, assets were grouped by their most upstream protection device, which was either a breaker, recloser, or a fuse. This approach focuses on reducing customer outages. The objective is to harden each asset that could fail and cause a customer outage. Since only one asset needs to fail downstream of a protection device to cause a customer outage, failure to harden all the necessary assets still leaves vulnerable components that could potentially fail in an event and result in an outage. Rolling assets into projects at the protection device level allows for hardening of all vulnerable components in the circuit and for capturing the full benefit for customers including avoidance or mitigation of an outage.

For distribution circuit projects (laterals and feeders), undergrounding was the hardening option considered. Overhead hardening rebuilds are generally lower cost than undergrounding projects, but they generally provide fewer resilience benefits than undergrounding since the hardened overhead infrastructure is still exposed to wind and debris from vegetation and other materials.

9.1.2 Sub-Transmission Project Identification

The 44 kV and 13 kV sub-transmission circuits primarily supply distribution substations and large customers. Sub-Transmission circuits behave more like transmission than distribution since they are often looped and built with redundancy. However, very damaging events like very high damage thunderstorms and named storms cause enough damage to several circuits leaving 10,000+ customers without power. Due to the looped nature of the sub-transmission system, rebuilding smaller protection zones is not an option, and the entire sub-transmission circuit must be considered for resilience hardening.

9.1.3 Potential Resilience Projects Evaluated

Table 9-2 contains a list of potential resilience projects based on the methodology outlined above. Section 9.3 outlines the approach to selecting the resilience projects that provide the most value to customers from a perspective of reducing both restoration cost and CMI.

Table 9-2: Potential Resilience Projects Included in Evaluation

Count	Program	Project Count
1	Backbone OH to UG	324
2	Lateral OH to UG	1,338
3	Sub-Transmission OH to UG	81
	Total	1,743

For the resilience evaluation, 1898 & Co. evaluated each protection zone as independent from others. In other words, 1898 & Co. assumed each electrically connected protection zone was not physically connected to another protection zone on shared structures. Given the complexities of shared infrastructure within the GIS models, this simplifying assumption was made.

9.2 Project Cost

Project costs were estimated for the projects in the Resilience Investment Model. Project costs were estimated using the asset level data within the Resilience Investment Model to estimate scope (length and project type: lateral, backbone, sub-transmission) and then multiplying by unit cost estimates to calculate the project costs. See Table 9-3 for the estimates used per kilometer for lateral, backbone, and sub-transmission.

For each project, Hydro Ottawa's GIS data was used to determine the length of overhead conductor to be converted to underground, and additional GIS analysis determined adjustments that were made for downtown circuits and protection zones that were in the deep right of way.

Table 9-3: Hydro Ottawa Unit Costs

Project Type	Voltage	Cost per Kilometer
Lateral	All voltages	$718,000
Backbone	8kV, 12kV, and 28kV	$1,259,000
Backbone	13kV	$935,000
Backbone	13kv - Downtown	$1,485,000
Sub-Transmission	44kV	$1,459,000

9.3 Project Prioritization

For each of the projects outlined in Table 9-2, 1898 & Co. estimated a 50 year present value benefit. The benefits are based on a 50 year forecast of both likelihood of failure (LOF) and consequence of failure (COF) for each of the storm types. The calculation is done at the potential resilience project level, estimating the likelihood and consequence of failure of the existing infrastructure in the project during an event.

9.3.1 Likelihood of Failure (LOF)

Based on the event types and resilience upgrades 1898 & Co. developed a framework to estimate each asset's likelihood of failing during the events. The LOF values are based on the drivers of failure. Often the wind speeds can cause vegetation outside the typical trim zone to come into contact with the overhead lines. For more minor events, the consequence is simply vegetation coming into contact with electrical lines causing the protection device to lock out. Very little infrastructure may need to be replaced. For more major events, the dynamic loading of the vegetation in the lines and wind against the wires and structure can cause the structure top or structure to fail. These failures can be costly to fix. Compromised structure or older assets are more likely to fail given their internal strength is weakened.

Since vegetation and structure age / condition are the main drivers of what would cause infrastructure to fail given an event, the overhead infrastructure LOF is based on the vegetation density around the infrastructure and the age based remaining life of the asset. As described in Section 7.4, 1898 & Co estimated the vegetation density for each span of conductor in Hydro Ottawa's system. Additionally, as described in Section 7.5, 1898 & Co. estimated the age based LOF for each structure based on end-of-life curve and expected remaining life. The combination of these factors is the LOF for each overhead asset.

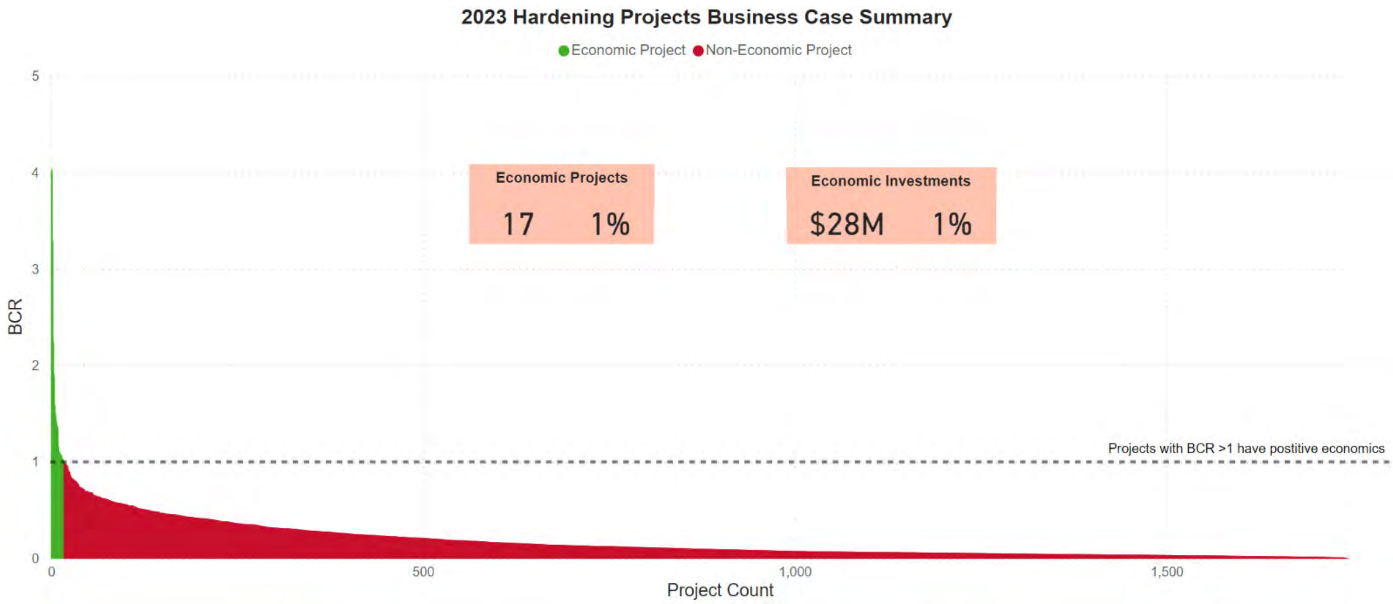
9.3.2 Consequence of Failure (COF)

The consequence of failure for each overhead asset is based on their downstream customers. As described in Section 7.3, 1898 & Co. linked each asset to their downstream customer count and type. The consequence of each asset is based on the monetization of the outage duration based on the customer outage from the DOE ICE Calculator (see Section 6.2) for the customers impacted should that asset fail.

9.3.3 Resilience Prioritization

The resilience projects are prioritized based on the benefit cost ratio of each potential project. Figure 9-1 shows the resulting project resilience ranking, BCR per project cost, for all potential projects included in the evaluation with a historical baseline storm forecast.

Figure 9-1: **Project Resilience Ranking by BCR for Historical Baseline Storm Forecast**



As the figure shows approximately 1 percent of the projects evaluated show a resilience benefit cost ratio value of more than one. This metric is used to identify the most vulnerable parts of the system that yield the greatest return per dollar spent.

Figure 9-2 shows the resulting project resilience ranking, BCR per project cost, for all potential projects included in the evaluation with climate change storm forecast.

Figure 9-2: **Project Resilience Ranking by BCR for Climate Change Forecast**

As the figure shows approximately 1 percent of the projects evaluated show a resilience benefit cost ratio value of more than one. This metric is used to identify the most vulnerable parts of the system that yield the greatest return per dollar spent.

These results are based on a 60 year time horizon with 2.0% escalation and a discount rate of 6.0%. The business case for each project is a sum of the avoided reactive costs and avoided monetized customer outages for each of the events within the Major Events Database. The output of the Resilience Business Case Module is:

- Resilience Business Case for highest resilience improvement projects
  - Project Cost and High Level Scope
  - Life-Cycle Net Present Value (NPV) Benefits
  - Benefit to Cost Ratio (BCR)

10.0 RESULTS & CONCLUSIONS

Hydro Ottawa and 1898 & Co. utilized a resilience-based planning approach to identify, prioritize, and justify resilience investments in Hydro Ottawa's distribution system. Project benefits are shown in terms of the:

1. Decrease in the Storm Restoration Costs
2. Decrease in the customers impacted and the duration of the overall outage, calculated as CMI.

Additionally, the results are presented assuming monetization of the CMI using the DOE ICE Calculator, modified for resilience. The ICE Calculator is discussed in Section 6.2. The monetization of the CMI in conjunction with the storm restoration costs allows for the calculation of a benefit cost ratio for each potential overhead to underground project.

10.1 Resilience Business Case Results for Beneficial Projects

The Resilience Investment Model calculates the Resilience Benefit Cost Ratio for each potential overhead to underground project. The Resilience BCR is the sum of the present value of avoided restoration costs and the present value of the monetized avoided customer outages divided by the project cost. Table 10-1 shows the summary business case results for resilience investments within Hydro Ottawa's system with a resilience benefit to cost ratio greater than or equal to 1. The table shows:

- There is significant opportunity to improve the resilience of Hydro Ottawa's grid for the benefit of customers with strategic projects that have quantified benefits that outweigh the costs.
  - Approximately $27.5 million in total investment when using historical baseline forecasts and approximately $57.3 million in total investment when using climate change forecasts
  - A range between 12.6 – 28.4 kilometers of resilience overhead to underground investment, depending on the scenario being evaluated.

- For both the historical forecast scenario and climate change forecast, over 15 potential projects were identified where benefits outweigh their costs, note 1898 & Co. organized Hydro Ottawa system into over a thousand projects that were evaluated within the Resilience Investment Model.

- Each of the programs have robust business cases results with benefit to cost ratios in the range of 1.0 to 4.03 with an average of 1.60 based on the historical forecast scenario. Similarly, for the climate change forecast scenario, the benefit to cost ratios range is 1.0 to 4.78 with an average of 1.66.
- Most of the benefits come from the monetized avoided customer outages benefit. This is an alignment for the main case for resilience investment, the integration of the modern customer and integrated society and major events.
- Avoided restoration costs cover approximately 6 percent of the resilience investment level, the remaining benefit stream to cover the resilience investment is the monetization of customer outages.

It is expected that any initial resilience plan budget would be based on a subset of the provided list. Each project was evaluated based on appropriate planning assumptions, however, upon detailed review and walkdowns, Hydro Ottawa may discover technical challenges that dramatically impact the business case of a project. For instance, Hydro Ottawa may discover that underground rock conditions are much worse than anticipated or easement costs or other costs will be much higher than planned. These discovered challenges would cause the project cost to increase significantly. In this situation, Hydro Ottawa would swap out the project for another from the provided Excel project list. It should be noted that the projects in the table can be filtered such that the quantified benefits are equal to or greater than the costs (BCR ≥ 1).

Table 10-1: Historical Baseline Resilience Business Case Summary Results

Program	Project Count	Length (km)	Avoided $CMI Benefit ($000)	Avoided Restoration Cost Benefit ($000)	Total Avoided Cost Benefit ($000)	Resilience Investment ($000)	Benefit to Cost Ratio (BCR)
Backbone OH to UG	3	3.34	$7.6	$0.27	$7.6	$6.6	1.15
Lateral OH to UG	13	6.82	$26.7	$1.9	$28.6	$16.4	1.75
Sub-Transmission OH to UG	1	2.47	$4.7	$0.3	$5.0	$4.6	1.10
Total	**17**	**12.64**	**$38.7**	**$2.5**	**$41.2**	**$27.5**	**1.50**

Table 10-2: Climate Change Forecast Resilience Business Case Summary Results

Program	Project Count	Length (km)	Avoided $CMI Benefit ($000)	Avoided Restoration Cost Benefit ($000)	Total Avoided Cost Benefit ($000)	Resilience Investment ($000)	Benefit to Cost Ratio (BCR)
Backbone OH to UG	3	3.34	$9.2	$0.27	$9.5	$6.6	1.43
Lateral OH to UG	18	8.93	$37.9	$2.3	$40.2	$22.0	1.83
Sub-Transmission OH to UG	5	16.11	$31.8	$3.1	$34.9	$28.7	1.22
Total	**26**	**28.38**	**$78.9**	**$5.7**	**$84.6**	**$57.3**	**1.48**

10.2 Conclusions

The following include the conclusions of this resilience evaluation for Hydro Ottawa:

- The resilience of the grid is becoming increasingly important. The case for selective overhead to underground resilience investment is sound for Hydro Ottawa; resilience is at the cross section of major events, the modern customer and integrated society. The impact of major events to today's customer and society are much greater than in the past. Much of this is due to:
  - Number of critical customers
  - Number of people working from home
  - Aging in place
  - Electrification and Decarbonization
  - Integrated society

  Major grid disruptions due to major events now cause real economic harm to customers, increases customer stress levels, and puts societies' most vulnerable at risk to life. This is evident from recent events in 2022. Proactive investment today and over the next decade is needed to mitigate the impact of these events. With the expectation of an even more integrated and connected society with electrification and decarbonization causing greater reliance on electricity in the Ottawa area, the resilience of the grid becomes increasingly important. Additionally, the case for resilience effectively mitigates reactive costs and safety risks.
- There is opportunity to improve the resilience of Hydro Ottawa's grid for the benefit of customers over the long-term with strategic overhead to underground projects that have quantified benefits that outweigh the costs.
  - Approximately fifty million in total investment that will benefit customers.
  - Over Twelve km of resilience circuit investment.
  - 17-26 of potential beneficial overhead to underground projects.
- The development of a Resilience Investment Strategy using the Resilience Investment Model results provides confidence to Hydro Ottawa grid stakeholders. The model provides confidence for the following reasons:

- **Event-Based –** each project is evaluated against its event performance for 14 different weather events types that are based in the historical record and also climate forecasts with similar conclusions.
- **Asset and Root-Caused Focused –** each project includes the relationship to their underlying assets. Asset likelihood of failures are based on the assets age and surrounding vegetation.
- **Data-Centric** – the model utilizes Hydro Ottawa's GIS, OMS, CIS, distribution circuit models, and critical customer information.
- **Customer-Centric** – the model links each asset to the impacted customer count and type.
- **Granular -** the granularity at the asset and project levels allows Hydro Ottawa to invest in portions of the system that provide the most value to customers from both a restoration cost reduction and avoided CMI perspective.
- **Comprehensive -** The approach is comprehensive and evaluates nearly all of the assets on Hydro Ottawa's overhead distribution systems.
- **Business Case Foundations** - The output of the model is the life-cycle resilience benefit and benefit cost ratio in financial terms.
- **Consistency**: The model calculates benefits consistently for all potential projects.
- **Drives Prudency**: The assessment and modeling approach drives prudency for the comprehensive overhead to underground hardening evaluation on two main levels. First, the granularity of potential resilience projects allows Hydro Ottawa to target investment in the portions of the system that provide the most value to customers. Secondly, the customer-centric financial justification of project investments allows Hydro Ottawa to prioritize investments that provide significant customer 'bang for buck'.

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FINAL REPORT

HYDRO OTTAWA DECARBONIZATION STUDY

Prepared by Black & Veatch

PREPARED FOR

15 OCTOBER 2024

Disclaimer

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1.0 Executive Summary

1.1 REPORT BACKGROUND AND OBJECTIVES

In June 2021, the Canadian Net-Zero Emissions Accountability Act became law and codified the country's commitment to Net Zero Emissions by 2050 in alignment with the Paris Agreement. The City of Ottawa has made a similar commitment with interim emissions reductions targets in the near-, mid-, and long-term. These goals will have far-reaching implications for the energy sector, particularly for the infrastructure, assets, and systems of utilities.

Hydro Ottawa Limited (HOL), the primary electric distribution utility for the City of Ottawa, has prioritized and is embarking on an important initiative to evaluate the complex impacts of these decarbonization policies on their distribution system. HOL engaged with Black & Veatch to explore the implications of decarbonization initiatives and the relative impact of decarbonization-driven electrification on future load and the HOL distribution system. The results of this study are provided in this comprehensive narrative final report. While broader decarbonization-driven impacts are expected, this study specifically and intentionally does not explore changes in the electricity generation mix or downstream customer impacts.

More specifically, this study examines the changes in load curves resulting from decarbonization-driven electrification of buildings and transportation between 2024 and 2050. Decarbonization load projections, rough-order-of magnitude (ROM) capital costs, and insights from this study are provided to inform how Hydro Ottawa's distribution assets could change to serve these increasing and evolving load requirements.

This report provides a directional overview of when and where new infrastructure investment will be required, the forecasted impact of electrification on the resiliency of the HOL grid, and the role of non-wires solutions (NWS) to maintain reliability and resiliency of HOL-owned assets. This report summarizes the methodology and results of this study, including key policy drivers and uncertainties that should be considered in future-looking assessments. This study and results summarized herein were guided by the following objectives:

1. Evaluation and understanding of the main variables impacting electrification in the HOL service territory.
2. Evaluation of the impact of the future decarbonized load projections on the HOL distribution system.
3. Consideration of the NWS that may be leveraged in the short-, mid-, and long-term to defer traditional wires upgrades.
4. Development of directional ROM investments for the necessary NWS and traditional wires upgrades forecasted to maintain reliability on the HOL grid.

Decarbonization In Ottawa: Policy Context and Trends

Electrification is expected to dramatically increase across the globe as end-users, utilities, and corporations transition from carbon-intensive fuels such as oil, diesel, and natural gas to low carbon solutions. As interim decarbonization targets quickly approach, distribution utilities like HOL need to be prepared to fully plan for the dramatic increases of electricity needs on their system.

It is well documented that global temperatures are increasing, and Canada is no exception to this global increase. According to Canada's Changing Climate Report, Canada is warming at double the rate of the rest of the world.[1] The Canadian government has taken serious strides to ensure that their global emissions impact actively declines. As an example, the Canadian Net-Zero Emissions Accountability Act sets a legally binding target for Canada to achieve net-zero greenhouse gas emissions by 2050, which means that any remaining emissions would need to be balanced by removing an equivalent amount of emissions from the atmosphere. The Act also requires the Canadian government to set interim emissions reduction targets for 2030, 2035, and 2040, and to report on progress towards these targets every five years.[2]

Similarly, the Greenhouse Gas Pollution Pricing Act imposes a federal price on carbon pollution, incentivizing the adoption of low carbon energy sources and electrification.[3] The 2030 Emission Reduction Plan complements these efforts by promoting electric vehicle adoption and setting targets for zero-emission vehicle sales. Ottawa's Climate Change Master Plan further outlines strategies for emission reduction and resilience building. Together, these policies strive to expedite the transition to a low carbon economy, foster renewable energy uptake, and address the impacts of climate change in Ottawa and throughout Canada.

An increase in electricity demand across Canada and in Ottawa can further be expected in part due to the incentives outlined in the 2030 Emission Reduction Plan. This plan aims to facilitate the transition to electric vehicles by allocating $900 million CAD towards the installation of an additional 50,000 Zero-Emission Vehicle chargers nationwide.[2] Moreover, the Canadian government is providing $1.7 billion CAD to extend incentives for the Zero-Emission Vehicles (iZEV) Program, making it more affordable and convenient for Canadians to purchase and operate new electric light-duty vehicles.[2]

The goal of the iZEV funding is to ensure that, by 2026, at least 20% of new light-duty vehicle sales will be zero-emission vehicles, with at least 60% by 2030, and 100% by 2035. It is important to note that the medium- and heavy-duty vehicle (MHDV) market will also be affected, as the Government intends to develop an MHDV ZEV regulation requiring 100% of MHDV sales to be ZEVs by 2040 for a subset of vehicle types.[2]

The City of Ottawa, in addition to aligning with the required Canadian Net-Zero Emissions Accountability Act, has also aligned with the Intergovernmental Panel on Climate Change (IPCC). Through new short-, mid-, and long-term targets, the Canadian capital intends to reduce both community and corporate

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[1] Canada Changing Climate Report, 2019.
[2] Canada's 2030 Emissions Reduction Plan targets reducing emissions by 40-45% from 2005 levels. The 2030 plan was public in March of 2022, building on the existing 2020 climate plan, and the Pan-Canadian Framework from 2016.
[3] Greenhouse Gas Pollution Pricing Act, 2019.

emissions by 100% by 2050 and 2040, respectively.[4] This decarbonization of buildings and vehicles will undoubtedly impact the demand on HOL's distribution grid, potentially necessitating upgrades or even new wire networks to supply power to locations across the city.

In continuation of the plans and investment areas stated in the larger 2021 Canadian Net-Zero Emissions Accountability Act and the 2030 Emission Reduction Plan, the City of Ottawa's Climate Change Master Plan lays out the city's objectives for both its corporate and residential residents. The City of Ottawa's Climate Change Master Plan includes eight priority action areas to achieve its ambitious net-zero emissions target. These areas will impact the energy market, reliability, resiliency, and electrification within Ottawa. The plan includes initiatives such as implementing a Community Energy Transition Strategy, applying a climate lens to asset management and capital projects, exploring carbon sequestration methods, and developing a governance framework for tackling climate change.

These strategies and initiatives have already resulted in significant energy savings, with conservation initiatives creating an estimated cumulative annual utility savings of approximately 5.9 million kWh of electricity, 297,909 m^3 of natural gas, and 48,662 m^3 of water.[4] As the city continues to implement these strategies and invest in energy-saving projects, it will help reduce the total load of carbon emissions generated by current development, leading to a more sustainable and electrified future.

Canada's policies and regulations demonstrate a proactive approach to combating climate change and promoting sustainability. The Canadian Net-Zero Emissions Accountability Act, Greenhouse Gas Pollution Pricing Act, and 2030 Emission Reduction Plan in particular incentivize decarbonization and renewable energy sources. These legislative frameworks, coupled with Ottawa's Climate Change Master Plan, outline a comprehensive approach to address climate challenges, promote electrification, and enhance resilience.

By embracing these measures, critical stakeholders like HOL can adapt to evolving regulatory landscapes through forward-looking decarbonization studies like this one to ensure their organizations are prepared for the expected shifts in demand from decarbonization-driven electrification.

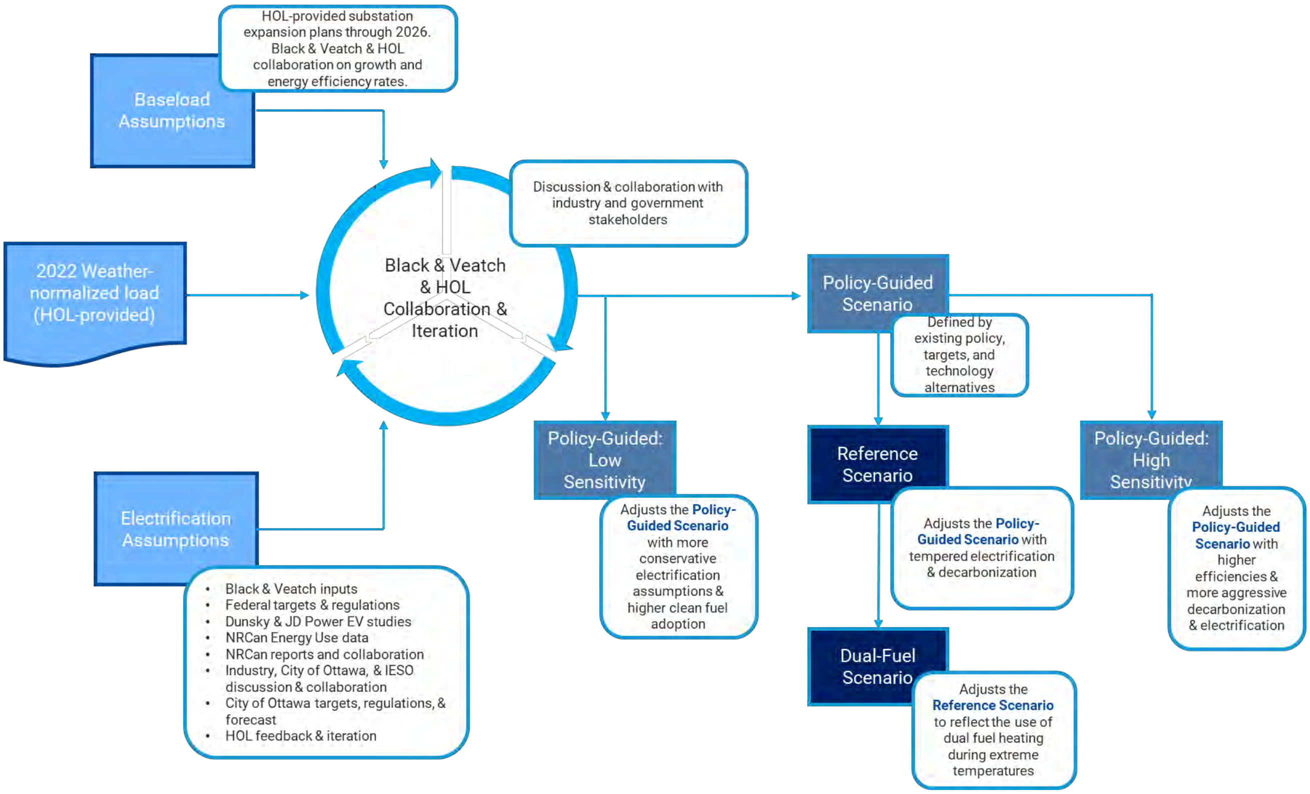
1.2 SUMMARY METHODOLOGY & APPROACH

To accomplish these objectives, HOL and Black & Veatch leveraged a scenario-based approach to model a future decarbonized system load. The team considered known policy drivers and trends, reviewed and examined existing decarbonization and emissions reduction studies, and leveraged subject matter expertise to forecast and evaluate the impact of decarbonization initiatives on the HOL service territory and distribution system.[5] Black & Veatch and HOL reviewed these assumptions on an ongoing basis with external stakeholders to ensure transparency in the assumptions development process and also to ensure

[4] Ottawa Climate Change Master Plan, 2020.
[5] Section 5: References provides an extensive list of public studies and resources reviewed in this assessment. The Electrification and Energy Transition Panel report titled "Ontario's Clean Energy Opportunities" was published after study assumptions were finalized. However, it is not expected that findings from that report would significantly alter assumptions used in this study.

input in a robust and thoughtful assumptions set. An overview of the study methodology approach is provided in Figure 1.

Figure 1. Study Summary Methodology and Approach



Once a primary base decarbonization load projection (referenced throughout this report as the Policy-Guided Scenario) had been completed, observed trends in load growth and electrification were paired with short-term planning projections to create a "most-likely" Reference Scenario. Two alternative decarbonization scenario load projections were modeled in addition to two sensitivities to capture a full range of plausible outcomes. Each load projection was evaluated through the lens of a possible decarbonized future in Ottawa and what that means for the HOL service territory. Further detail on the development of load projection scenarios can be found in Section 2.2.

This study explores the impact of decarbonization-driven load increases on HOL assets. Focusing on the Reference Scenario, it evaluates the opportunity of NWS as a mitigation strategy when compared to traditional infrastructure upgrades. Once the decarbonization load was projected, a mitigation strategy to manage increases in load was developed in two steps:

(1) an overload analysis to determine which substations are overloaded on an hourly basis; and

(2) review of strategies to manage the overload conditions at specific substations. Overload strategies consistent of either wires only upgrades at each substation or NWS at each substation.

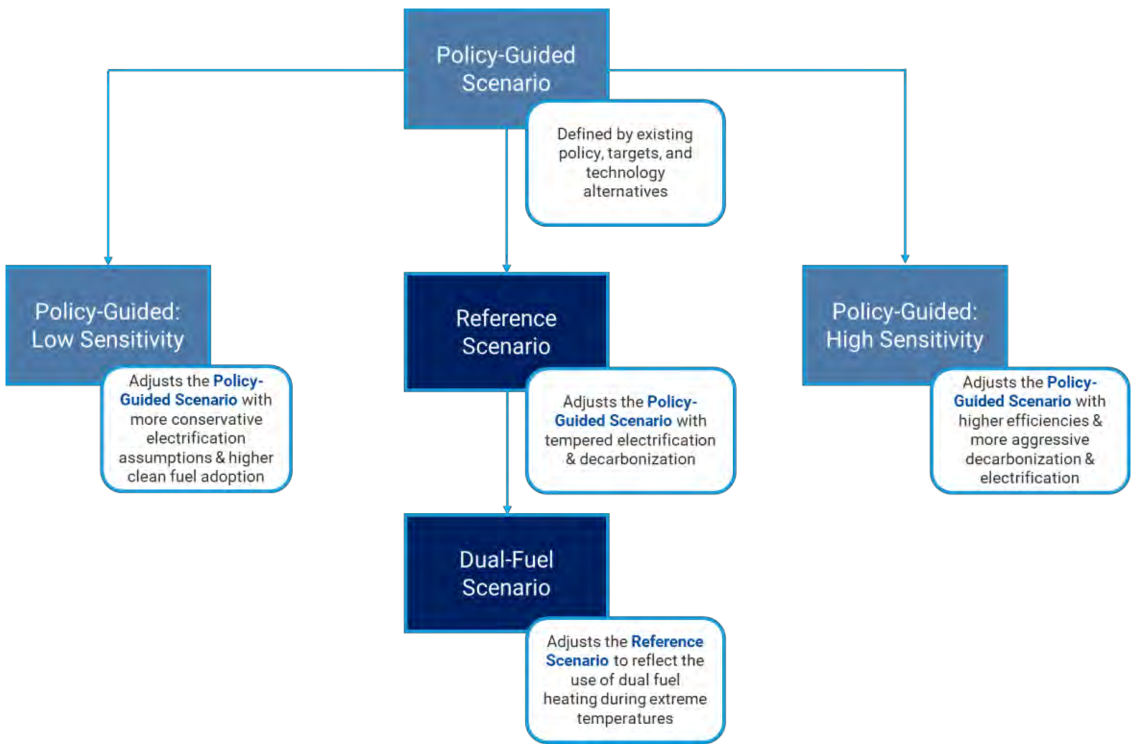
Once the potential for NWS was evaluated, an analysis was conducted to determine the optimal system upgrade solutions based on cost, safety, reliability, resiliency, and environmental factors. The overload analysis was done for the years 2035 and 2050. These two years were selected as 2035 would indicate a lower, but more certain load case in the short term, where the 2050 load case would indicate a higher, but more uncertain load case in the long run. These two cases are used to set lower and upper bounds for needed investments to address the new load profiles on the distribution system. Further detail on this analysis can be found in Section 3.2 in the main narrative of this report.

1.3 KEY FINDINGS

Decarbonization Load Projections

As with any projections, uncertainties around the rate of decarbonization-driven electrification, new technology adoption, technology cost variables, supply chain considerations, and changing political dynamics impact how electrification will change between now and 2050. Given these variations, this study leveraged a scenario-based approach in which one primary Reference Scenario was modeled and evaluated, with two alternative decarbonization scenarios complemented by two sensitivities. The primary and alternative scenarios, as well as the sensitivities, are characterized below.[6,7] The relationship between each projected scenario and sensitivity is shown in Figure 2.

Figure 2. Load Projection Scenario & Sensitivity High-Level Relationship & Descriptions



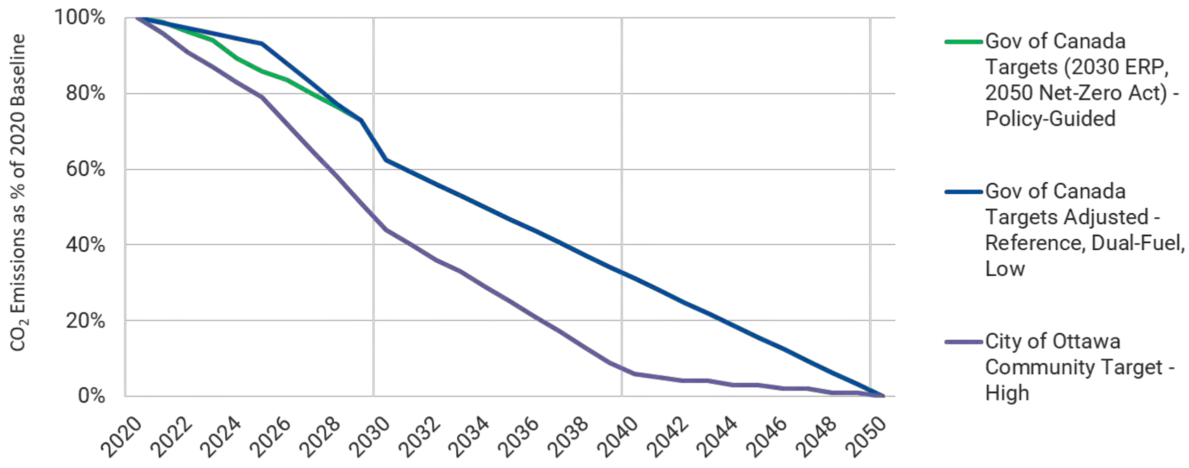
[6] A deep dive into each scenario is provide in Sections 2.2 and 2.3.
[7] Detailed findings in this report focus primarily on the three scenarios rather than the sensitivities, consistent with project scope and alignment with internal HOL forecasts.

Leveraging inputs from ongoing decarbonization trends, existing policy, other published reports and subject matter expertise, the final scenarios and sensitivities evaluated are described in greater detail below.

- The **Policy-Guided Scenario**: characterized by strict adherence to Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. This scenario is defined by existing policy, targets, and technology alternatives. All future scenarios and sensitivities were adjusted off this baseline scenario.
- The **Reference Scenario**: encapsulates the most likely scenario based on observed HOL load projection trends, electrification adoption trends, and subject matter expertise. These inputs position this scenario with tempered electrification in the short-term, as optimal to inform short- to mid-term investments required to maintain reliability on the HOL distribution power grid. For example, peak load on HOL's system has remained mostly flat for the past 15 years with a maximum of 1,518 MW in 2010, a minimum of 1,308 MW in 2014, and a most recent peak of 1,348 MW in 2022. In the mid- to long- term, this scenario assumes increasing policy-driven electrification.
- The **Dual-Fuel Scenario**: applies a space heating and water heating sensitivity during extreme temperatures to the Reference Scenario.
- The **High Case Sensitivity**: provides a sensitivity on more aggressive decarbonization and electrification than the Policy-Guided Scenario.
- The **Low Case Sensitivity**: provides a sensitivity on less aggressive decarbonization and electrification than the Policy-Guided Scenario.

The scenarios evaluated in this study explore different rates of decarbonization in the HOL service territory informed from three primary sources. The Policy-Guided Scenario in this assessment leveraged the Government of Canada's stated goals in the 2030 Emissions Reduction Plan and 2050 Net-Zero Act, which target a 40% reduction in emissions by 2030 and net-zero emissions by 2050. The Reference and Dual-Fuel Scenarios, reflect a decarbonization curve adjusted from federal targets to capture short-term trends observed in HOL service territory. This adjusted curve still meets federal targets albeit at a slower pace in the next 3-5 years before ramping up ahead of the 2030 target date. These targets were used to inform the emissions targets and rates of electrification among each scenario. A comparison of these decarbonization targets is provided in Figure 3.

Figure 3. Scenario Decarbonization Targets



Decarbonization levers were adjusted within each scenario and sensitivity to further inform scenario decarbonization load projections. Decarbonization levers are defined in this study as the primary key inputs and assumptions that inform efficiency and volume of load impact. Though not every single driver of load change is included in the high-level summary below, this study identified these levers as having the highest impact on decarbonization load projections for HOL.[8] Section 2.1 Methodology & Assumptions outlines the following levers in much greater detail:[9]

- HOL service territory population growth
- Energy efficiency assumptions
- Electric vehicles adoption, efficiency, and charging assumptions
- Residential, commercial, and federal building heating and cooling assumptions; technologies and efficiencies
- The future role of low carbon fuels and natural gas
- Adoption and generation from distributed photovoltaics (PV)

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[8] Black & Veatch understands that there are numerous other assumptions that could be considered for the purposes of this analysis. The assumption categories provided above were identified as the most impactful and necessary to complete this scope of work.

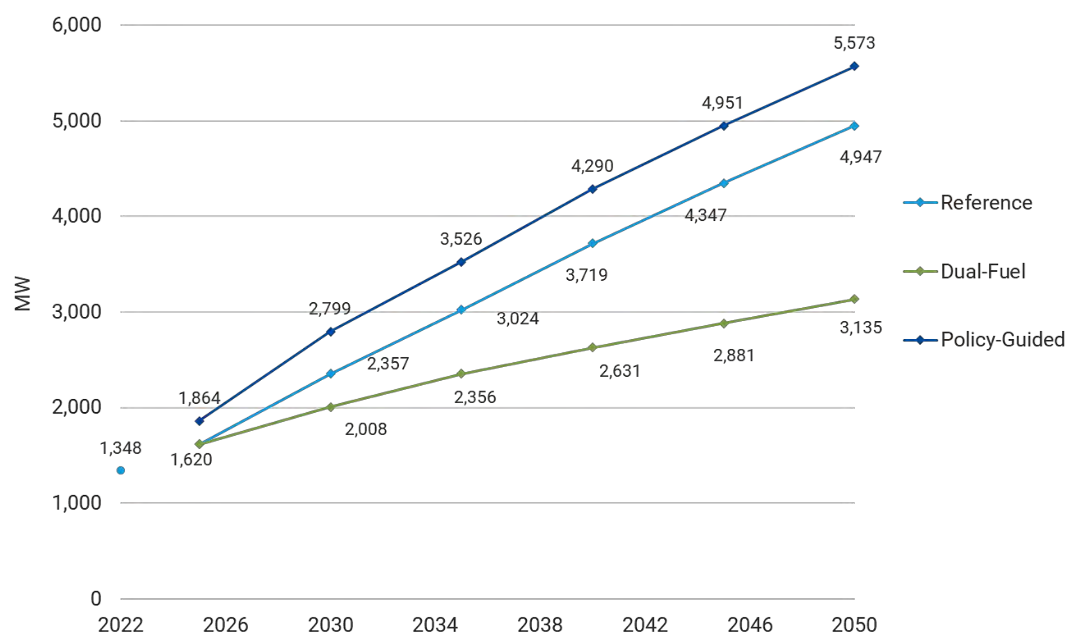
[9] Of important note, this study does not explore or evaluate changes in electric generation portfolios in Canada or Ottawa, or the impacts of decarbonization from the perspective of electric generation. Further this study did not explore the future of natural gas in Canada nor the Hydro Ottawa service territory. Both are outside of the scope of this study.

Figure 4 provides a peak demand comparison of the decarbonization scenarios modeled. In 2022, HOL's weather-normalized peak reached 1,348 MW.[10]

- The Reference Scenario projected a 2050 peak of 4,947 MW, 267% higher than the 2022 HOL weather normalized peak. Decarbonization-driven electrification, particularly associated with heating electrification assumptions drove this load increase.
- The Policy-Guided Scenario was developed to capture the impact of full electrification in meeting decarbonization goals without any load mitigation measures, resulting in a projected peak of 5,573 MW in 2050, or a 313% increase from 2022.
- The Dual-Fuel Scenario represents a future where gas (assumed to be low carbon) continues to provide a portion of space heating needs, especially in extreme cold temperatures. Even with this prevalence of dual-fuel heating systems, peak demand grows by 133% to 3,135 MW in 2050.

In each of these three scenarios, HOL would expect significant impacts to their distribution system and parallel investment needed to maintain reliability and resiliency.

Figure 4. Decarbonization Scenario Peak Demand Comparison of Primary Scenarios



Distribution System Impact Assessment

As part of this study, Black & Veatch evaluated different wires and NWS to ensure that substations facing future overload conditions could meet the required demand. The purpose of this assessment was twofold:

[10] At the time of this study, 2022 load data was the most current available.

(1) to evaluate the directional costs of a wires only solutions scenario to meet project load growth in the Reference Scenario, and

(2) to identify the system-wide combination of wires and NWS that could provide a lower system-wide cost.

Two primary overload solutions scenarios were developed to compare the system-wide cost over both study horizons described above: a wires only solution scenario and a cost optimized solutions scenario. These two primary solution scenarios were developed to inform future detailed feasibility studies in which HOL can use to determine the highest priority substations to upgrade and solutions in which should be considered. The primary solution scenarios are defined as follows:

- The Wires Only Solution Scenario – This scenario assumes that only traditional wires solutions are considered to addressed substation overload conditions. Wires only solutions include upgrades to existing substations and/or the addition of new substations.
- The Cost Optimized Solutions Scenario – This final scenario considered the lowest cost option to each qualified overloaded substation to determine the lowest system-wide rough order of magnitude (ROM) cost assumptions over the horizon. This scenario leverages a mix of wires, Battery Energy Storage Systems (BESS) (if feasible), and reciprocating engines (RECIPs) to address substation overloads.

To account for uncertainty of the decarbonization load projection and limitations of the system model used to determine station overload conditions, each scenario was evaluated at two different years and two different load transfer conditions for a total of four investment model sensitivities. First, each scenario was evaluated using the decarbonization load projection of 2035 and the decarbonization load projection of 2050; 2035 provides a lower but more certain load projection, and 2050 provides a higher but less certain load projection. Then, within each year, the potential to transfer the load to another substation is evaluated. The combined result is four different investment profiles for each scenario. The year 2035 with all potential load transfers assumed to be possible provides the lowest bound of investment required, and the year 2050 load projection with none of the potential load transfers assumed to be possible provided the upper bound of investment required.

In order to develop the cost optimized solutions scenario, two NWS technology assessments were completed: a wires and BESS solution assessment and a RECIP solution assessment. The outcomes of these two assessments, combined with the wires only solutions scenario, directly informed the development of the cost-optimized scenario. The two NWS technology assessments are described below.

- Wires + BESS Solution Technology Assessment – This assessment evaluated the role of BESS as an NWS to address substation overloads over the study horizon. If the substation had enough capacity during non-overload hours to sufficiently charge a BESS to discharge during an overload condition, the substation was determined to be eligible for a BESS. If there was not sufficient power available to charge a BESS prior to the overload, a BESS was not used and the wires only solution was applied.

- RECIP Solution Technology Assessment– This assessment evaluates the role of RECIPs as an NWS to address substation overloads. Each overloaded substation was evaluated to determine the required size and directional cost of the RECIP required.

While the outcome of these technology assessments was necessary in developing the cost optimized solutions scenario, this study dives into the results of these assessments from the perspective of the cost optimized solutions scenario only. Importantly, the two assessments (wires and BESS and RECIPs) are intended as a screening assessment only, meaning that they do not consider BESS and RECIP size limitations, land availability and other important considerations that should be evaluated in future phases of work. Thus, the results provided should be viewed through such lens.

To evaluate the two primary solution scenarios, as well as the NWS, five key measures were identified and evaluated. Each measure was scored on a scale of one to ten, with one being the least desirable and ten being the most desirable. The total score represents the sum of each measure's independent score. The intent of this scoring matrix is to review and evaluate each of the solution scenarios against one another. The measures are defined as follows:

- Solutions Scenario Cost: Represented as the total net present value (NPV) of system-wide capital expenses (CAPEX) and operating expenses (OPEX). Rough order of magnitude (ROM) directional pricing estimates were developed for each solution scenario. The two solutions scenario NPVs were compared against one another, and the lowest cost solution was evaluated as the most desirable.
- Safety: Evaluated as how safe the proposed solutions is and potential risk it could pose to the surrounding area.
- Reliability: Evaluated as to how much power and for how-long an overload could be served by the evaluated solutions. Scenario solutions leveraging dispatch limited solutions were measured as less favorable.
- Resiliency: Evaluated as the total capacity of the wires or NWS assets as well as vulnerabilities to external pressures such as grid outages or fuel limitations.
- Environmental: Evaluated considering greenhouse gas (GHG) considerations, noise, and land use considerations.

The two solution scenarios were evaluated through both the mid-term and long-term lens. The solutions scenario matrix assessment was applied to the 2035 findings to inform shorter-term investment strategies. Figure 5 shows the summary findings of the solutions scenarios in the matrix assessment. Black & Veatch applied quantitative cost metrics from its directional investment modeling results and a mix of qualitative and quantitative expertise to inform a high-level assessment of safety, reliability, resiliency, and environmental considerations. A deep dive into these findings and methodology can be found in Section 3.1 Methodology & Assumptions and 3.2 Substation Overload Results & Solution Scenarios.

Figure 5. Solutions Scenario Comparison Matrix (2035 Horizon Considerations)[11]

	WIRES ONLY	COST OPTIMIZED
Measures		
Cost	5	9
Safety	10	7
Reliability	10	9
Resiliency	5	8
Environmental	5	5
Total Score (Sum)		
Overall Score	35	38

Measures Scoring

1 2 3 4 5 6 7 8 9 10

Least Desirable → Most Desirable

Conclusion & Summary Recommendations

This study evaluated the potential for increases in system load in the HOL distribution system based on various decarbonization and end use electrification scenarios. Additionally, impacts to the system were assessed and potential methods to mitigate those impacts were developed. The model analysis reveals that the electrification of energy end use cases such as transportation and heating will result in a significant increase in system load and is projected to require significant expenditures to address.

The main body of this narrative final report provides a deep-dive into the methodology and assumptions of each decarbonization load scenario, as well as scenario-based comparison of each scenario decarbonization load projection. The impact on peak, load profiles, and total demanded are summarized in great detail in an effort to provide a comprehensive comparison of the impact of different decarbonization levers. Further, a detailed overview of the methodology and approach and resulting findings of the system substation overload analysis, as well as recommended next steps for considerations are provided in Section 3.0 Decarbonization Load Impacts to HOL's Distribution System.

[11] Individual measures were scored on a scale of one to ten. The overall score is the sum of all scores. Discussion regarding each measure score is provided in Section 3.2.

This study provides a robust analysis and thorough examination of potential adjustments needed between now and 2050 for HOL to effectively address future decarbonization-driven load impacts. Though this study provides robust and comprehensive analysis into the possibility of the impact of decarbonization initiatives in the HOL service territory, additional considerations, studies, and analyses should be considered. The analysis performed in this study should be leveraged and built upon to further assess and finalize mitigation strategies to optimize capital investment. In addition to the results provided within this narrative final report, an additional appendix is included titled "Appendix A: HOL Provided Substation Data." The appendix includes a table which outlines all of the substation assumptions included in the overload analysis provided by HOL. These inputs were used in the assessment of substation overloads from the Reference Scenario load profiles over the study horizon.[12] All public sources used to inform assumptions in this analysis are also provided in Section 5: References.

[12] In additional to the two appendices summarized, Black & Veatch completed and provided extensive data analysis and financial modeling not included herein but used to determine the outcome of this analysis.

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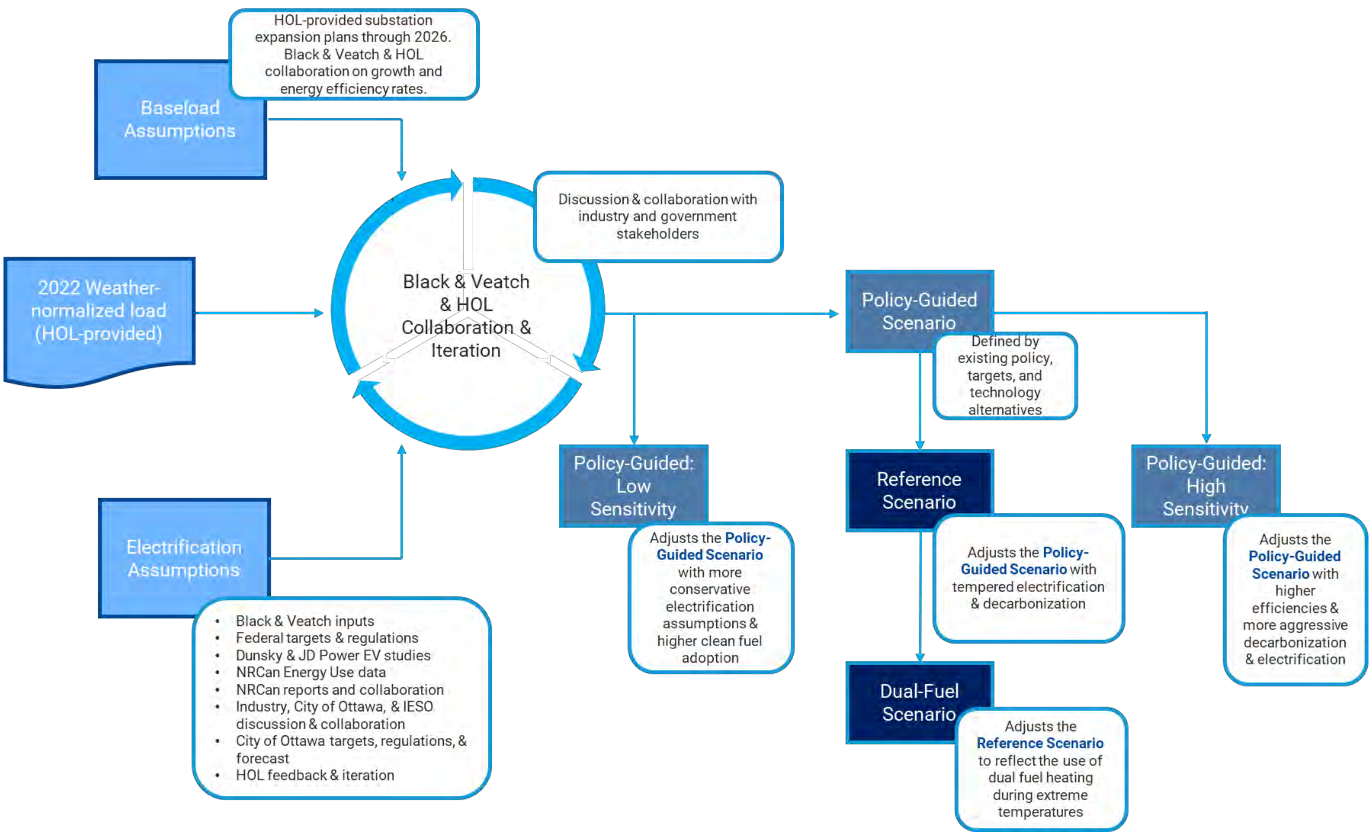
2.0 Decarbonized Load Projections

2.1 METHODOLOGY AND ASSUMPTIONS

In developing the decarbonization load scenarios used in this analysis, Black & Veatch leveraged a combination of public and proprietary HOL data to inform decarbonization assumptions and load trends. This data included historical load profiles at the substation level, weather normalization techniques, short-term system upgrade plans, growth forecasts, distributed energy resources (DER) information, and publicly available decarbonization plans and goals. Black & Veatch and HOL collaborated to define decarbonization load scenarios to inform decarbonization load projections. An overview of the study methodology and approach is provided in Figure 6.

Figure 6. Study Summary Methodology and Approach



As part of the methodology, load modeling was broken into two load categories (baseload and new electrification load). This methodology allows for greater visibility into the drivers of the decarbonization-driven new electrification load, specifically. All decarbonization load projections were completed in 5-year increments for each scenario for the following six years: 2025, 2030, 2035, 2040, 2045, and 2050. The baseload and new electrification load categories are defined as follows:

- **Baseload:** Considers the existing hourly electric consumption at the system level for all end use customer types. It does not include flow transfers between substations and derives from the actual 2022 weather-normalized electric load at the system level. The baseload is projected through 2050 considering growth rates and energy efficiency measures defined for each customer segment, such as residential, commercial, large customers, and federal. The short-term growth rate between 2023 and 2026 was informed by HOL planned capacity expansion at the substation level; and post-2026, the growth rate at the substation level varies by customer segment. The baseload projection is the same across all scenarios and sensitivities modeled.

- **New Electrification:** Includes six segments: Transportation Electrification, Residential Electrification, Commercial Electrification, Federal Building Electrification, Large Customer Electrification, and Distributed PV Generation. Each category was projected using a decarbonization curve and additional assumptions specific to each category, such as space heating, water heating, and technology adoption. Of note, in several scenarios some buildings continue using gaseous fuels through 2050.[13] For the purposes of ensuring that Canada's climate targets are met, this gas was assumed to have net-zero emissions intensity.

Load Category 1: Baseload Methodology

The baseload projection was developed by estimating growth of existing load on HOL's distribution system. Beginning with 2022 weather-normalized hourly electric load, organic load growth was estimated for 2023-2026 based on known capacity expansion plans at the substation level. New substation plans and enhancement projects for existing substations were used to create growth rates that were then applied to specific substation loads.

Beyond 2026, projections were estimated for each of the following customer segments using segment-specific growth and energy efficiency rates: residential, commercial, federal, street lighting, and large customers.

The **Residential** customer segment was created from the Residential HOL rate category, and load growth was projected based on population growth[14]. Energy efficiency gains were estimated at 0.5% per year based on the Independent Electricity System Operator's (IESO's) Gatineau Corridor End-of-Life Study.[15]

The **Commercial** customer segment was created from the following HOL rate categories: Commercial, 50-1,000 kW, 1,000-1,500 kW, and 1,500-5,000 kW. Load growth was projected based on population growth, and energy efficiency gains were estimated at 1% per year based on the IESO's Gatineau Corridor End-of-Life Study.[15]

The **Federal** customer segment was created by mapping 130 federal facilities in the Ottawa region to Canada's 2021 Greenhouse Gas Emissions Inventory to measure annual energy consumption. For federal customers who were also large customers, metered electricity was used instead. Load growth was projected based on historic growth, and energy efficiency gains were estimated at 1% per year based on

[13] A detailed assessment of the role of the data centers was not included as part of this decarbonization study scope but should be considered in future load projection assessments.
[14] City of Ottawa Growth Projections for the New Official Plan – Medium Projection, 2019. Extrapolated from 2047 to 2050.
[15] IESO Gatineau Corridor End-of-Life Study, 2022.

the IESO's Gatineau Corridor End-of-Life Study.[15] It was assumed that federal buildings with plans to transition to commercial or residential use would maintain similar consumption profiles and growth rates.

The **Large Customer** segment was created from the metered data of 28 of HOL's largest customers. This segment was broken down into subsegments with specific assumptions for each.

- Office Building large customers: growth and energy efficiency were the same as the Commercial customer segment.
- Hospital large customers: growth and energy efficiency were informed by the Commercial customer segment.
- University large customers: growth estimates informed from other university decarbonization and sustainability plans, energy efficiency assumed equal to commercial segment.
- Water Treatment Plant large customers: growth based on population growth and energy efficiency estimated at 0.5% for the industrial segment from IESO's Gatineau Corridor End-of-Life Study.[15]

The **Street Lighting** customer segment was created from the Street Lighting HOL rate category, and load growth was projected based on population growth. No energy efficiency gains were estimated due to the high existing penetration of LED street lighting in Ottawa.

Load Category 2: New Electrification Methodology

Transportation Electrification

Transportation Electrification includes the load from charging electric light-duty, medium-duty, and heavy-duty vehicles (LDV, MDV, HDV). LDVs are projected to comprise the vast majority of EV charging load in the HOL service territory and the following parameters were developed and defined to estimate annual electricity consumption of electric vehicles.[16]

- Number of electric vehicles: informed from existing regulations and public forecast adoptions
- Electric vehicle electric consumption per distance (efficiency rating): utilized the IESO Annual Planning Outlook (APO)[17] estimate of 0.2 kWh/km
- Distance traveled per EV per year: 16,196 km[18]
- Charger efficiency: estimated at 0.85[17]

Annual consumption from EVs was allocated to hourly load profiles at the substation level via:

- Hourly charging profiles developed for different types of residential (L1, L2) and public chargers (L3)
- Residential charging allocated based on population/number of residential customers at the substation

[16] Unless otherwise noted LDV assumptions leveraged proprietary Black & Veatch analysis and research. A detailed study of LDV efficiencies, miles traveled and charging efficiency were outside the scope of this assessment.
[17] IESO Annual Planning Outlook, 2022.
[18] IESO Annual Planning Outlook, 2022, modified slightly by Black & Veatch subject matter experts.

- Public charging allocated based on historical locations (indicative of demand at the location)
- Seasonality of consumption accounted for by using EV consumption data from climates similar to Ottawa

The significant impact of new LDV load is expected to be tempered by rate structures designed to incentivize customers to charge when electricity demand is low, lessening the impact on system-level peaks. From 2023 to 2030, some adoption of the Ontario Government's ultra-low overnight (ULO) rate was assumed. [19] After 2030, new rate structures optimized to flatten future system-level load curves were assumed to be implemented as HOL adapts to the changing load profile of its system. Adoption rates for these rate incentives differ by scenario.

For City of Ottawa's buses, a separate load projection was created using the following assumptions:

- Full electrification of fleet by 2040
- Observed data from the existing OC Transpo Zero Emission Bus Program, including:
    - Distance traveled per bus
    - Electric efficiency of buses
    - Charging load profiles

Outside of LDVs and city buses, MDV and HDV load was estimated as a proportion of LDV load using a combination of public and proprietary Black & Veatch sources. Projected MDV and HDV load was then added to the total LDV load.

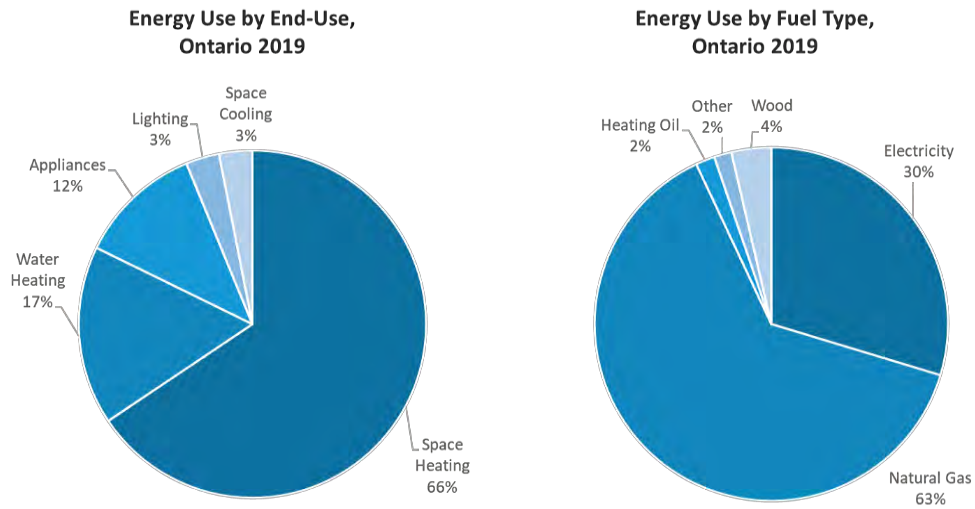
Residential Electrification

Residential Electrification includes potential electrification load from space heating, water heating, and appliances in the residential sector. According to Natural Resources Canada (NRCan) data, space cooling and lighting in the residential sector are already 100% electric. [20] NRCan data was used to quantify energy consumption by end use (space heating, water heating, appliances) and energy end use fuel type, as shown in Figure 7. Black & Veatch applied a decarbonization curve based on Federal or local climate targets to the entire residential sector. For each energy end use, specific electrification assumptions were developed.

[19] Ontario Ultra-Low Overnight Rate

[20] NRCan Residential Sector Energy Use, Ontario.

Figure 7. Residential Energy Use in Ontario, ***Natural Resources Canada***



Space heating and water heating were electrified based on expected technology share (heat pumps, electric resistance, gas) at the end of the study's horizon. These target technology shares leveraged existing publicly available forecasts such as Canada Energy Regulator's (CER) Canada's Energy Future, Enbridge's Pathways to Net Zero Emissions in Ontario, and the City of Ottawa's Energy Evolution GHG Modeling to inform forecasts for this study. For example, the Reference Scenario utilized the forecast in Canada's Energy Future report to arrive at 50% heat pumps, 26% electric resistance heating, and the remainder served by low carbon gas by 2050.

From these technology adoption assumptions, Black & Veatch applied a blended coefficient of performance (COP) to convert the amount of energy used by natural gas to electricity or low carbon fuels such as hydrogen or RNG. Black & Veatch utilized historical weather data in Ottawa to project electrified space heating load curves over the course of a year. For water heating, efficiency metrics (COP) were applied to known energy demand from natural gas-fired residential water heating (NRCan) and known load profiles from similar climates to create annual hourly load projections.[20]

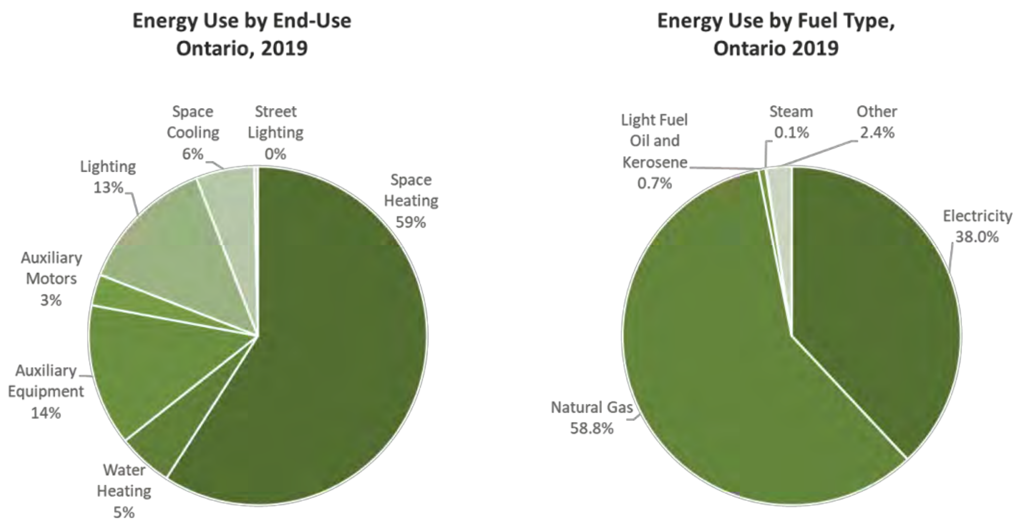
Roughly 63% of energy used in household appliances is provided by natural gas, consistent with NRCan data.[20] In this assessment, the natural gas portion was assumed to be electrified based on scenario-specific decarbonization curves.

Importantly, blended efficiency metrics for both space heating and water heating were reduced in all scenarios for hours at or below -10°C based on historical weather data. This was to account for the assumed diminished efficiency of air-source heat pump technology in extreme temperatures sometimes experienced in Ottawa's climate.

Commercial Electrification

Commercial Electrification includes potential electrification load from space heating, water heating, space cooling, and auxiliary equipment in the commercial sector. Like the residential sector, NRCan data was used to quantify energy consumption by end use (space heating, water heating, etc.) and energy end use fuel type as shown in Figure 8.[21] Black & Veatch applied a decarbonization curve based on federal or local climate targets to the entire commercial sector. For each energy end use, specific electrification assumptions were developed.

Figure 8. Commercial Energy Use in Ontario, *Natural Resources Canada*



Space heating, space cooling, and water heating were electrified based on fuel share (electric vs. low carbon gas) at the end of the study horizon. These target fuel shares leveraged publicly available forecasts such as Canada Energy Regulator's (CER) Canada's Energy Future, Enbridge's Pathways to Net Zero Emissions in Ontario, and the City of Ottawa's Energy Evolution GHG Modeling to inform projections for this study.[22,23,24] Based on the electrification options available for commercial buildings and the minimum performance of alternatives from the National Energy Code of Canada for Buildings, Black & Veatch applied a blended coefficient of performance (COP) to convert the amount of energy used by natural gas to electricity.[25] Black & Veatch utilized historical weather data in Ottawa to project electrified space heating load curves over the course of a year. For water heating, efficiency metrics (COP) were applied to known energy demand from natural gas-fired commercial water heating (NRCan) and load profiles from similar climates to create annual hourly load projections.[21]

Roughly 17% of energy used in auxiliary commercial equipment (e.g., clothes dryers, cooking appliances) is provided by natural gas. [21] Similar to the residential sector, the natural gas portion was assumed to be electrified based on scenario-specific decarbonization curves.

Like the residential sector, blended efficiency metrics for both space heating and water heating were reduced in all scenarios for hours at or below -10°C based on historical weather data. This was to account

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[21] NRCan Commercial Sector Energy Use, Ontario.
[22] Ottawa Energy Evolution Modelling Ottawa's Greenhouse Gas Emissions to 2050.
[23] CER Canada's Energy Future, 2023.
[24] Enbridge Pathways to Net-Zero Emissions in Ontario, 2022.
[25] National Energy Code of Canada for Buildings, 2020.

for the assumed diminished efficiency of existing air-sourced heat pump technology in extreme temperatures sometimes experienced in Ottawa's climate.

Federal Building Electrification

The government of Canada publishes annual Greenhouse Gas Emissions (GHG) Inventories which include all federal facilities in the country. One hundred thirty (130) federal facilities were identified from this inventory in the Ottawa region; each facility was mapped to a substation on HOL's distribution system based on the facility address. From the GHG Inventory, Black & Veatch determined the annual energy consumption at the substation level. For large federal users, metered electricity was used instead (see next section on Large Customer Electrification). Due to similar consumption profiles, commercial electrification assumptions around space heating & cooling, water heating, and auxiliary equipment were applied to federal buildings. These assumptions were applied to scenario-specific decarbonization curves. Black & Veatch assumed these facilities would either remain operational as federal buildings or transition to commercial use cases with similar consumption profiles and growth rates.

Large Customer Electrification

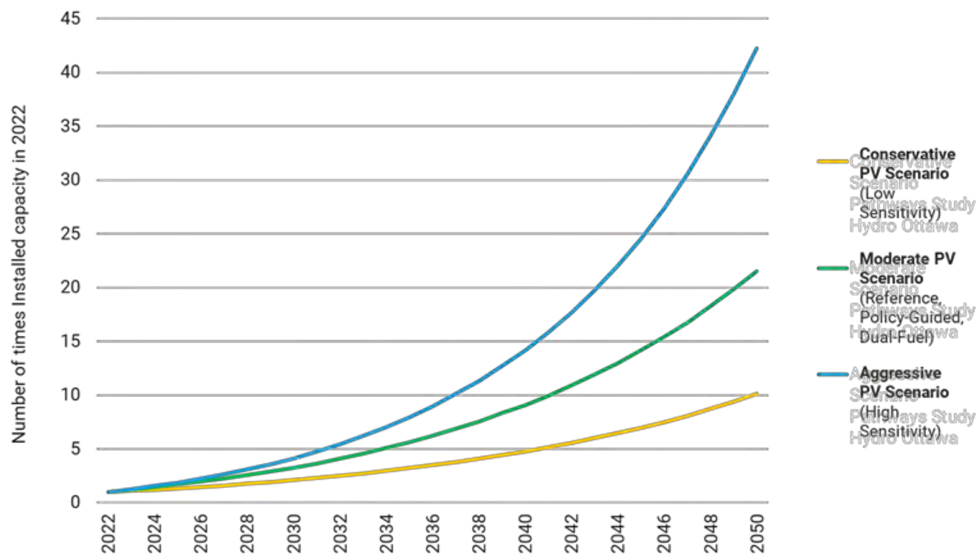
As in the baseload projection, Black & Veatch created a specific set of electrification assumptions for 28 large customers broken into 6 subsegments. Large Customer Electrification did not vary by scenario. Of important note is that the intent of this study was not to develop and project large customer specific or custom decarbonization trends and trajectories, but to understand the directional impact of decarbonization on the HOL distribution system. Thus Black & Veatch leveraged publicly available information to inform assumptions of these large customer groups.

Distributed PV Generation

Black & Veatch completed a load projection of distributed photovoltaic (PV) solar generation growth given its ability to significantly influence system-level peaks, especially during summer months. HOL provided current installed capacity estimates of roughly 42 MW as well as generation profile data observed at selected substations. Substation-level generation profiles and capacity factors were applied to growing capacity load projections. Black & Veatch leveraged forecasts from the City of Ottawa's Pathway Study on Solar Power to apply growth patterns by scenario.[26] Each solar scenario from this study assumes different levels of local effort to encourage rooftop PV and global inputs such as improved economics and technology performance. Figure 9 shows the different distributed PV projections leveraged for this analysis.

[26] City of Ottawa's Pathway Study on Solar Power in Ottawa, 2017.

Figure 9. Distributed PV Projection Assumptions



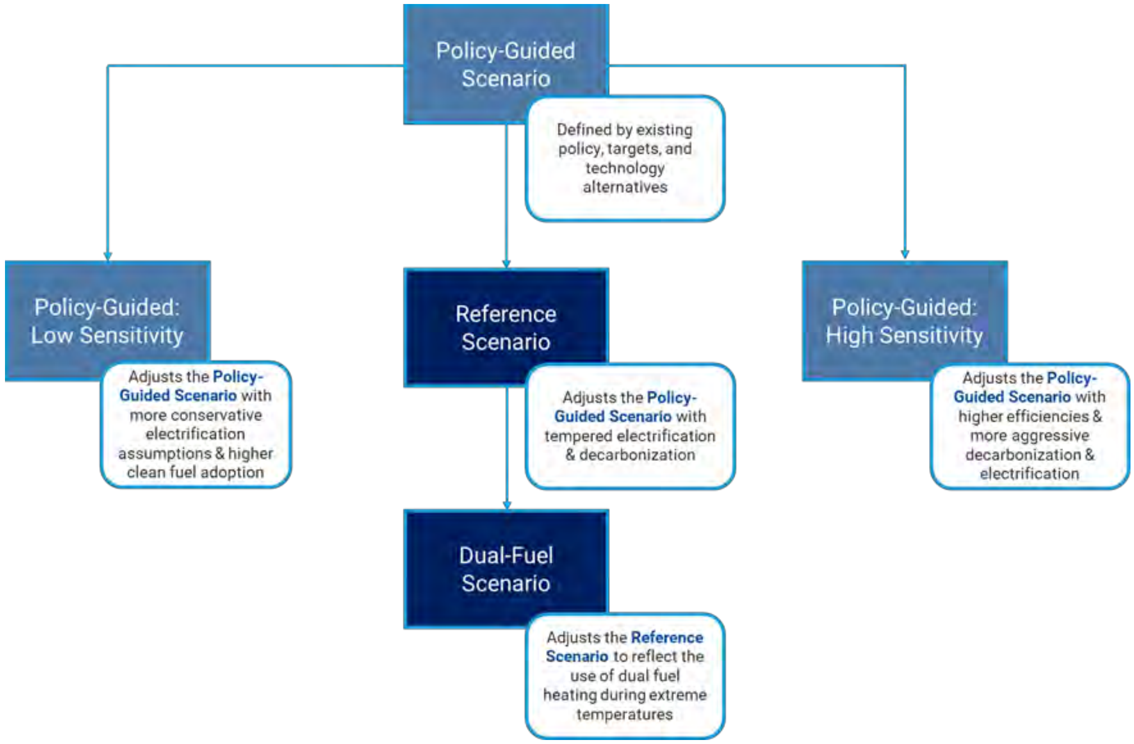
Substation-level Projection Methodology

To apply all new electrification assumptions to HOL substations, Black & Veatch conducted a thorough analysis of customer segmentation. Utilizing both publicly available and proprietary HOL data, Black & Veatch created an estimated customer segment breakdown for all 92 substations in HOL's distribution system. Customer segment-specific new electrification growth factors were applied proportionally based on these customer breakdown estimates. The end result was both system- and substation-level load projections for each load category for each scenario.

2.2 OVERVIEW OF LOAD SCENARIOS

In order to capture a range of possible outcomes to HOL's distribution system resulting from decarbonization, Black & Veatch developed one primary reference decarbonization scenario, two alternative decarbonization scenarios, and two sensitivities. This section defines each scenario, presents an overview of assumptions, and examines customer segment-level results. In Section 2.3 Results Summary and Comparison, system-level results for the three scenarios are presented and analyzed comparatively. Each scenario's development and influences are described below, along with the scenario-specific results of each load category. Figure 10 shows the logical flow of developing these scenarios.

Figure 10. Load Projection Scenario & Sensitivity High-Level Relationship & Descriptions



Leveraging inputs from ongoing decarbonization trends, existing policy, other published reports and subject matter expertise, the final scenarios and sensitivities evaluated are described in greater detail below.

- The **Policy-Guided Scenario**: characterized by strict adherence to Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. This scenario is defined by existing policy, targets, and technology alternatives. All future scenarios and sensitivities were adjusted off of this baseline scenario.
- The **Reference Scenario**: encapsulates the most likely scenario based on observed HOL load projection trends, electrification adoption trends, and subject matter expertise. These inputs lead Black & Veatch and HOL to assert this scenario, with tempered electrification in the short-term, is optimal to inform short-to-mid term investments required to maintain reliability on the HOL distribution power grid. For example, peak load on HOL's system has remained mostly flat for the past 15 years with a maximum of 1,518 MW in 2010, a minimum of 1,308 MW in 2014, and a most recent peak of 1,348 MW in 2022. In the mid- to long- term, this scenario assumes increasing policy-driven electrification.
- The **Dual-Fuel Scenario**: applies a space heating and water heating sensitivities during extreme temperatures to the Reference Scenario.
- The **High Case Sensitivity**: provides a sensitivity on more aggressive decarbonization and electrification than the Policy-Guided Scenario.

- The **Low Case Sensitivity**: provides a sensitivity on less aggressive decarbonization and electrification than the Policy-Guided Scenario.

Load Projection Assumptions

Each of these scenarios contain the *same baseload projection* but utilize levers of electric vehicle (EV) adoption, building heating and cooling, water heating, decarbonization curves, and distributed PV adoption to measure the impact of decarbonization policy on load modeling. This section describes the methodology used and variables accounted for to build each portion of the decarbonized load projections. A number of assumptions remained the same in each load projection scenario. A list of those shared common assumptions is provided in Table 1.

Table 1. Common Assumptions Across Scenarios

Load Category	Shared Assumptions (assumptions were identical in each scenario & sensitivity)
Baseload	• All baseload assumptions, including historical load profile, growth rates & energy efficiency
Residential	• Energy efficiency • Load profile • Space cooling & appliance electrification
Commercial	• Energy efficiency • Load profile • Space cooling & auxiliary equipment electrification
Federal	• Energy efficiency • Load profile
Transportation	• EV efficiency • Vehicles miles traveled • Charger efficiency • City bus electrification
Large Users	• All large user assumptions, including historical load profile, growth rates & energy efficiency
Distributed PV	• Generation profile • Capacity factor

Importantly, the five load categories used as levers for scenarios were Transportation Electrification (LDV specifically), Residential Electrification, Commercial Electrification, Federal Electrification, and Distributed

PV Generation. A summary of the scenarios and each level assumption is provided in Table 2. The baseload projection and Large Customer Electrification results are presented here outside individual scenarios, as they remained constant across all five scenarios and sensitivities.

Table 2. Scenario and Sensitivity Assumptions Comparison[27]

	Dual Fuel Scenario	Reference Scenario	Policy-Guided Scenario	High Sensitivity	Low Sensitivity
Scenario Description	Defined by adjusting the Reference Scenario with dual fuel heating during extreme temperatures	Defined by adjusting the Policy-Guided Scenario with tempered electrification & decarbonization	Defined based on existing policy, targets, and technological alternatives	Defined by greater efficiency and more aggressive decarbonization & electrification assumptions	Defined by more conservative decarbonization assumptions, with greater clean fuel adoption
Decarbonization Curves & Targets	Government of Canada Targets (tempered in short-term)	Government of Canada Targets (tempered in short-term)	Government of Canada Targets (2030 ERP, 2050 Net Zero Act)	City of Ottawa Climate Change Master Plan Community Target	Government of Canada Targets (tempered in short-term)
Electric Vehicles	EV adoption to meet federal targets	EV adoption to meet federal targets	EV adoption to meet federal targets	Faster EV adoption than federal targets	Slower EV adoption than federal targets
Residential, Commercial & Federal Buildings	Partial electrification with moderate heat pump adoption Dual-fuel heating assumptions Remaining pipeline gas assumed as low-carbon fuels	Partial electrification with moderate heat pump adoption Remaining pipeline gas assumed as low-carbon fuels	Complete electrification Second highest heat pump adoption	Most aggressive electrification Highest heat pump adoption, highest efficiency assumptions	Least aggressive electrification with higher remaining load served from low-carbon fuels Lowest heat pump adoption
Distributed PV	Moderate PV Growth	Moderate PV Growth	Moderate PV Growth	Most aggressive PV growth	Most conservative PV growth

Baseload Results

As described in Section 2.1, the baseload projection is driven by a combination of existing substation plans, population growth forecasts, and energy efficiency assumptions. After beginning at 1,348 MW in 2022 and increasing to 1,737 MW in 2030 baseload levels out and decreases on the back end of the study horizon due to energy efficiency projections outpacing load growth from the increasing population. By 2050 the baseload peak is 1,797 MW, only 3.4% higher than 2030 (0.17% annualized growth). As demonstrated in Figure 11, the baseload projection utilizes the same load profile as HOL's system today.

[27] Assumptions detailed are discussed in greater detail later in this section.

The baseload peak and load profile are identical across all scenarios. Figure 12 shows baseload peak demand projections.

Figure 11. Baseload Annual Load Profile

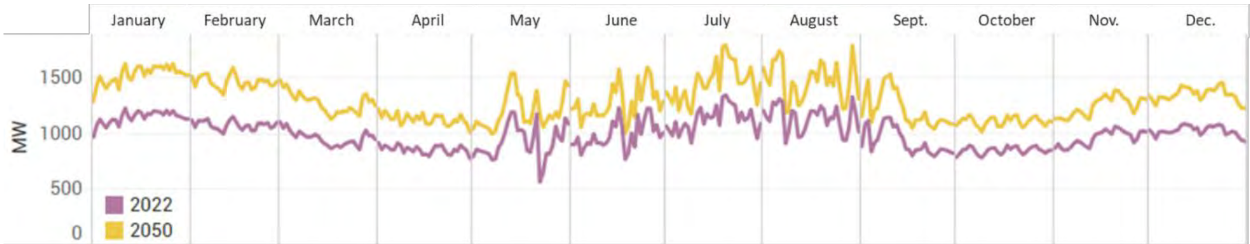
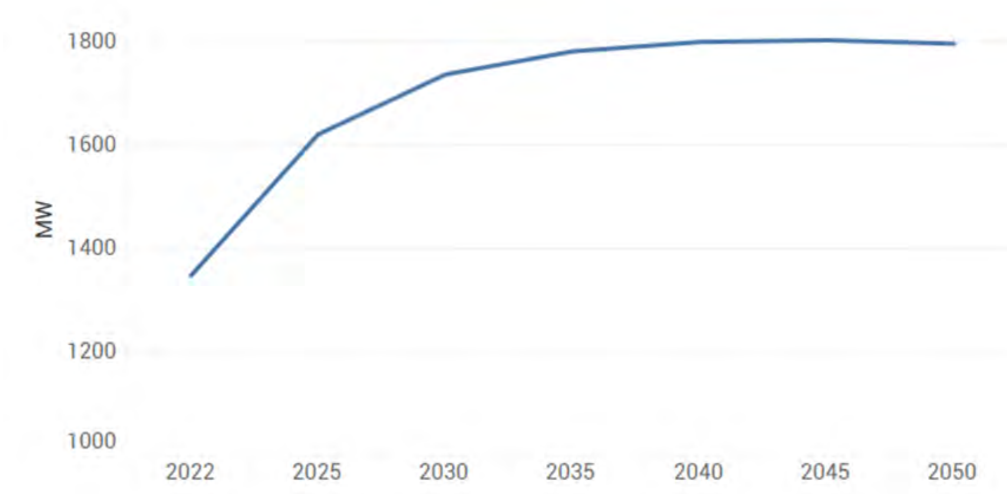


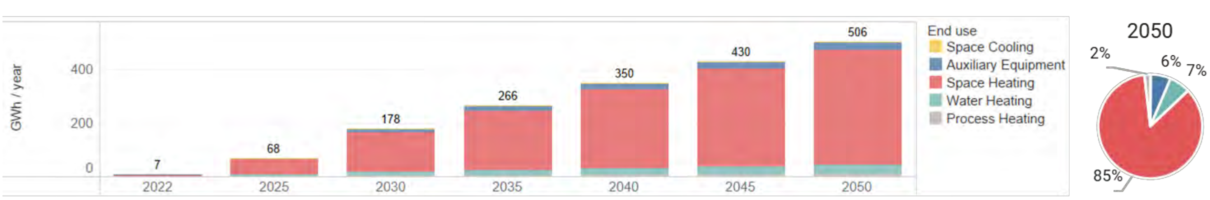
Figure 12. Baseload Peak Demand Projection



Large Customer Electrification

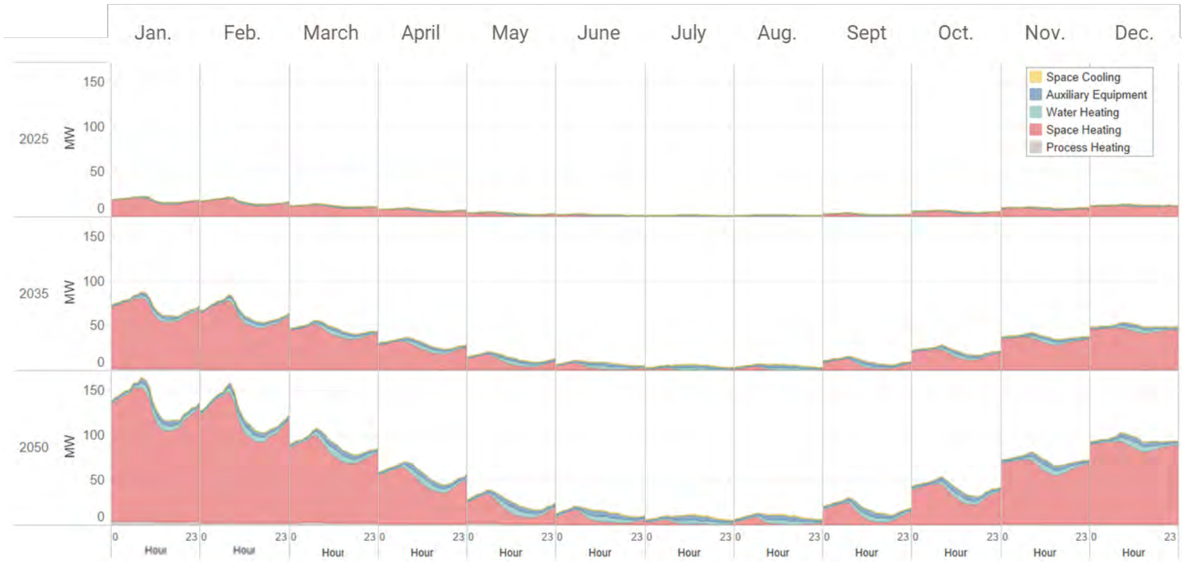
The Large Customer Electrification load projection (as seen in Figure 13) includes specific assumptions for each subsector of customer. Space heating electrification is the primary driver of this load projection, as seen by the increased load in winter comparative to summer months. By 2050, 85% of the 506 GWh consumed by large customers annually is for space heating. Overall, Large Customer electrification represents a relatively small proportion of system load (3% in the Reference Scenario) – outpaced by load growth in Residential, Commercial, and Transportation sectors. The Large Customer Electrification load projection did not vary across scenarios.

Figure 13. Large Customer New Electrification Load Projection by End-Use



As expected, space heating load is highly seasonal (as seen in Figure 14), dropping dramatically between winter months and summer months. Though noticeable in 2025, by 2035 and 2050 the seasonality and associated peaks will become increasingly severe. The associated increase of spacing heating related electricity demand is tied to a transition away from gas heating.

Figure 14. Large Customer Hourly Electricity Load Profile (Average Day Per Month)



Reference Scenario and Dual-Fuel Scenario

The Reference Scenario in this study reflects the most likely short-to-mid-term load projection expected in the HOL service territory. Based on historical data and existing trends, Black & Veatch and HOL believe this scenario is optimal to inform short-to-mid term investments required to maintain reliability on the HOL distribution power grid. Thus, the Reference Scenario is the decarbonization load projection in which distribution modeling and ROM investment estimates were performed. A narrative of those findings is provided in more detail in Section 3. Decarbonization Impacts to HOL's Distribution System.

In the Reference Scenario, the new electrification load projection is characterized by a tempered pace of decarbonization in the short-term but still meeting Canada's 2030 Emissions Reduction Plan and Canada's wider 2050 decarbonization goals. This curve was developed from the existing Government of Canada targets adjusted for slower electrification in the near-term informed by observed trends in HOL's service territory. Further, this scenario assumes full electrification of most buildings, with a minority continuing to utilize gas distribution networks by 2050. However, to meet decarbonization targets in this scenario, pipeline fuel is assumed to be decarbonized via adoption of low carbon fuels. While identical to the Policy-Guided Scenario in EV adoption and PV generation, these cases differ in the implementation and adoption of EV charging rate incentives.

Alongside the Reference Scenario, Black & Veatch assessed a Dual-Fuel Scenario in which all assumptions match the Reference Scenario except for space heating and water heating. In this sensitivity, it was assumed that the majority of buildings that adopt heat pumps also maintain their gas space heating and water heating as back-up allowing for the use of gas-fired heating during extreme cold weather.

Reference Scenario and Dual-Fuel Scenario: Transportation Electrification

Transportation Electrification assumptions for these two scenarios are shown in Table 3. From 2023 to 2030 a rate design similar to the Ontario Government's existing ULO rate is assumed.[19] Beyond 2030, Black & Veatch assumed charging rate incentives would be adapted to provide optimal load flattening (i.e., incentivizing charging during times when demand from other load sectors is low.) These scenarios assume a rate incentive adoption rate of 75%, informed by the reference case of BC Hydro's Optional Residential Time-of-Use 2023 Rate Application.[28] Charging profiles in the Reference Scenario were informed by the Electric Vehicle User Behavior: An Analysis of Charging Station Utilization in Canada report.[29]

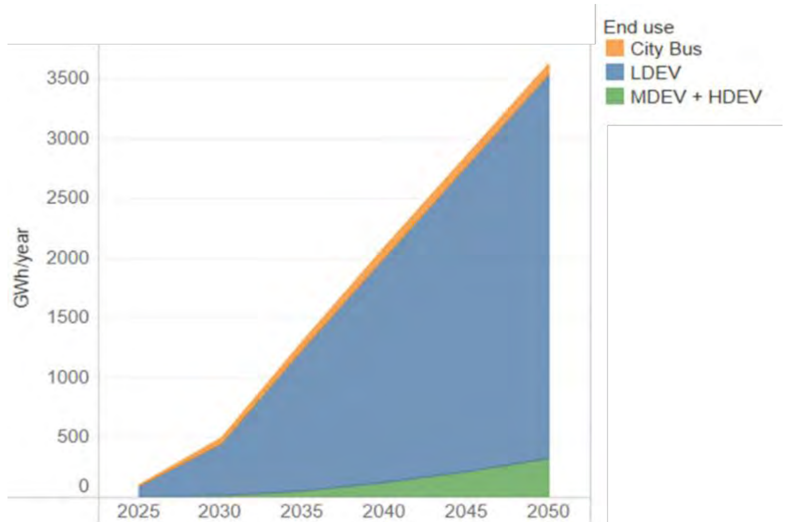
Table 3. Reference Scenario Transportation Electrification Assumptions

METRIC	ASSUMPTION	INFORMED BY
% of New Electric LDV Sales	2026 – 20% of new LDVs 2030 – 60% of new LDVs 2035 – 100% of new LDVs	Canada Zero-Emission Vehicle Sales Targets
Charger Types	Residential L1 or L2 – 80% Public L2 – 17% Public DCFC – 3%	Dunsky & NRCan,[30] J.D. Power,[31] Black & Veatch analysis
Rate Incentive Adoption	75%	BC Hydro's Optional Residential Time-of-Use 2023 Rate Application[28]
MDV/HDV Load as a Percentage of total LDV load	2050 – 10% (increases incrementally up to 10% by 2050)	Black & Veatch analysis. MDV/HDV load should be assumed as an addition to LDV load

As expected, EV-related load increases dramatically over the study horizon, growing from approximately 492 GWh/year in 2030 to 3,624 GWh/year in 2050, as shown in Figure 15. Peak EV load sees similarly dramatic increases, from 55 MW in 2030 to 772 MW in 2050. LDV related load makes up the majority of this increase, as expected given the assumed compliance of Canada's Zero-Emission Vehicle Sales Target of reaching 100% of new LDVs by 2035. Annual consumption growth from Transportation Electrification averages 123% between 2025 and 2035 as federal EV sales mandates ramp up before slowing to 11% per year between 2035 and 2050.

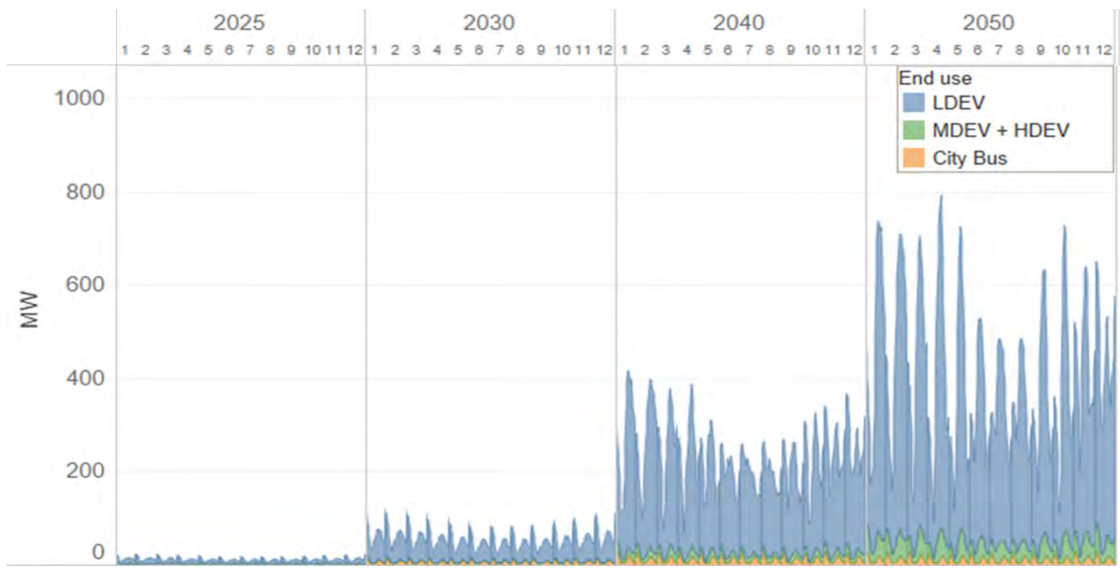
[28] BC Hydro Optional Residential Time-of-Use Rate Application, 2023.
[29] Electric Vehicle User Behavior: An Analysis of Charging Station Utilization in Canada, 2023.
[30] Dunsky & NRCan Updated Projections for Canada's Public Charging Infrastructure Needs, 2022.
[31] J.D. Power Electric Vehicle Experience Home Charging Study, 2023.

Figure 15. Reference Scenario Transportation Electrification Annual Load



The impact of a rate or other EV charging incentives is modeled as effective in shifting EV charging load from high-demand times (typically in early morning and evenings in the winter when heating load is at the highest) to lower demand hours. This trend is demonstrated in Figure 16.

Figure 16. Reference Scenario Transportation Electrification Load Profile



Reference Scenario and Dual-Fuel Scenario: Residential Electrification

Residential energy use in the Reference Case & Dual-Fuel Scenario was projected based on the adjusted decarbonization curve to account for slower progress in the near term while electrification technologies reach greater adoption in Ottawa. By 2050, the Reference Scenario assumes that residential buildings are mostly electrified, with space heating and water heating provided by heat pumps and electric resistance heating. However, roughly a quarter of heating needs are projected to be provided by gas distribution networks in 2050 (assumed to be low carbon such as RNG or hydrogen to meet Canada's decarbonization goals.) In the Dual-Fuel Scenario, a majority of households that adopt heat pumps also maintain their connection to gas distribution networks for use during extreme low temperatures. These technology forecasts were informed by CER's Canada's Energy Future report and collaboration with the team who authored the report.[23]

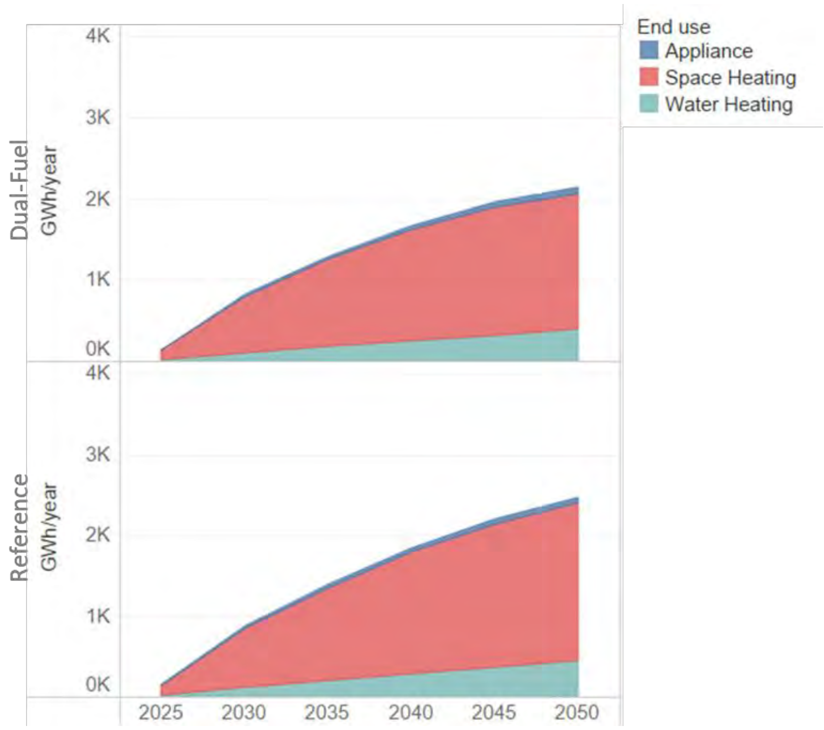
In both the Reference Scenario and the Dual-Fuel Scenario, space heating and water heating was assumed to be more efficient than in the Policy-Guided Scenario to accommodate expected technological advancement in heating technologies over the duration of the study horizon. During the hours in which temperatures remained above -10° C, water and space heating efficiencies remained the same between the Reference Scenario and the Dual-Fuel Scenario. During extreme cold hours (-10°C or lower), the efficiency of electric space heating was assumed to decline given the limitations of certain heat pumps technologies' ability to maintain efficiency during extreme cold temperatures. Table 4 provides a summary of the residential and commercial electrification assumptions used in each load scenario.

Table 4. Residential & Commercial Segment Electrification Assumptions

METRIC	REFERENCE SCENARIO	DUAL-FUEL SCENARIO	INFORMED BY
Space Heating Electrification Target (Achieved by 2050)	76% electric heating (combination of heat pumps and electric furnaces)	76% electric heating (combination of heat pumps and electric furnaces)	Canada's Energy Future report[23]
Heat Pump Space Heating COP	Residential - 3.94 Commercial – 3.65	Residential - 3.94 Commercial – 3.65	• Weighted average electric heating efficiencies • Canada's Energy Future report[23] • National Energy Code of Canada for Buildings[25]
Extreme Temperature (-10°C) Space Heating COP	Space Heating – 1.36	Space Heating – 10.14	Black & Veatch & HOL analysis
Water Heating Electrification Targets	76% electric	76% electric	Canada's Energy Future report[23]

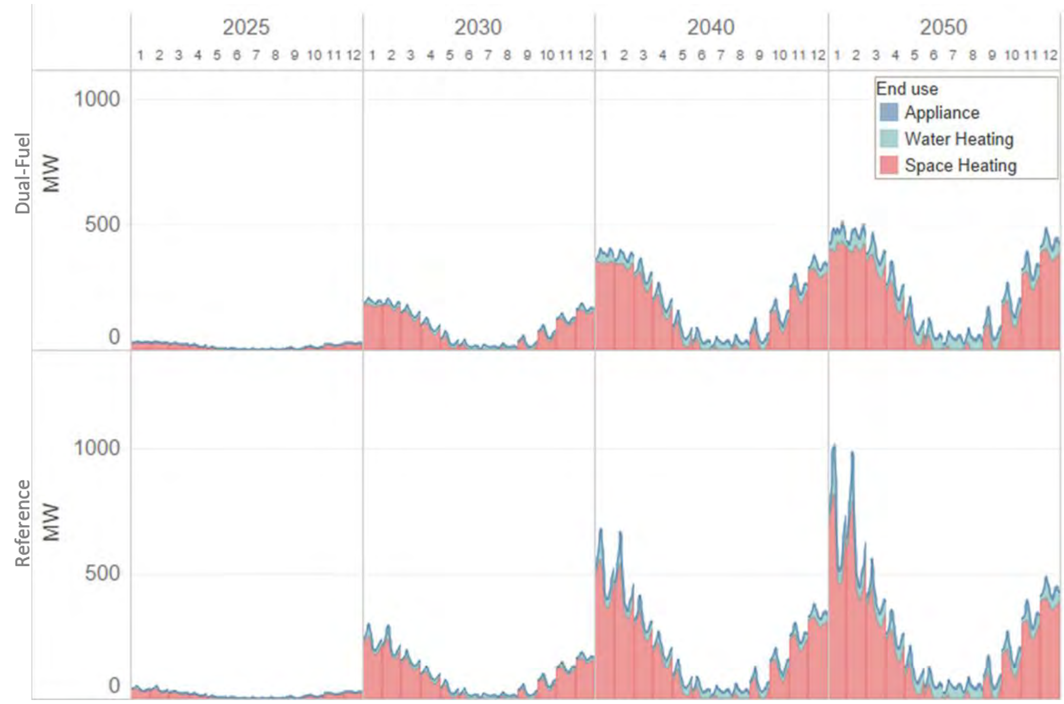
As demonstrated in Figure 17, the revised decarbonization curve slows load growth in the short-term when compared to the Policy-Guided Scenario (summarized in the Policy-Guided Scenario section). Lower space heating and water heating loads drive lower residential loads due to higher efficiency from increased heat pump penetration and continued use of low carbon gas in some buildings.

Figure 17. Reference Scenario Residential Electrification Annual Load



As shown in Figure 18, the use of dual-fuel systems significantly decreases load when comparing the sensitivity to the Reference Scenario. This trend becomes increasingly noticeable in 2035 when Reference Scenario customer electrification reaches 1,389 GWh per year, compared to 1,285 in the Dual-Fuel Scenario. By 2050 the gap increases to 2,472 GWh and 2,147 GWh in the Reference Scenario and Dual-Fuel Scenario, respectively. When extreme temperatures cause heat pump efficiency to drop below a certain threshold, gas-fired heating will ramp up, nearly eliminating electric space heating demand from households with these heating systems. For the purposes of this analysis, that extreme temperature was assumed to be at or below -10°C.

Figure 18. Reference & Dual-Fuel Scenarios Residential Electrification Load Profile

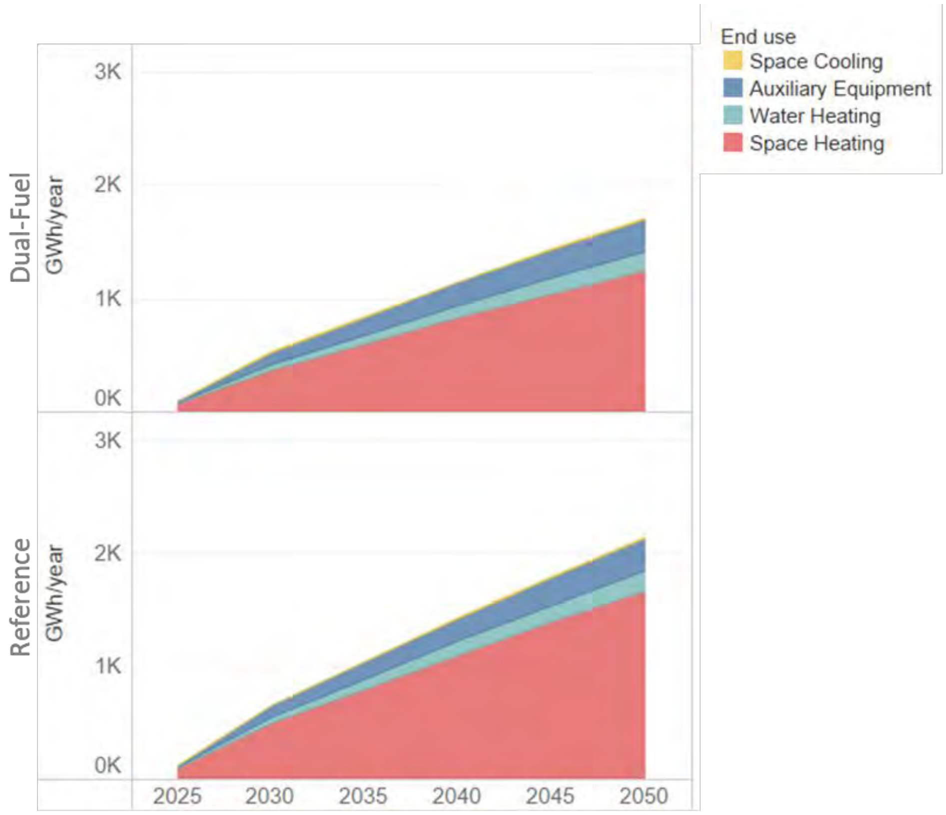


Seen in Figure 18, the seasonal impacts of dual-fuel heating compared to electric-only heating are clear. The most extreme examples occur in early January 2050, when Reference Scenario heating load exceeds 1,000 MW compared to 471 MW during that same hour in the Dual-Fuel Scenario.

Reference Scenario and Dual-Fuel Scenario: Commercial & Federal Building Electrification

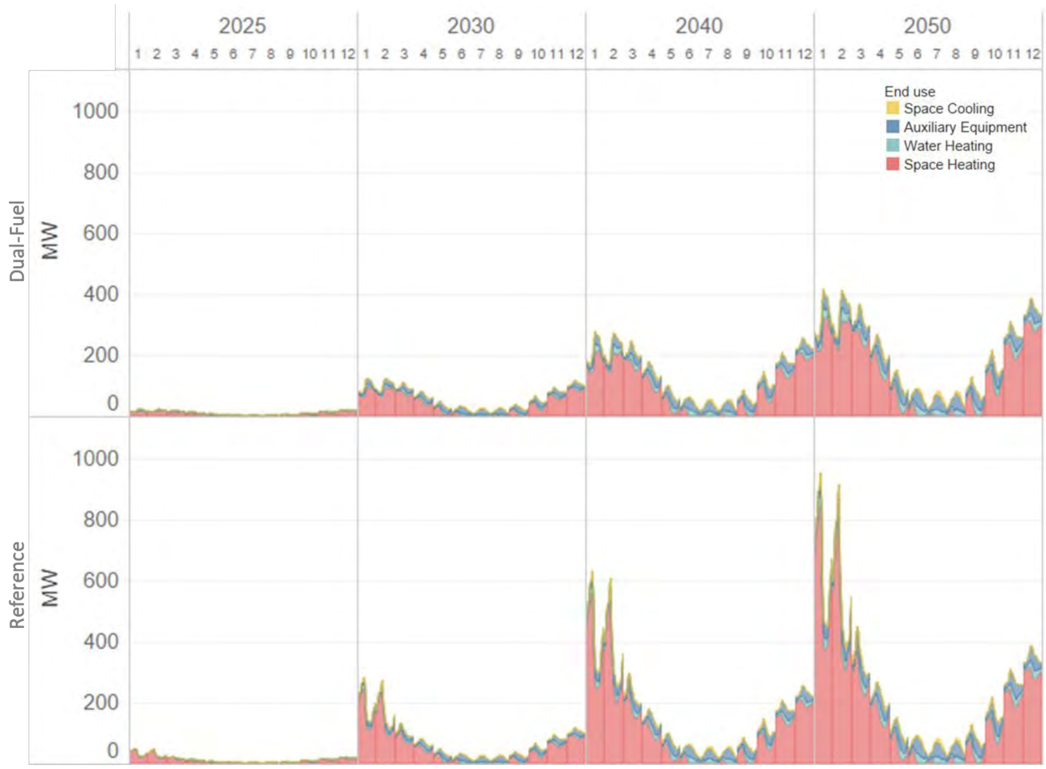
Commercial electrification in the Reference Scenario and Dual-Fuel Scenario follows similar assumptions as residential electrification. Like residential electrification, the adjusted short-term decarbonization curve was used to account for slower progress in the near term to align more closely to observed short-term trends. By 2050, buildings are assumed to be mostly electrified, with space heating and water heating provided by heat pumps and electric resistance heating. These trends are displayed in Figure 19. Roughly a quarter of heating needs are assumed to be provided by gas distribution networks in 2050 (assumed to be low carbon alternatives such as RNG or hydrogen to meet Canada's decarbonization goals). In the Dual-Fuel Scenario, most commercial buildings that adopt heat pumps are assumed to maintain their connection to gas distribution networks for use during extreme low temperatures. These technology forecasts were informed by CER's Canada Energy Future Net-Zero report and collaboration with the team who authored the report.

Figure 19. Reference & Dual-Fuel Scenarios Commercial Electrification Annual Load



The same trends projected in residential electrification are also exhibited in the commercial projections. As observed in Figure 19, the revised decarbonization curve slows load growth in the short term. Higher efficiency from increased heat pump penetration and some continued use of low carbon gas offset the load growth from electrification in later years. In the residential electrification sector, the use of dual-fuel systems significantly decreases load when comparing the sensitivity to the Reference Scenario, as can be observed in Figure 20. When extreme temperatures cause heat pump efficiency to drop below a certain threshold, gas-fired heating will ramp up, nearly eliminating electric space heating demand from buildings with these heating systems.

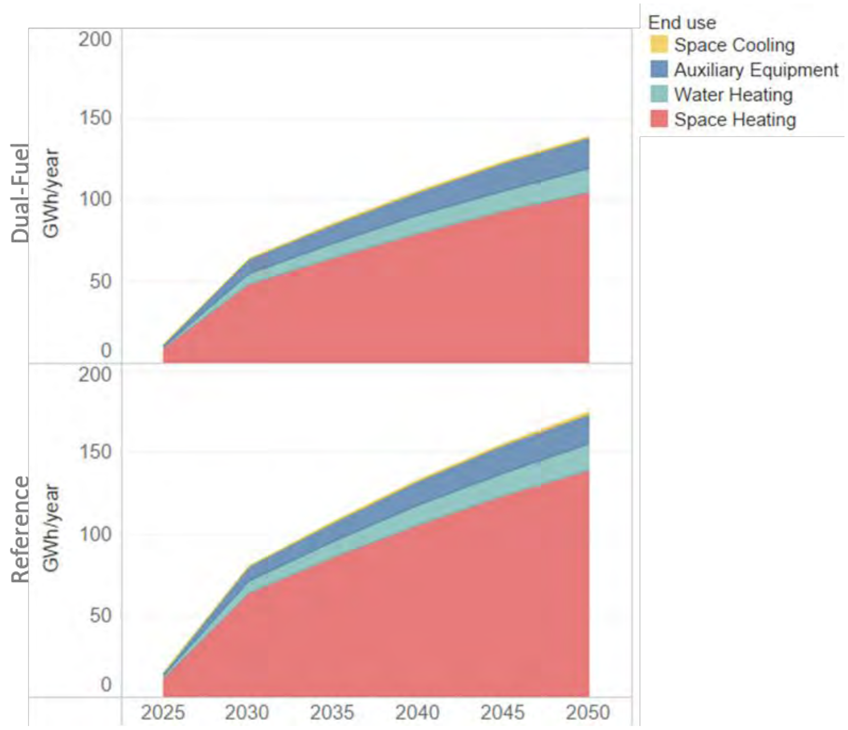
Figure 20. Reference & Dual-Fuel Scenarios Commercial Electrification Load Profile



As observed in the residential sector, seasonal impacts of dual-fuel heating compared to electric only heating are equally observed in the commercial sector. The most extreme examples occur in early January 2050, when Reference Scenario heating load exceeds 900 MW compared to 237 MW during that same hour in the Dual-Fuel Scenario.

Federal Building Electrification in the Reference Scenario and sensitivity utilized the same assumptions as Commercial Electrification, thus the results displayed in Figure 21 represent results consistent with that sector.

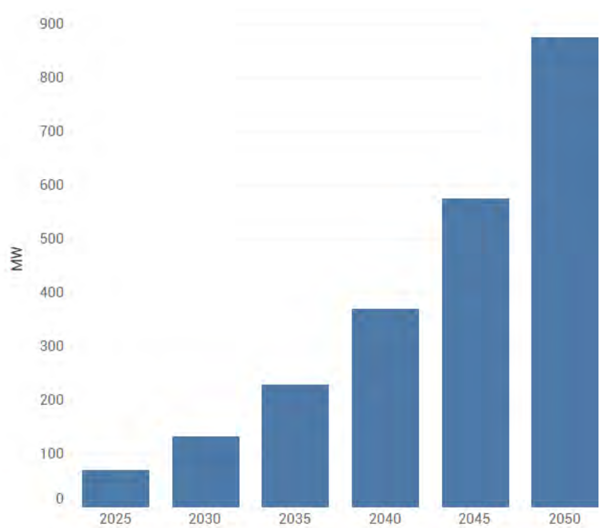
Figure 21. Reference Case Federal Electrification Annual Load



Reference Scenario and Dual-Fuel Scenario: Distributed PV Generation

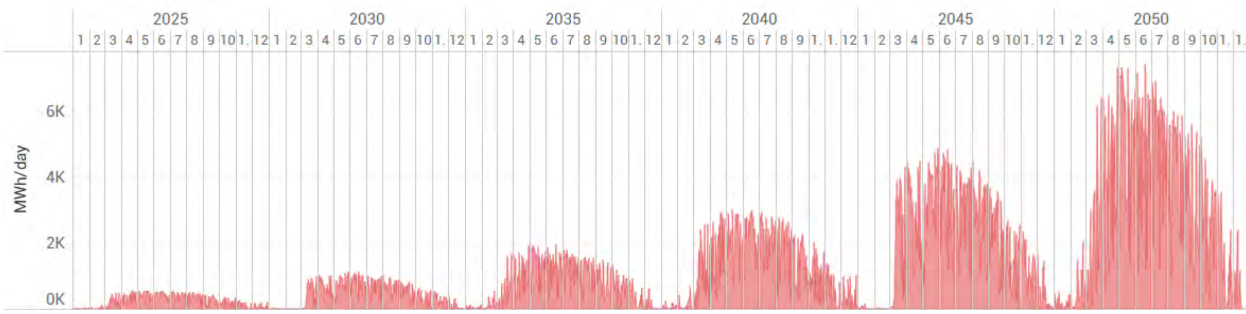
The moderate solar growth scenario from the City of Ottawa's Pathways Study on Solar Power was applied to project the Reference Scenario PV generation.[26] As a result, installed PV capacity grows incrementally throughout the projection horizon from 42 MW in 2022 to 875 MW in 2050, as shown in Figure 22. This same growth is observed in the Dual-Fuel Scenario given that this baseline assumption was unchanged.

Figure 22. Reference Case Distributed PV Installed Capacity



By 2050, distributed PV is projected to provide 5 to 6 GWh of generation on summer days. While this significantly offsets total load, it does not counteract evening peaks driven primarily from residential, commercial, and transportation electrification. Further, distributed PV generation also does little to offset winter evening peaks caused by space heating and water heating, as shown in generation profiles in Figure 23. This dynamic is important as HOL considers the impacts of NWS on the distribution system given that the system shifts from a summer peak to winter peak by 2030 in both the Reference Scenario and the Dual-Fuel Scenario. The role of solar and its ability to be paired with other NWS to increase reliability and resilience at substations is described in greater detail in Section 4.

Figure 23. Reference Scenario Distributed PV Generation Profile



Policy-Guided Scenario

The Policy-Guided Scenario was defined and projected assuming strict adherence to Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. Decarbonization curves and EV adoption curves in this scenario were built based on these policies and targets**.** In doing so, buildings across all sectors were projected to be fully electrified by 2050, phasing out natural gas use to reach zero emissions targets. This scenario represents significant potential impacts to HOL's grid if climate goals are successfully met and there is little done to address the electrification impacts.

Policy-Guided Scenario: Transportation Electrification

Table 5 provides a summary of the transportation electrification assumptions and the sources which informed such assumptions. Unlike the Reference Scenario and Dual-Fuel Scenario, no charging incentives were assumed, resulting in charging profiles that reflect no load-flattening effects driven from incentives. Charging profiles in the Policy-Guided Scenario were informed by the Electric Vehicle User Behavior: An Analysis of Charging Station Utilization in Canada report.[29]

Table 5. Policy-Guided Scenario Transportation Electrification Assumptions

METRIC	ASSUMPTION	INFORMED BY
% of New Electric LDV Sales	2026 – 20% of new LDVs 2030 – 60% of new LDVs 2035 – 100% of new LDVs	Canada Zero-Emission Vehicle Sales Targets
Charger Types	Residential L1 or L2 – 80% Public L2 – 17% Public DCFC – 3%	Dunsky & NRCan,[30] J.D. Power,[31] Black & Veatch analysis

METRIC	ASSUMPTION	INFORMED BY
Rate Incentive Adoption	0%	No load mitigation efforts in the Policy-Guided Scenario
MDV/HDV Load as a Percentage of total LDV load	2050 – 10% (increases incrementally up to 10% by 2050)	Black & Veatch analysis. MDV/HDV load should be assumed as an addition to LDV load

Annual consumption from transportation electrification increases at a compound annual growth rate (CAGR) of 29.5% between 2025 and 2035 as federal EV sales mandates ramp up before slowing to 7% CAGR between 2035 and 2050. Peak load occurs on average around 6:00 pm, driven by the existing trend of commuters getting home and plugging in for the evening. Energy consumed by electric vehicles is greater in the winter than in the summer because of decreased charging efficiency in colder months. This can be seen most pronounced in 2050 where winter peak approaches 1 GW while summer peak is about 650 MW. Figure 24 shows the amount of transportation electrification end use, followed by Figure 25 which shows the transportation load profiles over the study horizon.

Figure 24. Policy-Guided Scenario Transportation Electrification by End-Use

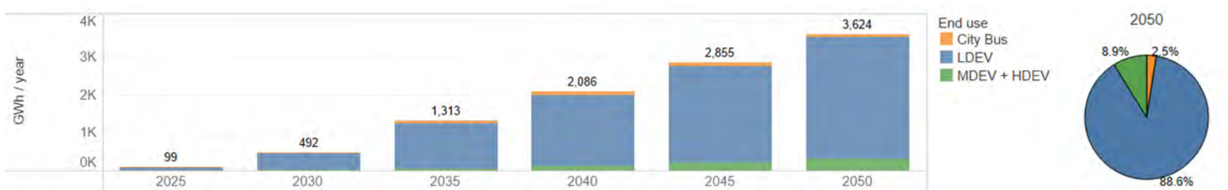
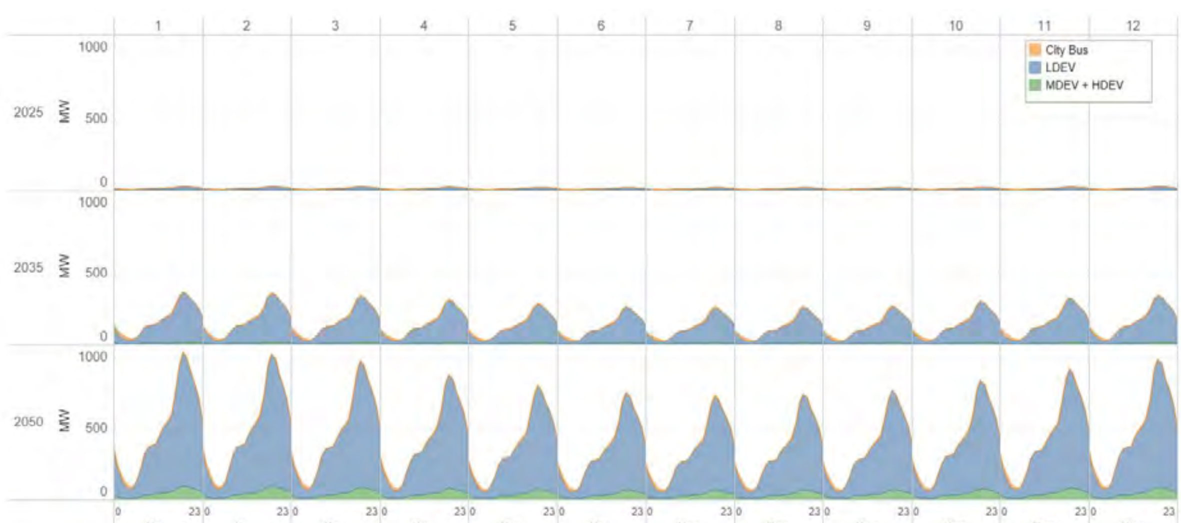


Figure 25. Policy-Guided Scenario Transportation Electrification Load Profile



Policy-Guided Scenario: Residential Electrification

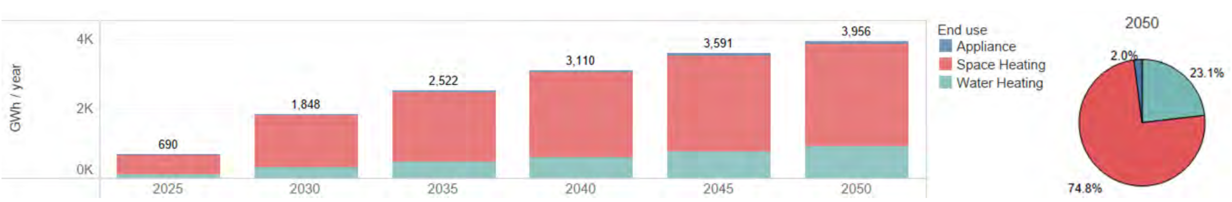
Residential energy use in the Policy-Guided Scenario was decarbonized based on Canada's 2030 Emissions Reduction Plan and the Canadian Net-Zero Emissions Accountability Act. Buildings are assumed to be completely electrified, with space heating and water heating provided by heat pumps and electric resistance heating. Residential heating (both water heating and space heating) was projected to be 100% electrified by 2050, consistent with decarbonization targets leveraged in this scenario. Black & Veatch used a mix of publicly available sources to develop weighted average heating efficiencies. Coefficients of performance (COPs) of both water and space heating declined during hours in which temperature reached below -10°C. Table 6 provides a summary of the residential and commercial electrification assumptions incorporated in this scenario analysis.

Table 6. Residential & Commercial Segment Electrification Assumptions: Policy-Guided Scenario

METRIC	POLICY-GUIDED SCENARIO	INFORMED BY
Space Heating Electrification Target (Achieved by 2050)	100% electric heating (combination of heat pumps and electric furnaces	Scenario assumption that federal targets are met via full building electrification
Heat Pump Space Heating COP	Residential – 3.24 Commercial – 3.00	• Weighted average electric heating efficiencies • Canada's Energy Future study[23] • City of Ottawa Energy Evolution[22] • National Energy Code of Canada for Buildings[25]
Extreme Temperature (-10°C) Space Heating COP	Residential Space Heating – 1.76 Commercial Space Heating – 1.76	Black & Veatch & HOL analysis leveraging combination of datasets above
Water Heating Electrification Targets	100% electric	National Energy Code of Canada for Buildings[25]

Annual new electrification load from residential electrification increased to 1,848 GWh in 2030 and to 3,110 GWh in 2040, an increase of 68% in that 10-year period. While electrification-driven growth slows past 2040 it still grows a considerable 27%, reaching 3,956 GWh/year in 2050. The high electrification growth in the near- to mid-term is driven by the more aggressive decarbonization curve assumed in that period to meet interim Canadian emissions targets. Load growth, while still significant between the 2040 and 2050 period, slows due to a projected heating load comprised of more efficient heating technologies such as air- and ground-source heat pumps. Figure 26 shows residential electrification load increase by end-use over the study horizon.

Figure 26. Policy-Guided Scenario Residential Electrification by End-Use



Space heating and water heating dominate residential electrification, accounting for a combined 98% of new electrification residential load. Space heating drives early morning peaks while water heating has both an evening and early morning peak. This is due to typical residential behavior turning on heating and hot water first thing in the morning and at the end of the workday. Heating efficiency significantly impacts load, and the relatively high penetration of electric resistance heating causes higher residential values than other scenarios. Figure 27 shows residential electrification profiles by end-use.

Figure 27. Policy-Guided Scenario Residential Electrification by End-Use

Policy-Guided Scenario: Commercial Electrification & Federal Building Electrification

Similar to the residential sector, commercial energy use was decarbonized based on the Target for Buildings from the Government of Canada. In line with residential electrification assumptions, commercial buildings are assumed to be completely electrified, with space heating and water heating provided by various commercial technologies that meet the National Energy Code of Canada. Commercial heating (both water heating and space heating) was projected to be 100% electrified by 2050, consistent with decarbonization targets leveraged in this scenario. Black & Veatch leveraged a mix of publicly available sources to develop weighted average heating efficiencies. Coefficients of performance (COPs) of both water and space heating declined during hours in which temperature reached below -10°C.

Like the residential sector, commercial load is dominated by space heating and water heating, as displayed in Figure 28. However, auxiliary equipment such as dryers and ovens play a significant role as well, accounting for 10% of new load by 2050. Unlike residential load profiles, commercial electrification peaks only in the morning. This coincides with the beginning of the workday and trails off in the evening as the workday concludes, as shown in Figure 29.

Figure 28. Policy-Guided Scenario Commercial Electrification by End-Use

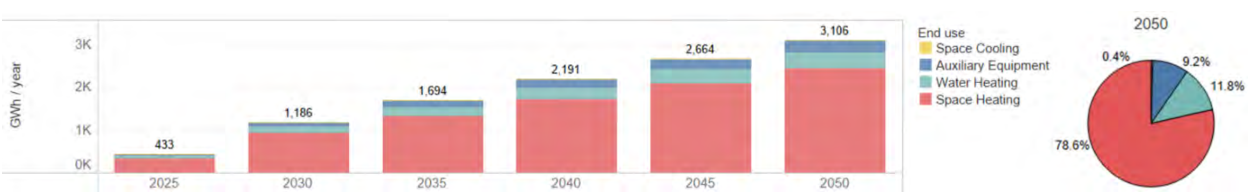
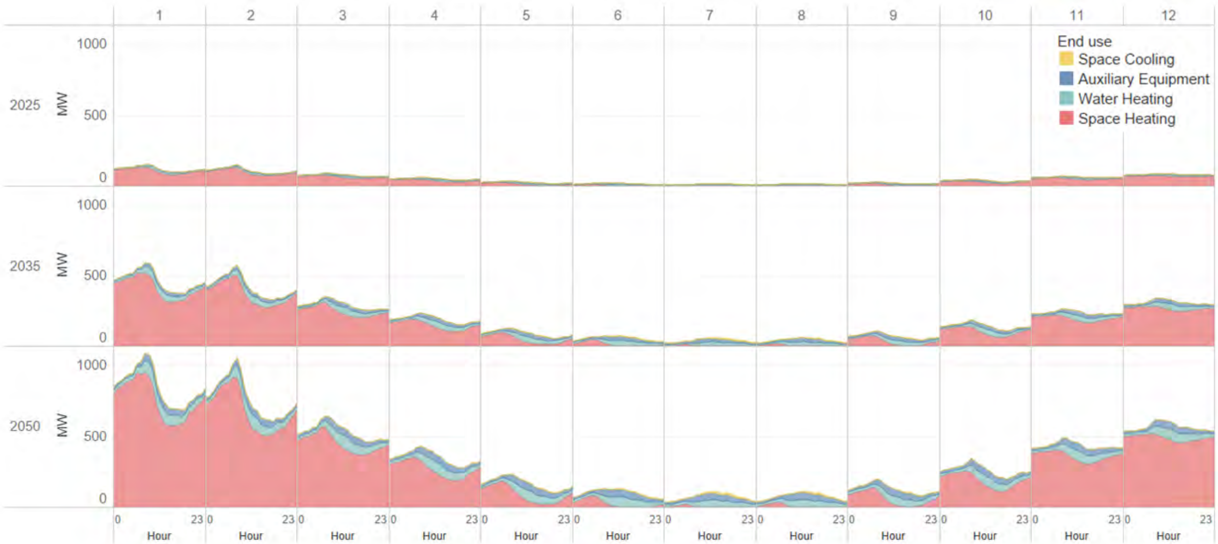
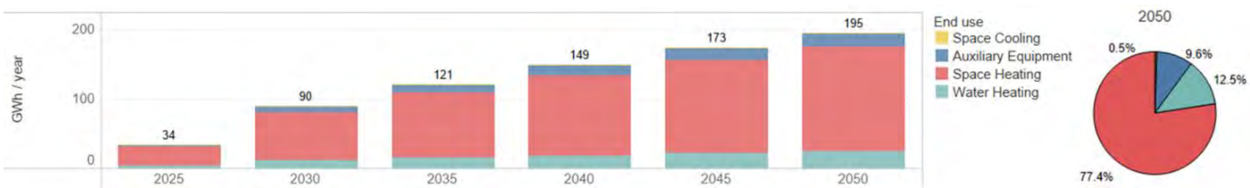


Figure 29. Policy-Guided Scenario Commercial Electrification Load Profile



The same decarbonization assumptions and energy uses for Commercial buildings were used for the 130 Federal buildings, however decarbonization targets were applied to each facility's estimated energy consumption rather than the sector's energy consumption as a whole. Because of these assumptions, results from Federal building electrification mirror those of commercial buildings, as shown in Figure 30.

Figure 30. Policy-Guided Scenario Federal Electrification by End-Use



Policy-Guided Scenario: Distributed PV Generation

The moderate growth scenario from the City of Ottawa's Pathways Study on Solar Power[26] was also applied to project the Policy-Guided Scenario PV generation. As a result, installed PV capacity increases incrementally throughout the horizon from 42 MW in 2022 to 875 MW in 2050, identical to the Reference and Dual-Fuel Scenarios, as shown in Figure 31 and Figure 32.

Figure 31. Policy-Guided Scenario Distributed PV Installed Capacity

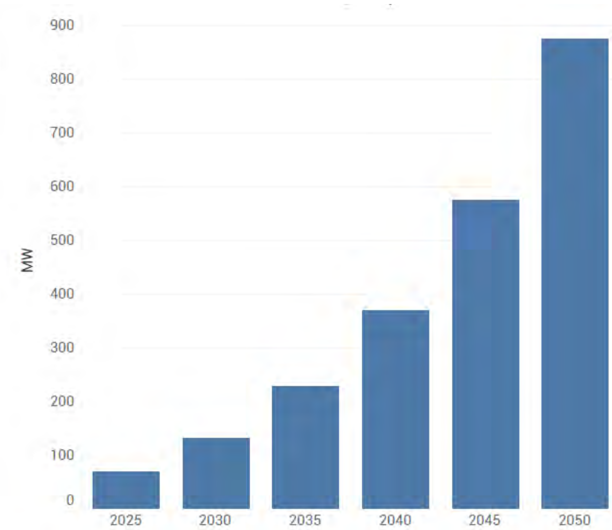
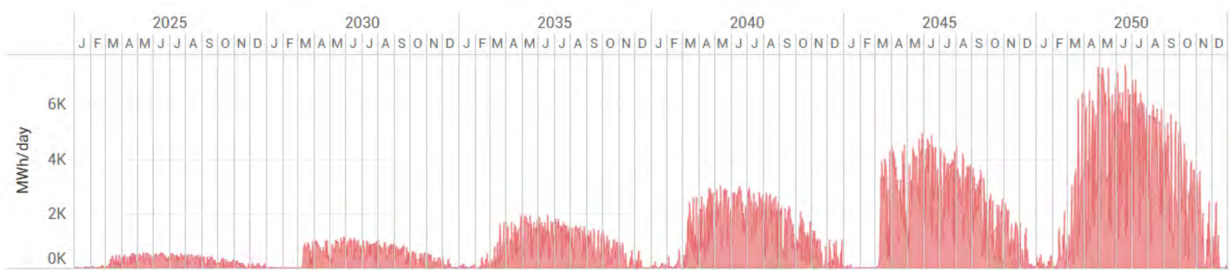


Figure 32. Policy-Guided Scenario Distributed PV Generation Profile



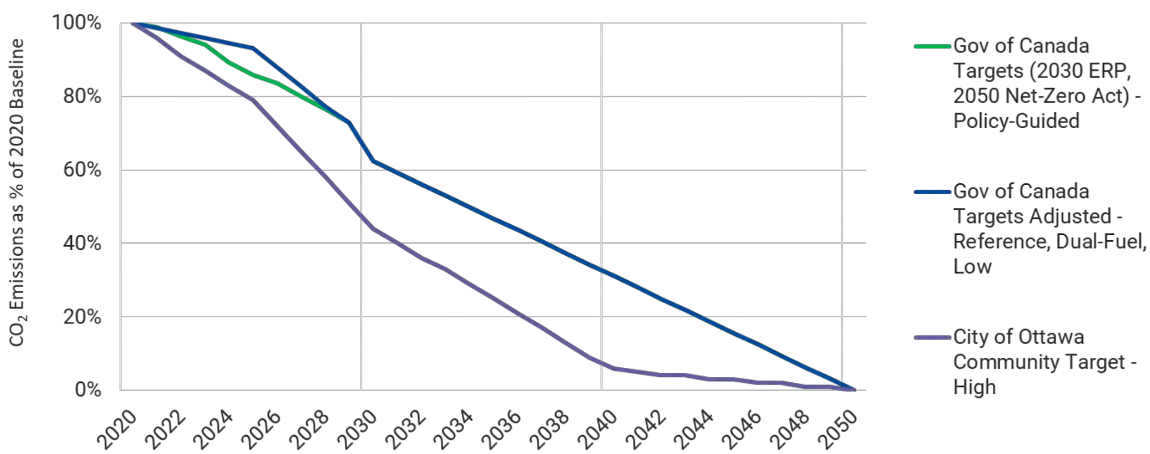
Given the use of the same solar projections and curves, solar projections in the Policy-Guided Scenario are identical to the Reference and Dual-Fuel Scenarios as summarized. By 2050, distributed PV contributes 5-6 GWh of generation on summer days. While this significantly offsets total load, it does not counteract evening peaks driven primarily from residential, commercial, and transportation electrification. Further, distributed PV generation also does little to offset winter evening peaks caused by space heating and water heating.

High & Low Sensitivities

The High Case Sensitivity and Low Case Sensitivity were developed to examine more aggressive and less aggressive decarbonization pathways, respectively, than current climate goals and expectations. Each sensitivity is meant to show possible high and low extremes in each customer segment and thus faster or slower progress towards climate goals.

To track with these trends, the High Case assumes a general societal shift towards a decarbonization mindset, where electrification not only happens faster but efficiencies of electrification technologies improve due to significant focus on research & development. Most notably, the High Sensitivity assumes the achievement of near-complete decarbonization by 2040, the most aggressive of all scenarios and sensitivities modeled in this study (see Figure 33). Conversely, electrification technologies are adopted slower in the Low Case and a higher proportion of households and commercial buildings continue to rely on decarbonized gaseous fuels.

Figure 33. Scenario & Sensitivity Decarbonization Profile Comparison



High & Low Sensitivities: Transportation Electrification

The primary differentiator in the sensitivities when compared to previously discussed transportation electrification is the rate of EV adoption (i.e., growth of new EV sales). In the High Sensitivity, EV adoption accelerates even faster than Canada's federal targets, reaching 90% of new vehicle sales by 2030 and 100% by 2035. Conversely, the Low Sensitivity models a significantly slowed pace of EV adoption, whether that be driven by societal resistance, lack of charging infrastructure build-out, or long-term supply chain issues. In the Low Sensitivity, EVs reach 40% of new sales by 2035 and 90% by 2050, indicating that a significant portion of the overall vehicle stock will remain gasoline or diesel powered past 2050. Table 7 shows the full list of assumptions specific to these sensitivities.

Table 7. High & Low Sensitivities Transportation Electrification Assumptions

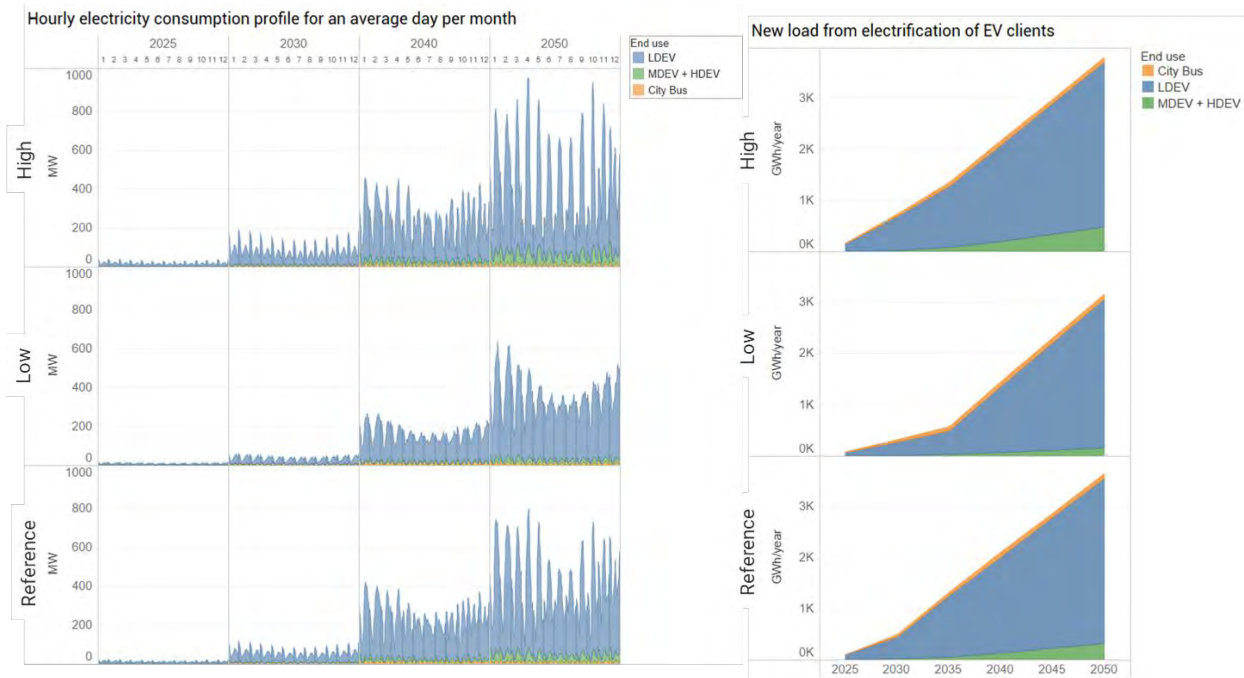
METRIC	HIGH SENSITIVITY	LOW SENSITIVITY	INFORMED BY
% of New Electric LDV Sales	2026 – 30% 2030 – 90% 2035 – 100%	2026 – 16% 2035 – 40% 2050 – 90%	High: Combination of City of Ottawa Energy Evolution[32] & Federal Targets Low: Sustainability Solutions Group's Pathway Study on Transportation in Ottawa[33]

[32] City of Ottawa Energy Evolution.
[33] Sustainability Solutions Group Pathway Study on Transportation in Ottawa, 2019.

METRIC	HIGH SENSITIVITY	LOW SENSITIVITY	INFORMED BY
Charger Types	Residential L1 or L2 - 85% Public L2 – 12% Public DCFC – 3%	Residential L1 or L2 – 80% Public L2 – 17% Public DCFC – 3%	Dunsky[30], JD Power[31], Black & Veatch analysis
Rate Incentive Adoption	90%	50%	High: BC Hydro TOU Rate Application High-End Sensitivity[28] Low: BC Hydro TOU Rate Application Low-End Sensitivity[28]
MDV/HDV Load as a Percentage of total LDV load	2050 – 15% (increases incrementally up to 15% by 2050)	2050 – 5% (increases incrementally up to 5% by 2050)	Black & Veatch & HOL analysis

As illustrated in Figure 34, adoption rates of both LDV and MDV/HDV significantly influence the rate at which EV load grows. From 2030-2040, the High Scenario outpaces the Reference Scenario because EVs have already reached 90% of new vehicle sales by 2030. The opposite can be seen in the Low Sensitivity, as EVs do not reach 40% of new sales until 2035 and have still not fully displaced ICE vehicles by 2050. Separate from the quantity of load, the transportation load profile changes drastically in the High and Low case due to the levels of rate incentive adoption. When compared to the Reference Scenario with 75% adoption, the High sensitivity (with 90% adoption) EV load shifted more towards midday hours when load is generally lower, potentially aiding in HOL load management. Conversely, the EV load in the Low sensitivity displays much less severe peaks than the other two shown because, with only 50% rate incentive adoption, fewer people are prioritizing charging at certain times of low demand during the day.

Figure 34. High & Low Sensitivity Transportation Electrification



Residential, Commercial, and Federal Electrification

In the building sectors for the High and Low Sensitivities, electrification rates, decarbonization timing, and efficiency of heating were all altered to reflect the more and less aggressive projection, respectively. Efficiencies were improved in the High Sensitivity to reflect a societal acceptance of electrification and the associated innovation to be expected with such a shift. The opposite logic was applied to the Low Sensitivity. Table 8 provides an overview of the residential and commercial electrification assumptions used in the high and low sensitivities.

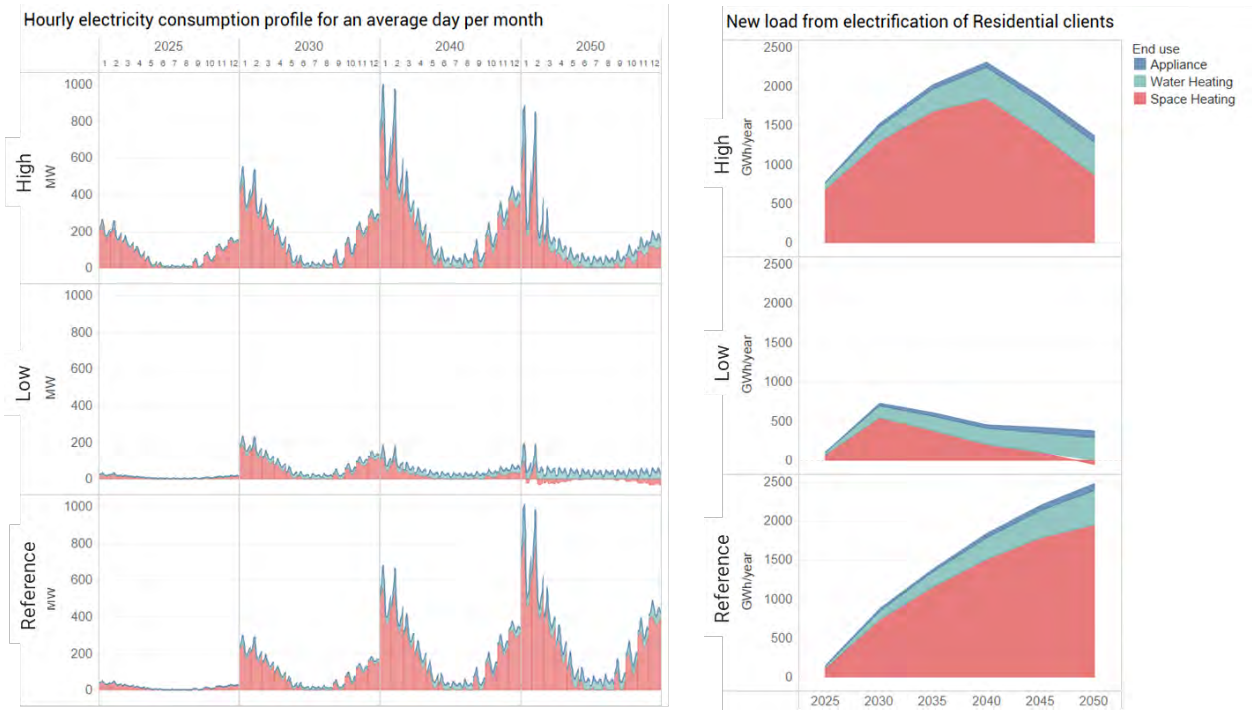
Table 8. Residential & Commercial Segment Electrification Assumptions: High & Low Sensitivities

METRIC	HIGH SENSITIVITY	LOW SENSITIVITY	INFORMED BY
Space Heating Electrification Target (Achieved by 2050)	85% electric heating	40% electric heating	High: Enbridge Pathways Study, Electrification Scenario[24] Low: Enbridge Pathways Study, Diversified Scenario[24]
Heat Pump Space Heating COP	Residential – 3.96 Commercial – 3.67	Residential – 3.24 Commercial – 3.00	• Weighted average electric heating efficiencies • Enbridge Pathways Study[24] • National Energy Code of Canada for Buildings
Extreme Temperature (-10°C) Space Heating COP	Residential Space Heating – 1.43 Commercial Space Heating – 1.43	Residential Space Heating – 1.76 Commercial Space Heating – 1.76	Black & Veatch & HOL analysis leveraging combination of datasets above

As expected, heating demand in the High Sensitivity and Reference Scenario shares more similarities when compared to the Low Sensitivity. However, the difference in the decarbonization curve between these two scenarios should be noted. The High Sensitivity assumes a more aggressive decarbonization curve compared to the more moderate curve assumed in the Reference Scenario. In the High Sensitivity, decarbonization is assumed to be nearly complete by 2040, compared to 2050 in the Reference Scenario. Further, residential heat pump adoption is assumed to be higher in the High Sensitivity compared to the Reference Scenario, resulting in overall more efficient heating loads in the later years in the horizon as adoption is increased. This is reflected in an observed decline in total electrification in the High Sensitivity post-2040 through the end of the horizon.

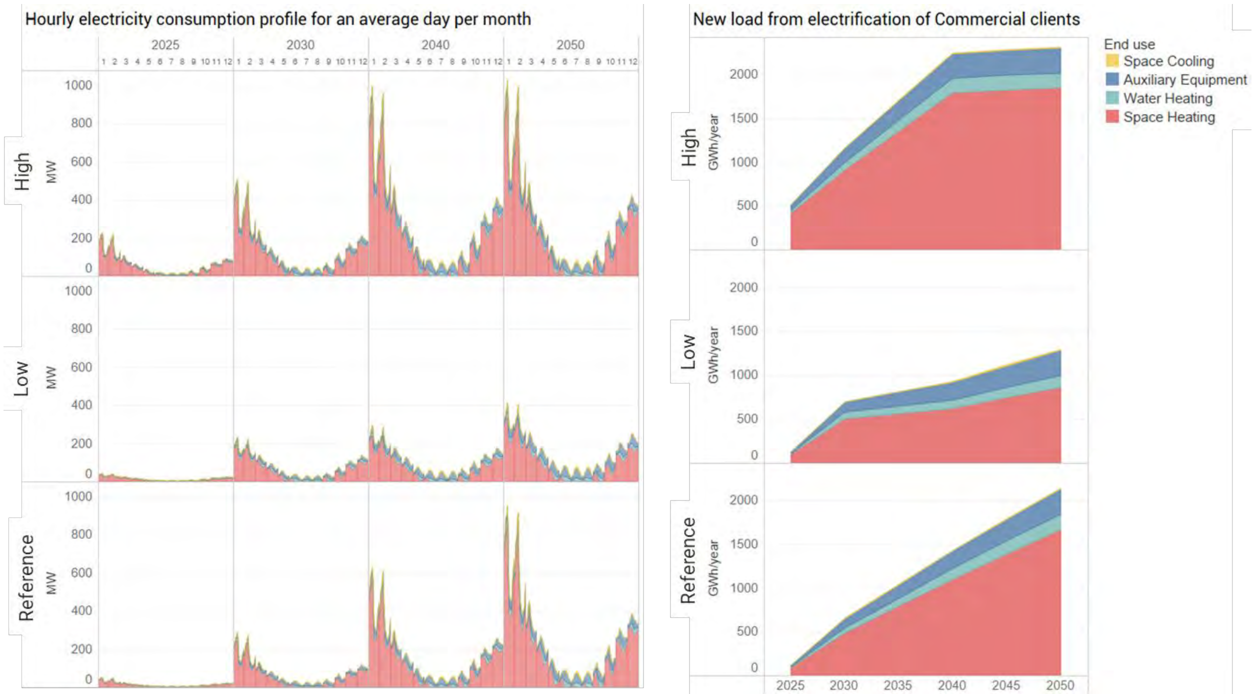
As an example, the Reference Scenario reaches over 1,000 MW of residential heating electrification in January on one day; during that same day, the High Scenario reaches 880 MW and the Low Scenario only 188 MW. This trend is more clearly shown in Figure 35. This trend is especially true for the period between 2040 and 2050 after full decarbonization is reached in the High Sensitivity. In the Low Sensitivity, space heating shows negative values at the end of the horizon as existing electric resistance space heating is converted to higher-efficiency heat pumps or low carbon gas.

Figure 35. High & Low Sensitivity Residential Electrification



The same trends observed in residential electrification are true for commercial electrification. As demonstrated in Figure 36, the High Sensitivity load increases driven by near-complete decarbonization by 2040 ramps up significantly towards 2040 compared to the Reference Scenario. After 2040, commercial, residential, and federal building electrification in the Reference Scenario catches up and then eventually outpaces the High Sensitivity.

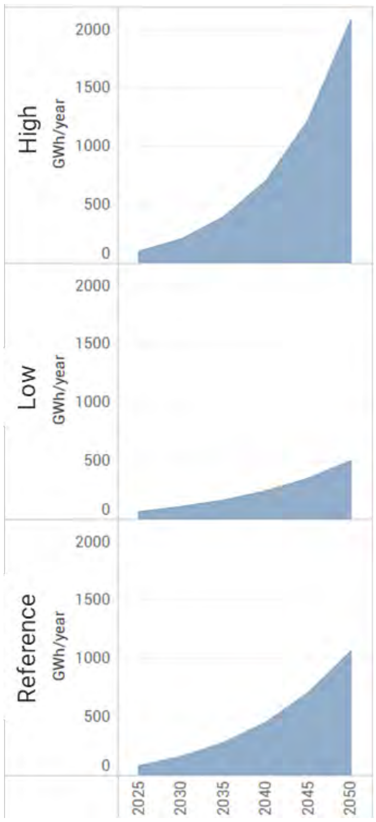
Figure 36. High & Low Sensitivity Commercial Electrification



Distributed PV Generation

The High & Low Sensitivities utilized the Aggressive Scenario and Conservative Scenario, respectively, from the City of Ottawa's Pathways Study on Solar Power (reflected in Figure 9).[26] The different growth rates across projections lead to significant differences in PV generation on HOL's grid. By 2050 PV in the High sensitivity generates 2,089 GWh per year, nearly twice as much as the Reference Scenario while the Low sensitivity generates 501 GWh – less than half the Reference Scenario. The resulting PV generation projection of each sensitivity is shown in Figure 37.

Figure 37. High & Low Sensitivity Annual Projected PV Generation



2.3 RESULTS SUMMARY & COMPARISON

Black & Veatch modeled system-level results for HOL's grid by compiling baseload and new electrification load across all customer segments for each of the three primary scenarios. This section summarizes key results for these scenarios and provides insights on the drivers of load growth and peak shifts throughout the study horizon. In all scenarios and sensitivities, load growth and peak demand are expected to increase dramatically. Projected building and heating electrification across all sectors paired with a shift from internal combustion engine vehicles (ICE) to EVs adds expected but considerable load increases to the HOL distribution system.

Impact on Peak Load and Peak Timing

All scenarios project significant peak load growth for HOL's grid (see Figure 38 and Figure 39). The Reference Scenario peak demand grows at a CAGR of 4.7% from 1,348 MW in 2022 to 4,947 MW in 2050. Policy-Guided Scenario peak demand grows at an annual rate of 5.2% to reach 5,573 MW in 2050 while Dual-Fuel Scenario peak grows at a slower CAGR of 3.1% per year, reaching 3,135 MW in 2050. This type of dramatic growth associated with the decarbonization of Ottawa's economy is an expected departure from the observed trend in the past decade-plus on HOL's system of flat or declining peak load (1,518 MW in 2010 and 1,308 MW in 2014.) This expectation is driven from the relatively aggressive decarbonization assumptions and existing initiatives supporting those assumptions for Canada to meet its aggressive emissions and net-zero targets in the mid-to-long term.

Figure 38. Scenario Peak By Year

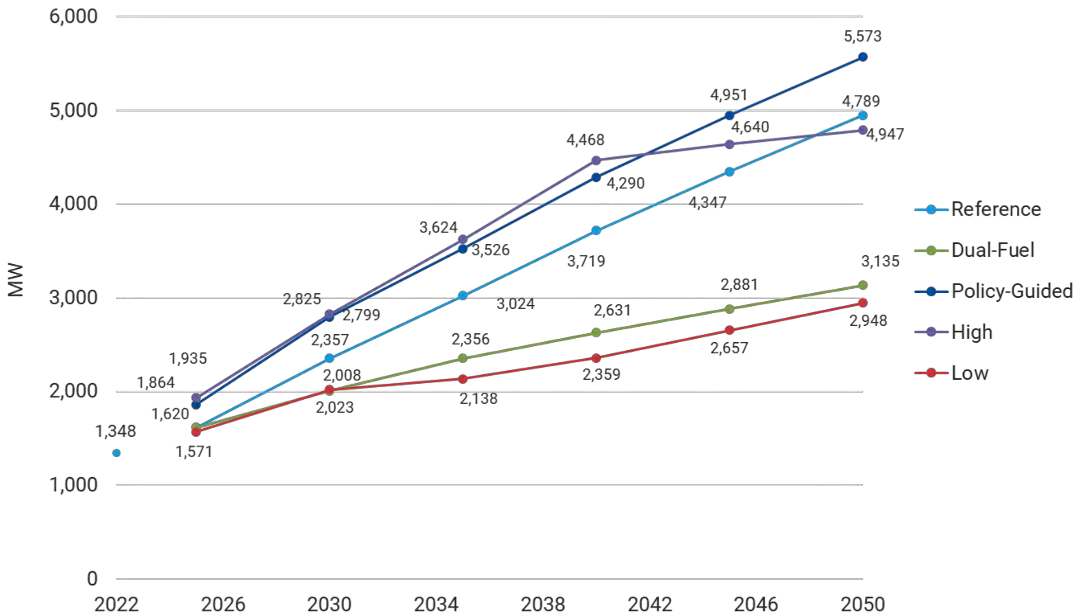


Figure 39. Scenario & Sensitivity Peak Timing Projections

Scenario		2022	2025	2030	2035	2040	2045	2050
Reference		17:00	15:00	18:00	18:00	18:00	18:00	18:00
		July 20	July 16	Jan 20	Jan 20	Jan 20	Jan 20	Jan 20
Dual-Fuel		17:00	15:00	18:00	18:00	18:00	18:00	13:00
		July 20	July 16	Jan 23	Jan 22	Jan 23	Jan 23	Mar 1
Policy-Guided		17:00	18:00	18:00	18:00	18:00	18:00	18:00
		July 20	Jan 21	Jan 20	Jan 20	Jan 20	Jan 20	Jan 20

Note: yellow indicates summer peak; blue indicates winter peak

In the Reference and Dual-Fuel Scenarios, HOL's system remains summer-peaking through 2025 (seen in yellow cells in Figure 39), as it is today. In all scenarios, the system-level peak shifts to winter by 2030 with the Policy-Guided Scenario becoming winter-peaking by 2025, as expected given that this scenario was modeled with the most aggressive decarbonization curve. Conversely, the delay in the switch to winter-peaking in the Reference and Dual-Fuel Scenarios is driven by the applied decarbonization curve which projects a tempered rate of decarbonization in the near term before decarbonization technologies such as heat pumps and electric vehicles reach widespread adoption in the mid-term.

The shift to winter peak timing is largely driven by space heating. This effect is especially pronounced in the Reference and Policy-Guided Scenarios, where higher electrification rates in buildings lead to spikes in space heating when temperatures are low and impact heating efficiency. Compounding this effect is the prevalence of electric resistance heating in the Policy-Guided Scenario, which has lower efficiency than heat pumps. The Dual-Fuel Scenario is much less exposed to these lower efficiencies due to high penetration of dual-fuel heat pump systems which switch to gas when efficiencies drop below a certain threshold.

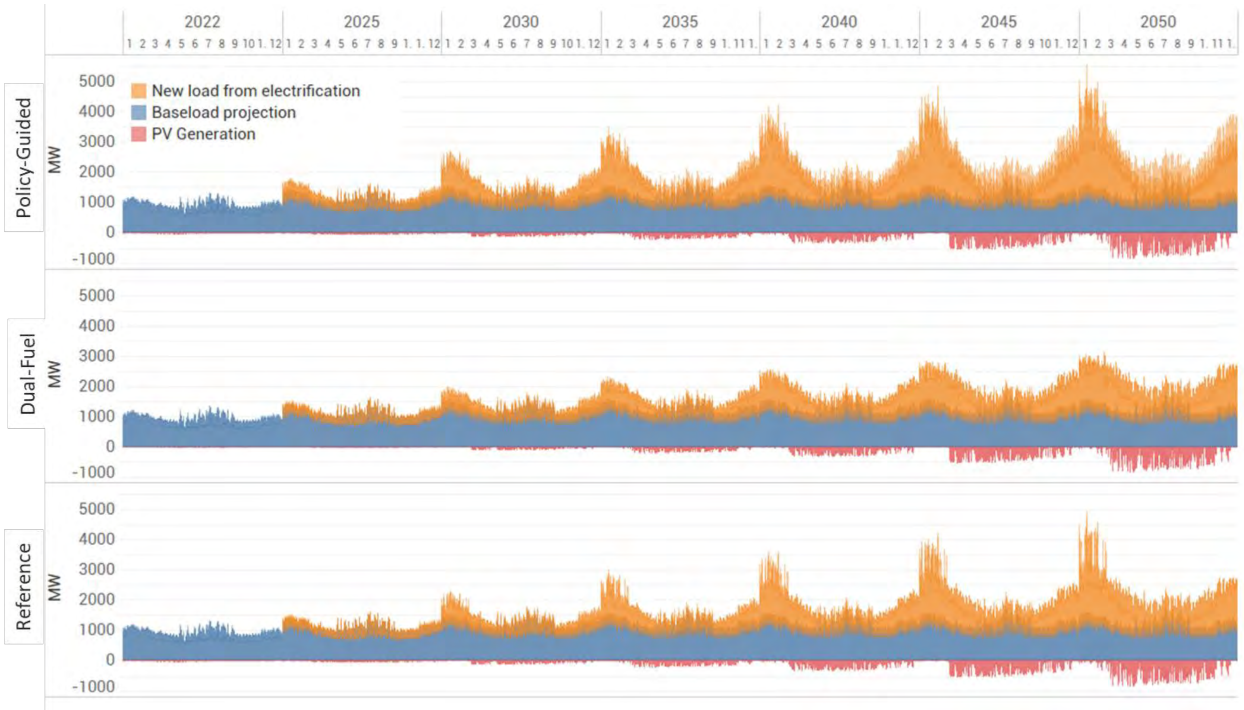
Peak demand in the Reference and Dual-Fuel Scenarios is also tempered by EV Charging incentives, which displace EV charging load from peak demand hours to low demand hours. These rate incentives are effective at lessening peak demand because they drive shifts in projected charging load away from the early evening when residents return from work, plug in their EV, turn the heat on, and begin cooking dinner.

Impact on Annual Electricity Consumption

Across the study horizon, new electrification load is the primary driver of load growth. Baseload consumption grows 10% between 2025 and 2050 while new electrification load grows over 2,000% in the same period in the Reference Scenario. In the summer months, EVs become the dominant source of new load for all scenarios as space heating and water heating become the dominant source of new load in the winter months.

The Policy-Guided Scenario projects the highest annual consumption of the three primary scenarios, 9% higher than the Reference Scenario and 10% higher than the Dual-Fuel Scenario in 2025. This trend continues and the gap widens through 2050, where it is 14% and 20% higher than the Reference and Dual-Fuel Scenarios respectively (see Figure 40). This higher annual load is driven by the full electrification of buildings across all customer segments in the Policy-Guided Scenario, while the other two scenarios maintain differing proportions of gas in the energy mix. While the Reference and Dual-Fuel Scenarios show similar annual consumption, the penetration of dual-fuel heating systems causes significantly different peak demand.

Figure 40. System-Level Annual Load Profile by Scenario



A detailed assessment of the implications of a decarbonization-driven electrification future on the HOL distribution system is outlined in the following section, specifically considering planning and systems upgrades for the HOL distribution system under a future in which the Reference Scenario is realized.

3.0 Decarbonization Load Impacts to HOL's Distribution System

3.1 METHODOLOGY & ASSUMPTIONS

Once the load was projected (approach and key findings by scenario in Section 2.0), a mitigation strategy to manage this increase in load was developed in two steps:

(1) an overload analysis to determine which substations are overloaded; and

(2) proposed strategies to manage the overload conditions at specific substations.

The methods for these tasks are described below.

Overload Analysis

The projected Reference Scenario load allocated to the existing 92 substations within HOL's service territory, as described in Section 2.1 Methodology and Assumptions, was utilized to assess if an overload condition was projected at each substation. HOL provided the characteristics for each of the 92 substations that was used as input into this analysis.[34] These inputs are included in Appendix A.

An initial screening was performed to evaluate if a substation needed to be included in the comprehensive overload analysis. Of the 92 existing HOL substations, 35 were excluded from the overload analysis if they met either of the following criteria. As such, only 57 substations are evaluated for overload[35]. Substations were not included for one of the following two reasons:

- If the substation is already planned for a voltage upgrade, or
- If the substation is planned to be decommissioned

Many of these planned voltage upgrades and decommissions are due to the load growth expected on HOL's existing 4kV system. Forecasts from HOL, further supported by this study, indicate the 4kV system will not be able to support expected load growth. As a result, the 4kV system is being upgraded to supported future load growth.

An overload condition is defined as when the allocated load from the Reference Scenario exceeds the station planning rating for each substation on an hourly basis. HOL provided the station planning ratings

[34] For the purposes of this analysis, Black & Veatch considered Bridlewood MS as two substations, one rated at 28kV and one at 8kV. If combined, the total substations is 92.
[35] Due to Bridlewood MS being modeled as 2 different substations with different characteristics, the overall results may vary resulting in 93 total substations being evaluated.

for each substation to be used in this analysis. Due to the effects of temperature on transformer capacity, separate planning ratings for summer and winter were used.[36]

The overload analysis compared the hourly projected load against the existing winter or summer planning rating depending on the month of the applied load. If the projected load exceeds the planning rating for the time of year the load occurs, the amount of overload was determined and an overload condition for that season is noted. If there is an overload for either winter or summer, then it is considered to be overloaded for that year.

The analysis was done for the years 2035 and 2050. These two years were selected as 2035 would indicate a lower, but more certain load case in the short term, where the 2050 load case would indicate a higher, but more uncertain load case in the long run. These two cases are used to set lower and upper bounds for needed investments to address the new load profiles on the distribution system.

Management of Overload Conditions

Once the overload conditions were established, two approaches were utilized to address the overload condition at each substation: evaluation of the potential to transfer the load from the overloaded substation to connected substations in the same grouping within the same distribution system and/or evaluation of the options for capital improvements to accommodate decarbonization load projections.

Potential to Transfer Load

HOL substations were organized in groupings that represent the potential capability of transferring load from one substation to another within the same grouping. This provides HOL flexibility in handling unusually high loads in times of peak stress or managing load when substations are unavailable for maintenance.[37] Given the new decarbonization projected load, these groupings could be utilized to distribute the load from the overloaded substation to connected substations in the same grouping. By doing so, this approach would allow HOL to avoid system modifications to address the overloaded condition and thus potentially avoid capital expenditure.

To evaluate whether the load that exceeds the planning ratings for equipment at each substation could be transferred, the amount of load above the planning rating (summer or winter, as appropriate given the time of year of the load) was compared to the available capacity in the connected substations within the same grouping. If there was available capacity in the connected substations based on their load at that same hour and their planning rating, then the potential to transfer the load was flagged. An illustrative example is shown in Figure 41. If not, it is not considered to be able to transfer the load. This is illustrated in Figure 42.

[36] The winter planning rating was applied from November through March, and the summer planning rating was applied from April through October.
[37] These groupings are shown in Appendix A.

Figure 41. Potential to Transfer Overload Illustrative Example

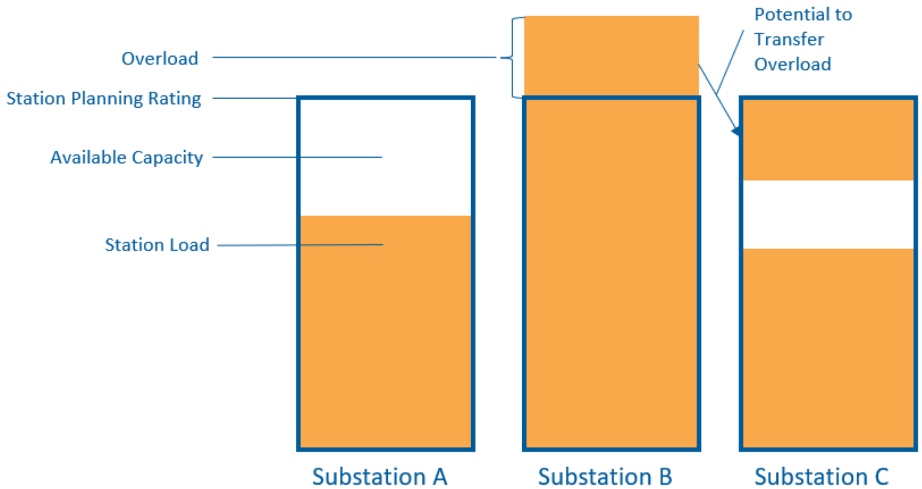
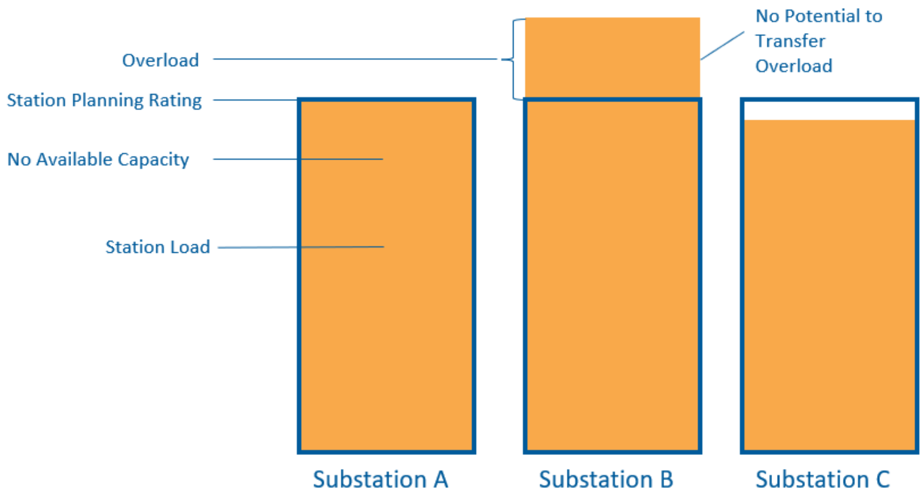


Figure 42. No Potential to Transfer Overload Illustrative Example



It should be noted that this evaluation only determines the potential to transfer the load as it evaluates the load against the substation planning ratings, but does not include the following considerations that would be required to do fully determine if a transfer is possible:

- Available feeder circuit capacity
- Available feeder tie circuit capacity
- Protection and coordination settings

A detailed system connected feasibility study and other distribution model studies are required to fully determine if a transfer can actually be performed. Because this evaluation only includes the potential to transfer the overload, this analysis was used to set upper and lower bounds on capital investment required to address the overload. Upgrades required for substations that cannot transfer the overload sets the minimum amount of capital investment needed to address the overload. The upper bound assumes that no substations can transfer the load and modifications are needed for all substations to handle the overload.

Capital Improvements to Accommodate Overload

The second approach to manage the new projected load in the Reference Scenario involved modifications to the existing distribution system, accomplished via either a wires only solution (i.e., traditional substation upgrades) or a non-wires solution. Examples of potential non-wires solutions (NWS) include solar, BESS, combustion turbines (CTs), RECIPS, fuel cells, and micronuclear. From these options, only BESS and RECIPs were considered. Solar was not included due to the large amount of land per MW required. Moreover, solar is least effective in winter when the new system peak occurs. CTs and fuel cells are not as effective in this use case due to significant dynamic and part load operation compared to RECIPs. Micronuclear was not considered due to technology maturity, cost, and schedule/licensing issues.

As a result of this NWS screening, the following technologies were evaluated for each of the overloaded substations:

- Wires Only Solutions – Consideration of only traditional wires solutions to addressed substation overload conditions. Wires only solutions include upgrades to existing substations and/or the addition of new substations.
- BESS – Evaluation of the role of BESS as an NWS to address substation overloads over the study horizon. If the substation had enough capacity during non-overload hours to sufficiently charge a BESS to discharge during an overload condition, the substation was determined to be eligible for a BESS. If there was not sufficient power available to charge a BESS prior to the overload, a BESS was not proposed, and the wires only was applied.
- RECIPs – Evaluation of the role of RECIPs as an NWS to address substation overloads. Each overloaded substation was evaluated to determine the required size and directional cost of the RECIP required.

The evaluation of each of these technologies only considers the required capacity to address the overload. No technical feasibility analysis was performed as part of the study. Items that were not considered but are recommended for future analysis include but are not limited to the following:

- Available footprint to upgrade existing transformers, add new transformers, add BESS or reciprocating engines to an existing substation.
- Available land to add new substations in the required service area.
- Ability of circuits outside of the substation to carry the additional load.
- Ability to provide sufficient natural gas to the reciprocating engines.

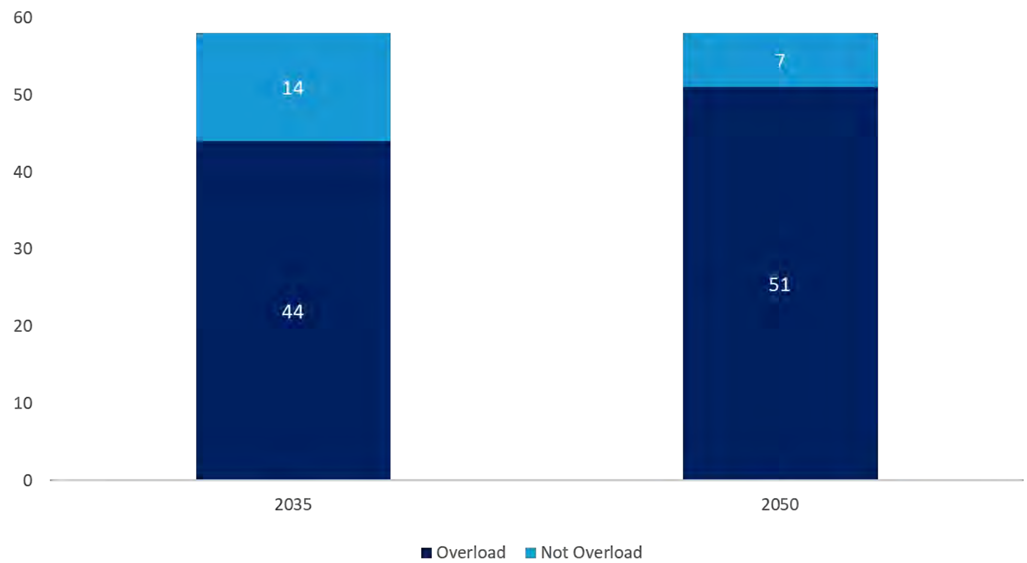
3.2 SUBSTATION OVERLOAD RESULTS & SOLUTIONS SCENARIOS

The results of the overload analysis are presented in two sections. The first section outlines the substation overloads that were identified and the second discusses the different wires and non-wires solutions assessed in this analysis to address substation overload. The second section provides a deep dive into the comparison of the two primary solution scenarios and compares the ROM cost of addressing the overload conditions to ensure future HOL system reliability.

Substation Overload Results

As discussed in Section 3.1, 35 of the 92 substations were excluded from this overload analysis. Of the remaining 58 substations, 44 of them are forecasted to experience an overload condition between 2025 and 2035, compared to 51 experiencing an overload condition between now and 2050.[38] Overloads were determined consistent with the methodology described in Section 3.1 Methodology and Assumptions. Figure 43 shows the cumulative number of overloaded substations of the 58 assessed substations, in 2035 and 2050 using the Reference Scenario load profiles. As shown in Figure 43, 44 of the 58 substations face their first overload condition by 2035, assuming Reference Scenario load profiles are realized this early in the study horizon. An additional 7 of the 58 substations reach overload conditions in 2040 or later. The remaining 7 substations do not reach overload conditions.

Figure 43. Cumulative Substation Condition in 2035 & 2050



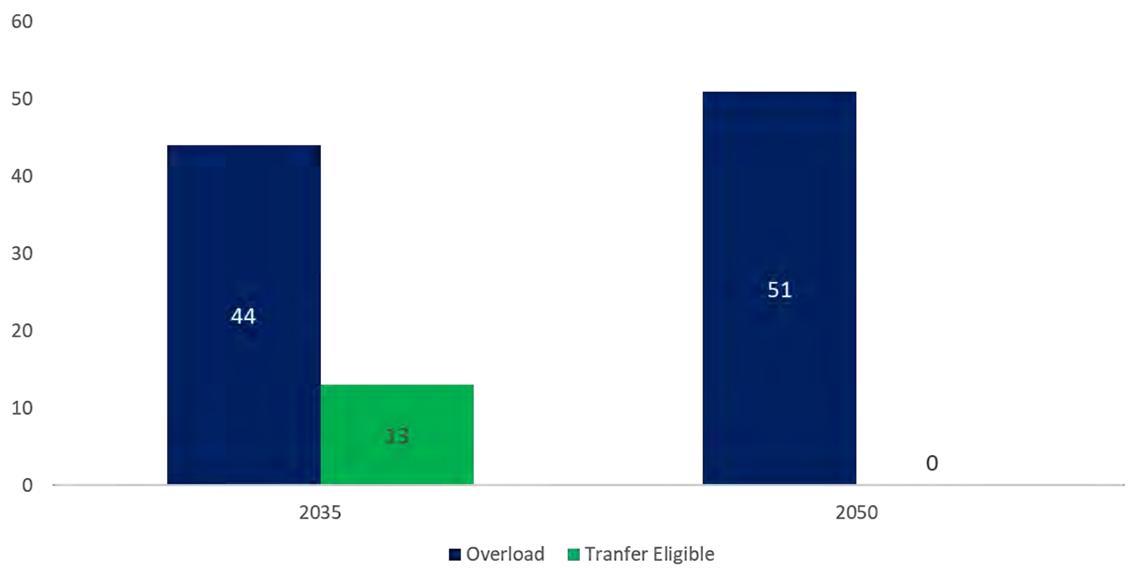
Though peak demand increases the most dramatically later in the study horizon, early horizon substation overload (overloads between now and 2035) are also very impactful, driving necessary investment of substation upgrades in the short-term. More simply, even in the near-term with tempered pace of electrification, HOL should expect that if projections actualize, significant investment will be required in the short- to mid-term to meet projected short-to mid-term load growth.

Though a number of overload conditions occur early in the study horizon, 13 substations may be able to leverage substation transfers to transfer load from the overloaded substation to other connected

[38] 58 Substations are evaluated due to Bridlewood MS being split into two separate substations for the analysis resulting in 93 total substations (35 excluded + 58 included).

substations. As an example, the Bayshore DS substation is projected to reach overload condition as early as 2025. However, this analysis determined there is available capacity in the connected substations to potentially transfer load. While a system impact study was outside of the scope of this assessment, load transfers during periods of overload conditions should be studied in greater detail to inform short-term investment strategies. Figure 44 shows the number of substations both facing overload and eligible for connected substation transfer. As an example. In 2025, of the 21 overload substations, 8 have enough available capacity at the connected substations that substation upgrades may not necessarily be required to prevent an outage.

Figure 44. Cumulative Substation Overloads with Transfer Eligibility in 2035 & 2050



Solutions Scenario Assessment and Findings

Investment Model Methodology

As part of the overload assessment, two NWS technology assessments were developed to measure the relative cost of non-wires solutions compared to traditional wires upgrades. As part of this assessment, an Excel-based directional ROM investment plan was developed to calculate non-wires solution capital expenses, operating expenses, and fuel requirements. Further, the investment plan compares the solutions scenario NPVs assuming transferable load (the low case) and assuming no transferable load (the high case).

This assessment does not take a position on behind-the-meter or utility scale assets. HOL can and should explore partnership opportunities with local organizations and solar, BESS, or RECIP owners to evaluate joint ownership models to reduce HOL total costs. While this assessment does contemplate the amount of NWS generation needed, deployment and alternative ownership strategies should be carefully considered and evaluated.

Wires and non-wires solution (BESS and RECIPs) capital costs were assumed to be incurred the year before required at the substation. Operating expenses were assumed on an ongoing annual basis from the point of investment. For the purposes of this assessment summary operating expenses were assumed, including annual substation OPEX, BESS OPEX, RECIP engine OPEX, BESS energy losses, and natural gas fuel costs.[39] The following financial assumptions were used as provided by HOL:

- Capital inflation rate: 5.3%
- Service inflation rate: 2.4%
- Discount Rate: 6.21%
- Borrowing costs: 6.5%
- NPV calculated on a 2026 CAD basis

Solution scenarios were evaluated in two separate horizons. The first is through 2035 and the second is from 2024 through 2050. When the 2035 NPV is provided, cash flow ends in 2035 to determine the short-to-mid-term NPV. In the 2050 horizon, cash flows end in 2050 for the long-term horizon NPV. All inputs are in 2024 CAD and cashflow NPV results are real values.

Costs were assessed and compared in two study horizons:

1. System-wide investments by 2035: This assessment evaluated the required capital infrastructure needed to address substation overload conditions between now and 2035. 2035 provides a lower but more certain decarbonization load projection.
2. System-wide investments by 2050: This assessment evaluated the required capital infrastructure needed to address substation overload conditions between now and 2050. Since Reference Scenario load continues to increase over the study horizon, substations overload and thereby capital investment is dramatically higher in this study horizon. 2050 provides a higher but less certain decarbonization load projection.

NWS Technology Assessment Summary Results

BESS were identified as a potential NWS to be considered given the technology's general power system flexibility, reliability services, and ability to potentially provide short-term deferment. For the purposes of this analysis, chemical BESS such as lithium-ion were assumed given that they are the most widely available and cost-effective technology on the market today. However, specific technology and chemistries are likely to evolve as technologies continue to advance and federal incentives promote the deployment of the BESS solutions. One limitation of the BESS when considering the Reference Scenario, specifically, is that BESS is typically most cost-effective in small to moderate overload conditions, which is generally not the case in the substation overloads identified.[40]

Substations with available capacity to charge the BESS were determined as feasible for a BESS. Aside from considerations of charging capacity, the general feasibility of the BESS including available land, specific

[39] Substation capital costs and operating expenses reflect proprietary HOL data. BESS and RECIP capital costs and operations expenses leverage Black & Veatch proprietary data and National Renewable Energy Laboratory (NREL) data. Natural gas cost forecasts are from Black & Veatch models in the Ottawa, Canada service territory.
[40] This analysis assumed a standard lithium-ion 4-hour BESS for cost assumptions. Additional BESS sizes and types should be considered in HOL's future required feasibility studies.

BESS types, etc. are not considered, as this phase of work is intended to provide a screen of BESS eligible substations. A detailed feasibility study should be completed to further evaluate the role of BESS technology at the eligible substations. BESS sizing was estimated based on the expected capacity needed to satisfy the highest overload hour at each eligible substation.

As a future phase of this study, a detailed feasibility study and due diligence of the BESS eligible substations should be considered. Given the pre-feasibility study phases of this assessment, the results of this scenario should not be interpreted as the optimal BESS strategy, but as a screen criterion of the substations in which BESS could be considered. Because of the magnitude of the overload conditions, the size of the BESS required at many of the substations is likely not feasible but highly informative to understand the limitation of this technology as a feasible solution during times of potentially extreme overload conditions.

The results of the BESS-eligible substations were used as an input into the cost optimized scenario (results which are summarized later in this section). In the 2035 horizon, four of the 44 substations did not have available capacity to charge the BESS and were therefore not considered eligible for BESS. Those four substations (Lisgar TL, Marchwood MS, Orleans TS, and Stafford Road DS) assumed the same wires upgrades considered in the wires only solution scenario. In the 2050 horizon, 21 of the 51 overloaded substations do not have the availability capacity to charge the BESS and therefore were not considered eligible for BESS.

RECIP engines are a common NWS as they provide numerous grid benefits and a reliable power supply during system overloads or grid interruptions. RECIPs offer comparatively low installed costs compared to other NWS and offer additional capabilities such as black start, peaking, and emergency power applications (typically greater than 98% availability) and can operate using low carbon fuels such as biogas, renewable natural gas, and hydrogen.[41]

Unlike BESS, RECIPs do not require available capacity to charge, so that step in the analysis was not required and therefore the estimated RECIP size and directional cost was evaluated for each of the 44 overloaded substations in 2035 and all 51 overloaded substations in 2050. The results of this level of analysis are intended to provide a screen of the required RECIP sizes and associated costs to serve the required load at each substation. However, like in the BESS technology assessment, a detailed feasibility study should be completed to further evaluate the role of RECIPs at the eligible substations. RECIP sizing was estimated based on the expected size needed to satisfy the highest overload hour and duration at each substation. All overloaded substations were evaluated.

As a future phase of this study, a detailed feasibility study and due diligence of the RECIP eligible substations should be considered. Given the pre-feasibility study phase of this assessment, the results of this scenario should not be interpreted as the optimal RECIP strategy, but as a screen criterion of the substations in which RECIPs could be considered. A future feasibility study should consider environmental

[41] This study assumed the use of natural gas powered RECIPs, but low carbon fuels should be considered in future feasibility studies.

considerations of RECIPs such as emissions and noise limitations, as well as fuel-availability, and environmental permitting.

Solution Scenario Results

Traditional Wires Only

As part of the wires only solution scenario it was assumed that only traditional wires upgrades would be available to ensure overloaded substations have the available capacity to meet the overload condition. Table 9 shows the wires upgrades considered for this analysis.

Table 9. Evaluated Substation Wires Upgrades

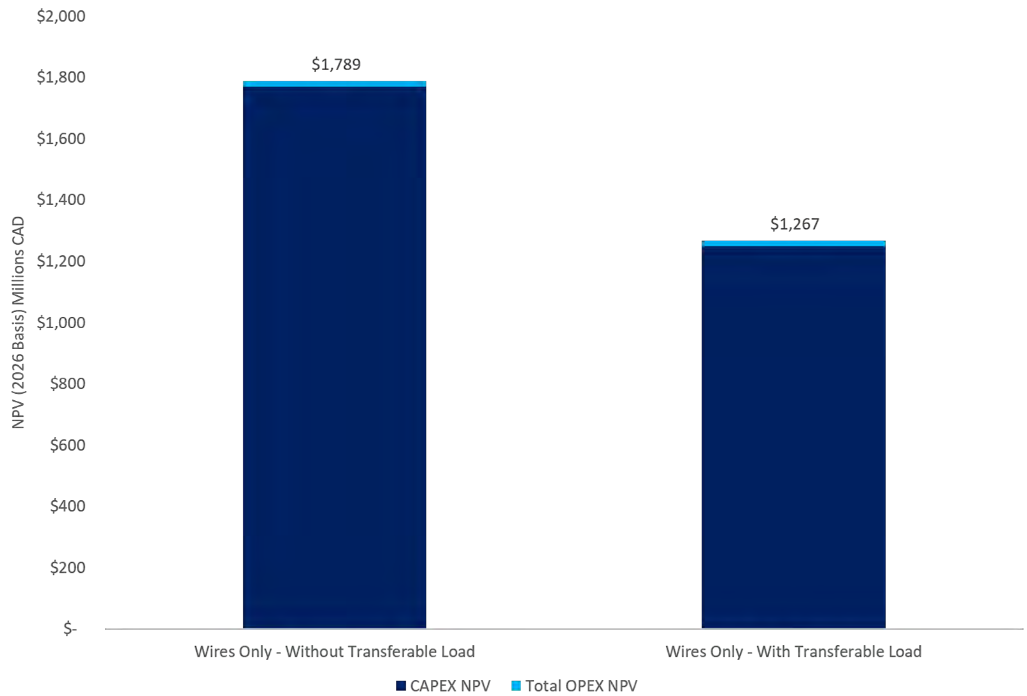
LOW SIDE VOLTAGE (KV)	NUMBER OF EXISTING TRANS-FORMERS	TYPE OF UPGRADE	NEW CAPACITY (MVA)	NEW SUMMER PLANNING RATING (MVA)	NEW WINTER PLANNING RATING (MVA)	COMMENTS
44	N/A	Add new substation (2 transformers)	2*100	120	130	Includes switchgear
44	2	Upgrade existing transformer(s), add one new transformer	3*100	240	260	Includes switchgear
44	2	Upgrade existing transformer(s)	2*100	120	130	
27.6	N/A	Add new substation (2 transformers)	2*100	120	130	Includes switchgear
27.6	4	Upgrade existing transformer(s)	4*100	360	390	
27.6	2	Upgrade existing transformer(s), add one new transformer	3*100	240	260	Includes switchgear
27.6	2	Upgrade existing transformer(s)	2*100	120	130	
27.6	1	Upgrade existing transformer(s), add one new transformer	2*100	120	130	Includes switchgear

27.6	1	Upgrade existing transformer(s)	1*100	100	100	If it continues to be a single transformer station, it cannot load to the LTR and will be restricted load to design rating.
13.2	N/A	Add new substation (2 transformers)	2*100	120	130	Includes switchgear
13.2	3	Upgrade existing transformer(s)	3*100	240	260	
13.2	2	Upgrade existing transformer(s), add one new transformer	3*100	240	260	Includes switchgear
13.2	2	Upgrade existing transformer(s)	2*100	120	130	

In the 2035 period, 44 substations reached overload conditions and required wires upgrades. Of the 44 substations, 13 could satisfy overload conditions through upgrades to the existing transformer(s) and nine require both upgrade of the existing transformer and the addition of a new transformer. 50% (22 substations specifically) are projected to require the addition of a new 27.6kV substation, the most capital intensive of the upgrades required.[42] Alternatively, if transferable load is considered, 13 of the 44 substations could potentially avoid costly substation upgrades. The estimated savings is shown in Figure 45, the wires only solutions scenario cash flow NPV drops by nearly $522 million CAD when assuming connective substations can absorb excess substation load to prevent and overload condition.

[42] Future system impact analyses could determine if fewer, but larger, new substations could address overload conditions rather than replacing every overloaded substation. For example, a new 100MVA station could support overloads from multiple other substations.

Figure 45. Wires Only Solutions Scenario Cashflow NPV (2035 Horizon): Comparison of Transferable & Non-Transferable Load

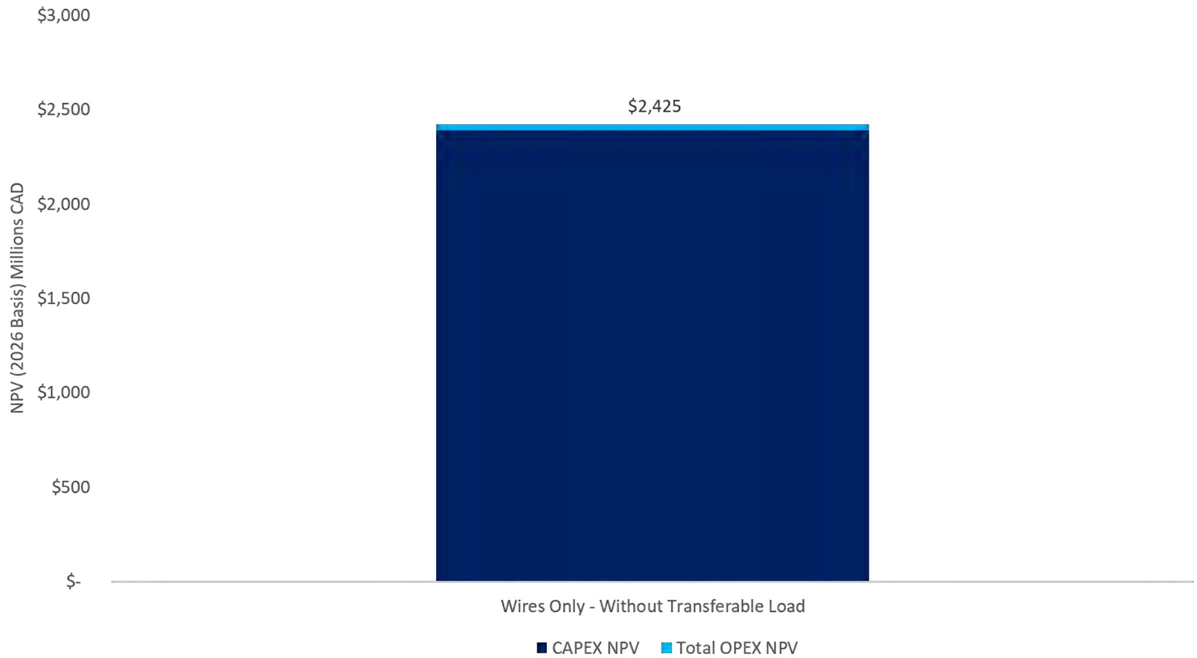


Given the projected increase in load the Reference Scenario and therefore CAPEX required in both scenarios, the required investment is considerable. Without transferable load, $1.77 billion CAD in wires investment is required, paired with an expected $18.5 million CAD in OPEX (in existing and incremental OPEX) to support new wires investment. Conversely, if considering transferable load CAPEX NPV reaches $1.25 billion CAD with $18 million CAD in supporting OPEX NPV in the 2035 horizon.

If HOL were to consider longer-term investment to meet 2050 load an additional $620 million CAD in CAPEX would be required, paired with an increase in OPEX of $16.3 million CAD (total CAPEX and OPEX as shown in Figure 46).[43] Transfers were not eligible during the long-term 2050 horizon study, given the lack of available capacity of connected substations, driven by the much larger increases in projected load later in the study horizon. The number of overloaded substations increased from 44 in the 2035 horizon to 51 in the 2050 horizon (assuming no transferable load).

[43] The comparison between 2035 and 2050 compares the NPV assuming no transferable load. If we compare the 2035 cashflow NPV with transferable load to the non-transferable load cashflow 2050 NPV, the increase is $1.14 billion CAD.

Figure 46. Wires Only Solutions Scenario Cashflow NPV (2050 Horizon)



Cost Optimized Solutions Scenario

The cost optimized solution scenario evaluates the lowest cost solution at each substation over the 2035 and 2050 periods. The lowest cost solution was identified by the lowest cashflow NPV (CAPEX NPV and OPEX NPV) over either the 2035 or 2050 horizon. It is important to note that the cost optimized solutions only contemplate the cost of distribution wires upgrades and not the associated upstream transmission or generation costs.[44] As a result, each substation within this solution scenario that realizes an overload condition is identified as addressing an overload with either a wires only solution, a BESS, or a RECIP. Table 10 shows the results of the cost optimization technology solution in the 2035 horizon for all 44 overloaded substations. BESS was the lowest cost solution at 2 substations, traditional wires was the lowest cost solution in 21 substations, and in the remaining 21 substation RECIPs were the cost optimized solution.

Table 10. Cost Optimized Substation Solutions: 2035 Horizon

SUBSTATION NAME	COST OPTIMIZED SOLUTION	SUBSTATION NAME	COST OPTIMIZED SOLUTION
HAWTHORNE TS	BESS	BLACKBURN MS	RECIP
TERRY FOX MTS	BESS	BORDEN FARM DS	RECIP
BARRHAVEN DS	RECIP	BRIDLEWOOD MS 8kV	RECIP
BAYSHORE DS	RECIP	CASSELMAN MS	RECIP
BEACONHILL MS	RECIP	CENTREPOINTE DS	RECIP

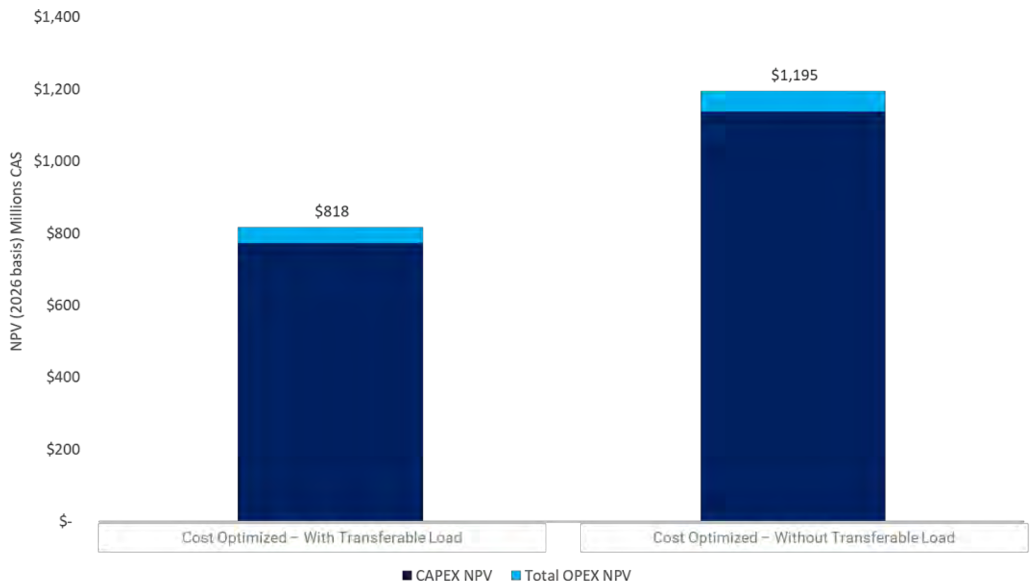
[44] Further, the timing and feasibility of the implementation was not included in this study. Black & Veatch provides detailed recommended next steps, which include a future feasibility study, in Section 4.

SUBSTATION NAME	COST OPTIMIZED SOLUTION
EPWORTH DS	RECIP
JOCKVALE DS	RECIP
LONGFIELDS DS	RECIP
MOULTON MS	RECIP
PARKWOOD HILLS DS	RECIP
Q.C.H. DS	RECIP
RICHMOND NORTH DS	RECIP
BEAVERBROOK MS	RECIP
BECKWITH DS	RECIP
MANORDALE DS	RECIP
SOUTH MARCH DS	RECIP
STARTOP MS	RECIP
WOODROFFE DS	RECIP
BRIDLEWOOD MS 28kV	Wires Upgrade
CARLING TM	Wires Upgrade
Cyrville MTS	Wires Upgrade
Ellwood MTS	Wires Upgrade

SUBSTATION NAME	COST OPTIMIZED SOLUTION
FALLOWFIELD MTS	Wires Upgrade
HINCHEY TH	Wires Upgrade
JANET KING DS 28kV	Wires Upgrade
KANATA MTS	Wires Upgrade
KING EDWARD TK	Wires Upgrade
LEITRIM MS	Wires Upgrade
LIMEBANK MS	Wires Upgrade
LINCOLN HEIGHTS TD	Wires Upgrade
LISGAR TL	Wires Upgrade
MARCHWOOD MS	Wires Upgrade
NEPEAN TS	Wires Upgrade
OVERBROOK TO	Wires Upgrade
RIDEAU HEIGHTS DS	Wires Upgrade
RIVERDALE TR	Wires Upgrade
SOUTH MARCH TS	Wires Upgrade
ORLEANS TS	Wires Upgrade
STAFFORD ROAD DS	Wires Upgrade

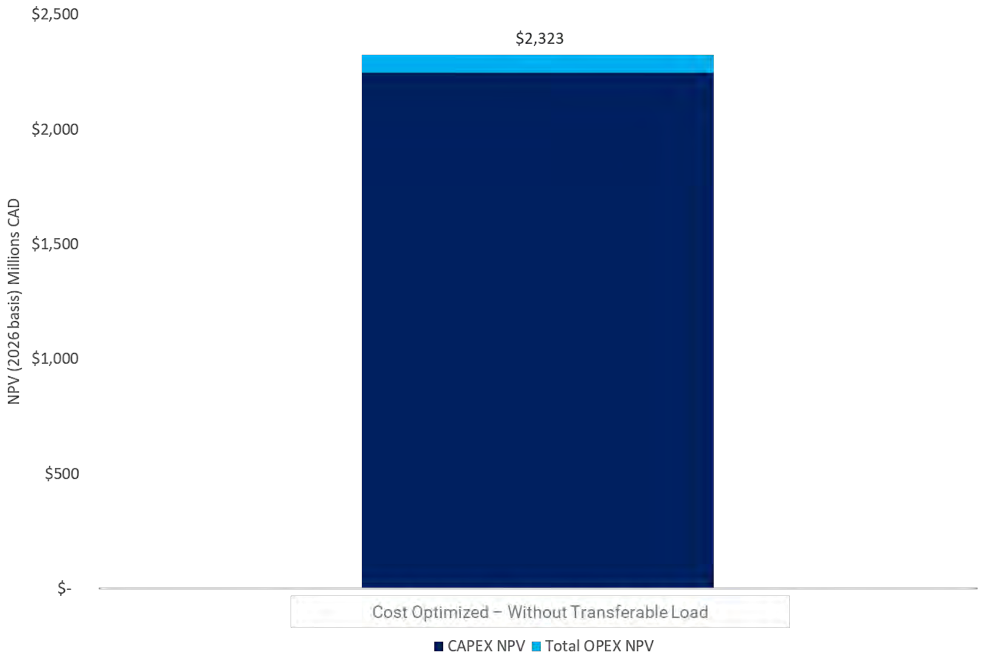
As expected, the cost optimized solution scenario has a lower scenario NPV compared to the wires only solution scenario, whether considering substation load transfer or not. If considering potential substation load transfers through 2035, the solution scenario cash flow NPV reaches nearly $818 million CAD. Conservatively, if not considering substation load transfers cashflow NPV through 2035, this increases to $1.2 billion CAD. The 2035 cashflow NPV for both transferable and non-transferable load are shown in Figure 47.

Figure 47. Cost Optimized Solution Scenario Cashflow NPV (2035 Horizon): Comparison of Transferable & Non-Transferable Load



When considering the most cost optimal solutions in the 2050 horizon, BESS was not the lowest cost option at any substation. Seven substations required no upgrades (Bells Corner DS, Janet King DS 8kV, Munster DS, Richmond South MTS, Slater TS, New 44, and Piperville). Of the 51 overloaded stations, RECIPs provided the lower cost solution in six (Bridlewood MS 8kV, Richmond North DS, Beaverbrook MS, Beckwith DS, South March DS, Woodroffe DS), and the remaining 45, wires only solutions provided the lowest cost upgrade. As expected even in the cost optimization solution scenario the 2050 cash flow NPV increased dramatically from the 2035 horizon, with the 2050 NPV exceeding $2.3 billion CAD as shown in Figure 48.

Figure 48. Cost Optimized Solution Scenario Cashflow NPV (2050 Horizon)



Solutions Scenario Comparison

The solutions scenarios present an opportunity for HOL to evaluate as it considers future feasibility studies to address substation overloads driven from Reference Scenario decarbonization load projections. Reviewing the required upgrades in the short- to mid-term 2035 horizon separately from the long-term 2050 horizon will allow HOL to make agile substation investments while future electrification driven load becomes realized.

The results of this analysis are intended to inform short and mid-term investment strategies for HOL as it evaluates both wires and non-wires solutions to address Reference Scenario decarbonization load projections. This section provides an analysis as to how each of the solution scenarios should be considered and evaluated, relative to each other, as HOL considers next steps in its system-wide upgrades.

If considering system-wide costs only, one scenario presents the most straight forward and optimal approach: the cost optimized scenario. As shown in Table 11 and Table 12, this scenario yields a lower solution cash flow and defers up to $594 million CAD in total cashflow NPV compared to the wires only solutions scenario. Table 11 and Table 12 display the projected deferred cost in the cost optimized solution scenario through both the 2035 and 2050 study horizon. Estimate deferred costs is represented as the total cash flow NPV difference between each solution scenario and the wires only solution scenario.

Table 11. Solutions Scenario Cashflow NPV Comparison (CAD) Assuming No Transfers

	WIRES ONLY	COST-OPTIMIZED
2035 NPV	1.78 billion	1.19 billion
2035 Deferred NPV	N/A	594 million
2050 NPV	2.43 billion	2.32 billion

	WIRES ONLY	COST-OPTIMIZED
2050 Deferred NPV	N/A	102 million

Table 12. Solutions Scenario Cashflow NPV Comparison (CAD) Assuming Transfers[45]

	WIRES ONLY	COST-OPTIMIZED
2035 NPV	1.27 billion	818 million
2035 Deferred NPV	N/A	449 million

To evaluate the solution scenarios, as well as the non-wires solutions developed in each scenario, five key measures were identified and evaluated. Each measure was scored on a scale of one to ten, with one being the least desirable and ten being the most desirable. The total score was calculated as the sum of all measure scores Black & Veatch applied quantitative cost metrics from its directional investment modeling results and a mix of qualitative and quantitative expertise to inform a high-level assessment of safety, reliability, resiliency, and environmental considerations. The intent of this scoring matrix is to review and evaluate the two primary solution scenarios against each other, outside of just cost considerations. The measures are defined as follows:

- Solutions Scenario Cost: Represented as the total net present value (NPV) of system-wide capital expenses (CAPEX) and operating expenses (OPEX). Rough order of magnitude (ROM) directional pricing estimates were developed for each solution scenario. The two solutions scenario NPVs were compared against one another, and the lowest cost solution was evaluated as the most desirable.
- Safety: Evaluated as how safe the proposed solutions is and potential risk it could pose to the surrounding area.
- Reliability: Evaluated as to how much power and for how long an overload could be mitigated by the evaluated solutions. Scenario solutions leveraging dispatch limited solutions were measured as less favorable.
- Resiliency: Evaluated as the total capacity of the wires or NWS assets, as well as vulnerabilities to external pressures, such as grid outages or fuel limitations.
- Environmental: Evaluated considering greenhouse gas (GHG) considerations, noise, and land use considerations.

Both solution scenarios were evaluated through both the mid-term and long-term lens. As an example, via the mid-term lens, solution scenarios and NWS were sized to meet substation load requirements through 2035. This mid-term lens is appropriate to evaluate the investments that HOL should consider in

[45] There was not enough transfer capacity in the 2050 year, so 2050 values are the same as shown in the 2050 year in Table 10.

the short-term to maintain reliability through the mid-term. Alternatively, the long-term lens (substation upgrades to meet reliability through 2050), presents larger and most costly substation upgrades. The solutions scenario heatmap was applied to the 2035 findings to inform shorter-term investment strategies.

According to the results of this analysis and known uncertainties and risks, the two solutions scenarios were compared according to the above 5 factors, and then a composite score was calculated. As description of the comparison is provided the narrative following this comparison in Figure 49.

Figure 49. Solution Scenario Comparison Matrix[46]

	WIRES ONLY	COST OPTIMIZED
Measures		
Cost	5	9
Safety	10	7
Reliability	10	9
Resiliency	5	8
Environmental	5	5
Total Score (Sum)		
Overall Score	35	38

Measures Scoring

1	2	3	4	5	6	7	8	9	10

Least Desirable → Most Desirable

Measure 1: Cost

Cost was scored and compared based on the relative cash flow NPV of each solution scenario. The wires only solutions scenario is considered the baseline, thus reflecting a score of 5. The cost optimized solution was rated as a 9, consistent with its name. As part of future studies, it is reasonable to assume that both solution scenario costs could decline.

[46] Individual measures were scored on a scale of one to ten. The overall score is the sum of all scores.

Measure 2: Safety

For the purposes of this measure the relative safety of each solution scenario is considered. Of important note is the recognition that not all of these solutions and technologies are 100% safe, but some have objectively more risks than others. Though safety considerations must be considered even in the wires only scenario, comparatively this solution scenario was measured as the safest. Albeit a safe technology, BESS leveraged in the 2035 cost optimized scenario reduced the score to a six given the low but existing concerns of fires and considerations of safety setbacks for this technology.

Measure 3: Reliability

The wires only solution scenario was considered the most reliable for the purposes of this analysis, given that wires upgrades are assumed to always be oversized to handle the required amount of load on the system. BESS use lowered the cost optimized scenario score, purely because of the limitation to the length of period that a BESS can provide backup support and the required availability capacity to charge. RECIPs are highly reliable but require access to natural gas fuels.

Measure 4: Resiliency

Reliance on fuels outside of grid electricity were measured as more desirable than the solutions scenarios relying on 100% of grid electricity. The mix of RECIPs, BESS, and wires in the cost optimized scenario makes this scenario highly favorable from the resiliency perspective, secondary only to the RECIPs only scenario.

Measure 5: Environmental

Unique to Canada, and Ottawa specifically, is the amount of zero-carbon energy generation powering the grid. However, during times of peak demand, gas-fired generation is utilized to address incremental demand. Because of this, the wires only scenario is rated equally to the cost optimized scenario given the BESS will likely be charged from the grid and the RECIPs will likely run on natural gas. HOL should carefully consider the use of carbon-intensive fuels (such as natural gas) in a non-wires solution. While natural gas fired RECIPs will certainly address substation overload challenges and are a highly commercial and reliable technology, the use of low carbon fuels (such as hydrogen and RNG) should be considered in future as hydrogen and RNG costs continues to decline. This would provide HOL with both a reliable and low carbon system.

4.0 Next Steps and Future Studies

This study has evaluated the potential for increases in system load in the HOL distribution system based on various decarbonization and end use electrification scenarios. Additionally, impacts to the system were assessed and potential methods to mitigate those impacts were developed. It has been demonstrated that the electrification of energy end use cases such as transportation and heating will result in a significant increase in system load and is projected to require significant expenditures to address. This analysis provides a thorough examination of potential adjustments needed between now and 2050 for the HOL system to effectively address future decarbonization-driven load impacts. Though this study provides robust and comprehensive analysis into the possibility of the impact of decarbonization initiatives in the HOL service territory, additional considerations, studies, and analyses should be considered. The analysis performed in this study should be leveraged and built upon to further assess and finalize mitigation strategies to optimize capital investment. The following actions are recommended for consideration as next steps by HOL.

- Assess Load Increases Compared to Reference Case Decarbonization Load Projections: On an ongoing annual basis, substation level and system-level load projections should be assessed and compared to load growth actuals. Changes in electrification incentives and standards should be carefully monitored to revisit and adjusted load projections as necessary. As with all load projections, this assessment should be monitored and updated to incorporate the most up-to-date assumptions and baseline consideration.
- Confirm Potential for Load Transfers: This study evaluated whether there was the *potential* to transfer loads from an overloaded substation to a connected substation in the same grouping. When available, future system connectivity and impact studies should be performed to confirm whether projected load transfers can actually occur by evaluating all other system constraints, including, but not limited to, available feeder capacity, available feeder-feeder tie capacity, and protection and coordination schemes.
- Evaluate Potential Combinations of Wires and NWS for Selected Substations: In the 2050 horizon evaluation specifically, 8 substations were overloaded to the extent that a new substation was required as well as an upgrade to the existing substation. A system connectivity study and a technology feasibility study should be completed to determine if it would be more cost effective to utilize an NWS such as a BESS or RECIP. This evaluation would determine the most cost-effective approach for handling these substations.
- Technical Feasibility: The scope of this study determined only the required capacity for wires and non-wires solutions to address the overloaded substation and did not address technical feasibility for the proposed solutions. It is recommended complete a detailed Pre-Front-End Engineering and Design Study as well as a detailed feasibility be completed to evaluate the lowest cost investment option for each site, considering substation specific constraints. Technical feasibility studies should evaluate the following at a minimum:
    - Available footprint to upgrade existing transformers, add new transformers, add BESS or RECIPs to an existing substation
    - Available land to add new substations or other NWS in the required service area
    - Ability of circuits outside of the substation to carry the additional load
    - Ability to provide sufficient natural gas to the RECIPs
    - Availability of other fuel alternatives such as hydrogen or renewable natural gas
    - Ability to permit NWS
- Determine the Capital Investment Horizon for Each Site: Because the 2050 projected Reference Scenario load was far higher than the 2035 projection, the amount of overload is higher for 2050 than 2035, which resulted in higher capital expenditure to address the overload. It is recommended to evaluate the load conditions for each site and the difference in capital investment to make a final decision on which year to base an investment decision.

5.0 References

The following public sources were reviewed or referenced to inform this study. All references are linked to the associated assumptions via a footnote in main narrative of the report.

British Columbia Utilities Commission

BC Hydro Optional Residential Time-of-Use Rate Application, 2023.

Canada Energy Regulator

Canada's Energy Future: Energy Supply and Demand Projections to 2050, 2023.

City of Ottawa

Ottawa Climate Change Master Plan, 2020.

Energy Evolution, 2024.

Growth Projections for the New Official Plan, 2019.

Leidos Canada Pathway Study on Solar Power in Ottawa, 2017.

Solutions Group Pathway Study on Transportation in Ottawa, 2019.

Enbridge

Pathways to Net-Zero Emissions in Ontario, 2022.

Government of Canada

Canada's Changing Climate Report, 2019.

Canada's 2030 Emissions Reduction Plan: Clean Air, Strong Economy, 2022.

Greenhouse Gas Pollution Pricing Act (S.C. 2018, C. 12, S. 186), 2019.

National Energy Code of Canada for Buildings, 2020.

Updated Projections for Canada's Public Charging Infrastructure Needs, 2022.

IESO

IESO Annual Planning Outlook, 2022.

IESO Pathways to Decarbonization, 2022.

East Ontario Bulk Planning: Gatineau Corridor End-of-Life Study, 2022.

J.D. Power

Electric Vehicle Experience Home Charging Study, 2023.

MDPI

Electric Vehicle User Behavior: An Analysis of Charging Station Utilization in Canada, 2023.

Natural Resources Canada
Commercial/Institutional Sector – Ontario Energy Use, 2024.

Residential Sector - Ontario Energy Use, 2024.

Ontario Energy Board
Ontario Ultra-Low Overnight Rate, 2024.

Ottawa Energy Evolution
Modelling Ottawa's Greenhouse Gas Emissions to 2050, 2020.

Hydro Ottawa Station Table

The following Hydro Ottawa and Hydro One owned stations in the table below are used to supply Hydro Ottawa's customers. The stations are herein referenced by the nomenclature (Hydro Ottawa Station Name) used by Hydro Ottawa.

Hydro Ottawa Station Name	Designation	Owner	Primary/Secondary Voltage (kV)
Albion TA	HVDS	Hydro One-Hydro Ottawa	230/13.2
Albion UA	DS	Hydro Ottawa	13.2/4.16
Augusta UD	DS	Hydro Ottawa	13.2/4.16
Bantree AL	DS	Hydro Ottawa	13.2/4.16
Barrhaven DS	DS	Hydro Ottawa	44/8.32
Bayshore DS	DS	Hydro Ottawa	44/8.32
Bayswater UJ	DS	Hydro Ottawa	13.2/4.16
Beaconhill MS	DS	Hydro Ottawa	44/8.32
Beaverbrook	DS	Hydro Ottawa	44/12.43
Beckwith DS	DS	Hydro One	44/27.6
Beechwood UB	DS	Hydro Ottawa	13.2/4.16
Bells Corner DS	DS	Hydro Ottawa	44/8.32
Bilberry TS	HVDS	Hydro One-Hydro Ottawa	115/27.6
Blackburn MS	DS	Hydro Ottawa	44/8.32
Borden Farm DS	DS	Hydro Ottawa	44/8.32
Bridlewood MS 28kV	HVDS DS	Hydro Ottawa	115/27.6 44/27.6
Bridlewood MS 8kV	HVDS DS	Hydro Ottawa	115/8.32 44/8.32
Bronson SB	DS	Hydro Ottawa	13.2/4.16
Brookfield AF	DS	Hydro Ottawa	13.2/4.16
Cahill AN	DS	Hydro Ottawa	13.2/4.16
Cambrian MTS	HVDS	Hydro Ottawa	115/27.6 230/27.6
Cambridge AM	DS	Hydro Ottawa	13.2/4.16
Carling SM	DS	Hydro Ottawa	13.2/4.16
Carling TM	HVDS	Hydro One-Hydro Ottawa	115/13.2
Casselman MS	DS	Hydro Ottawa	44/8.32
Centrepointe DS	HVDS	Hydro Ottawa	115/8.32

Church AA	DS	Hydro Ottawa	13.2/4.16
Clifton UL	DS	Hydro Ottawa	13.2/4.16
Clyde UC	DS	Hydro Ottawa	13.2/4.16
Cyrville MTS	HVDS	Hydro Ottawa	115/27.6
Dagmar AC	DS	Hydro Ottawa	13.2/4.16
Eastview UT	DS	Hydro Ottawa	13.2/4.16
Edwin UV	DS	Hydro Ottawa	13.2/4.16
Ellwood MTS	HVDS	Hydro Ottawa	230/13.2
Epworth DS	HVDS	Hydro Ottawa	115/8.32
Fallowfield MS	HVDS	Hydro Ottawa	115/27.6
Fisher AK	DS	Hydro Ottawa	13.2/4.16
Florence UF	DS	Hydro Ottawa	13.2/4.16
Gladstone UX	DS	Hydro Ottawa	13.2/4.16
Hawthorne TS	HVDS	Hydro One	230/44
Henderson UN	DS	Hydro Ottawa	13.2/4.16
Hillcrest AH	DS	Hydro Ottawa	13.2/4.16
Hinchey TH	HVDS	Hydro One-Hydro Ottawa	115/13.2
Holland SH	DS	Hydro Ottawa	13.2/4.16
Janet King DS 28kV	DS	Hydro Ottawa	44/27.6
Janet King DS 8kV	DS	Hydro Ottawa	44/8.32
Jockvale DS	DS	Hydro Ottawa	44/8.32
Kanata MTS	HVDS	Hydro Ottawa	230/27.6
King Edward SK	DS	Hydro Ottawa	13.2/4.16
King Edward TK	HVDS	Hydro One-Hydro Ottawa	115/13.2
Langs AP	DS	Hydro Ottawa	13.2/4.16
Leitrim MS	DS	Hydro Ottawa	44/27.6
Limebank MS	HVDS	Hydro Ottawa	115/27.6
Lincoln Heights TD	HVDS	Hydro One-Hydro Ottawa	115/13.2
Lisgar TL	HVDS	Hydro One-Hydro Ottawa	115/13.2
Longfields DS	DS	Hydro Ottawa	44/27.6
Manordale DS	HVDS	Hydro Ottawa	115/8.32
Marchwood MS	HVDS	Hydro Ottawa	115/27.6
McCarthy AQ	DS	Hydro Ottawa	13.2/4.16
Merivale MTS	HVDS	Hydro Ottawa	115/8.32
Moulton MS	HVDS	Hydro Ottawa	115/27.6
Munster DS	DS	Hydro Ottawa	44/8.32
Nepean AB	DS	Hydro Ottawa	13.2/4.16

Nepean TS	HVDS	Hydro One	230/44
Orleans TS	HVDS	Hydro One	230/27.6 115/27.6
Overbrook SO	DS	Hydro Ottawa	13.2/4.16
Overbrook TO	HVDS	Hydro One-Hydro Ottawa	115/13.2
Parkwood Hills DS	DS	Hydro Ottawa	44/8.32
Playfair AJ	DS	Hydro Ottawa	13.2/4.16
Q.C.H. DS	DS	Hydro Ottawa	44/8.32
Queens UQ	DS	Hydro Ottawa	13.2/4.16
Richmond North DS	DS	Hydro Ottawa	44/8.32
Richmond South DS	HVDS	Hydro Ottawa	115/8.32
Rideau Heights DS	DS	Hydro Ottawa	44/8.32
Riverdale SR	DS	Hydro Ottawa	13.2/4.16
Riverdale TR	HVDS	Hydro One-Hydro Ottawa	115/13.2
Russell TB	HVDS	Hydro One-Hydro Ottawa	115/13.2
Shillington AD	DS	Hydro Ottawa	13.2/4.16
Slater SA	DS	Hydro Ottawa	13.2/4.16
Slater TS	HVDS	Hydro One-Hydro Ottawa	115/13.2
South Gloucester DS	HVDS	Hydro One	115/8.32
South March TS	HVDS	Hydro One	230/44
South March DS	DS	Hydro Ottawa	44/12.43
Stafford Road DS	DS	Hydro Ottawa	44/8.32
Startop MS	DS	Hydro Ottawa	44/8.32
Terry Fox MTS	HVDS	Hydro Ottawa	230/27.6
Uplands MTS	HVDS	Hydro Ottawa	115/27.6
Urbandale AE	DS	Hydro Ottawa	13.2/4.16
Vaughan UG	DS	Hydro Ottawa	13.2/4.16
Walkley UZ	DS	Hydro Ottawa	13.2/4.16
Woodroffe DS	DS	Hydro Ottawa	44/8.32
Woodroffe TW	HVDS	Hydro One-Hydro Ottawa	115/13.2

CAPITAL EXPENDITURE PLAN

1. OVERVIEW

This schedule summarizes Hydro Ottawa's capital expenditures over the 2021-2023 Historical Period, the 2024-2025 Bridge Years, and across the 2026-2030 Forecast Period. The capital expenditure plan for the Forecast Period was prepared through the asset management and capital expenditure planning processes described in Section 3 of Schedule 2-5-4 - Asset Management Process. Hydro Ottawa confirms that there are no expenditures for non-distribution activities in the capital expenditure plan.

The Hydro Ottawa 2026-2030 Capital Expenditure Plan focuses on four key investment priorities:

1. **Growth & Electrification - Powering the Growing Community**, which focuses on expanding grid capacity to serve a growing community and ensure a reliable, resilient electricity system capable of meeting increasing demand driven by new customer connections and distributed energy resources (DERs);
2. **Renewing Deteriorating Infrastructure**, which prioritizes mitigating reliability risk by strategically upgrading or replacing aging and critical infrastructure based on condition assessments;
3. **Grid Modernization - Enabling the Energy Transition**, which focuses on modernizing the grid through strategic technology adoption and infrastructure upgrades to facilitate customer participation and optimize DER integration; and
4. **Enhancing Resilience**, which proactively upgrades infrastructure and implements measures to protect against increasingly frequent and intense severe weather events and cyber threats.

Relative to Hydro Ottawa's previous Distribution System Plan (DSP), the 2026-2030 Capital Expenditure Plan includes new programs and budgets, as well as a commitment to evaluating Non-Wires Solutions (NWSs) in accordance with OEB guidelines. In addition, Hydro Ottawa has analyzed past spending, forecasted future needs, and considered the impact on Operations and Maintenance (O&M) costs.

Hydro Ottawa's gross capital expenditure plan for 2026-2030 totals $1.4B, averaging $281.7M annually (gross expenditures) or $239.1M (net after deducting capital contributions). This represents a near doubling of the $762.4M spent during the 2021-2025 period. The top three focus areas are capacity expansions (new station construction, station upgrades, and Non-Wires Solutions), accommodating new customer connections (residential and commercial), and renewing aging assets (transformers, switchgear).

System Access gross spending, driven by customer and third-party requests, is expected to average $73.9M over the 2026-2030 period as shown in Table 1 below. This represents an increase from the $58.5M average annual investment during the 2021-2025 period, which exceeded the OEB-approved budget by 44%, detailed in Table 8 of Section 5.1 - System Access Expenditures. This variance was primarily due to the surge in the volume and complexity of customer connection requests, severe inflationary pressures on material and labor costs, and unforeseen large-scale system expansion projects, as detailed in Section 4.1 - Historical Variance Overview. The 2026-2030 investments will be driven by continued growth in commercial and residential connections, including major projects for new labs and hospitals, and the ongoing transition to electrification and Distributed Energy Resource (DER) adoption. Customer contributions are also expected to increase, to average $39.3M annually over the 2026-2030 period compared to an average of $31.7M annually during the 2021-2025 period.

System Renewal investments are expected to average $86.3M over the 2026-2030 period as shown in Table 1 below. This represents an increase from the $46.5M average annual investments during the 2021-2025 period, which despite material deferred expenditures, exceeded the OEB-approved budget by 11%, as detailed in Section 5.2 - System Renewal Expenditures. Unforeseen System Renewal expenditures during the historical period included material emergency spending in the aftermath of the 2022 Derecho, other higher-than forecast emergency renewal work and a period of significant inflation. Deferred expenditures included significant Station Major Rebuild projects and Capacity Voltage Conversion work, detailed in Section 4 - Historical and Forecast Expenditure Overview. The increased investment in 2026-2030 is driven by station asset renewal (including voltage conversion), along with substantial increases in overhead and underground asset renewal. Metering renewal will see a significant percentage increase due to the Advanced Metering Infrastructure 2.0 (AMI 2.0) initiative.

System Service investments are expected to average $94.7M over the 2026-2030 period as noted in Table 1 below. This represents an increase from the $32.2M average annual spend during the 2021-2025 period, which materially exceeded the OEB-approved budget by 31%, as detailed in Section 5.3 - System Service Expenditures. Incremental spending was required during the historical period due to a combination of factors including escalating costs for key stations equipment and incremental unbudgeted work required by updated regional planning with external stakeholders. The significant increase in spending in 2026-2030 is primarily driven by Capacity Upgrades and Distribution Enhancements (resiliency and observability projects). Additionally, to strengthen communication infrastructure, the Field Area Network capital program has been expanded to include new budget programs: Wireless Communication, Intelligent Electronic Device Management, and Optical Transport Network (OTN) Cyber Security. Furthermore, a dedicated Control and Optimization program has been established to focus on Advanced Distribution Management System (ADMS) enhancements. Both the expanded Field Area Network program and the new Control and Optimization program have been incorporated into the 2026-2030 System Service Investments, demonstrating Hydro Ottawa's commitment to grid modernization.

General Plant net spending is projected to average $24.2M over the 2026-2030 period which is an increase from the $14.6M average annual spend during the 2021-2025 timeframe. The 2021-2025 period investment was under the approved budget by 9%, as detailed in Table 32 of Section 5.4 - General Plant Expenditures. The 2026-2030 spending increases are driven by Connection Cost Recovery Agreement (CCRA) payments, fleet and tool replacements, building improvements, grid technology upgrades, AMI and CIS system upgrades, and increased cyber security needs.

Hydro Ottawa's Capital Expenditure Plan considers the impact of investments on System O&M costs as outlined in Section 6 - Impact on Operation and Maintenance Costs. Asset expansion, technological advances, and lifecycle management all play a significant role in the level of System O&M. Specifically, increased System Access investments will lead to higher O&M costs due to the expansion of the asset base, necessitating increased maintenance requirements. Similarly, while substantial system renewal investments prioritize replacing high-risk assets to mitigate immediate failures, they also require increased O&M spending on testing, inspection, and maintenance for remaining high-risks assets. This includes advanced inspection technologies like drones and specialized techniques for underground asset maintenance. Additionally, station preventative maintenance will also increase to improve asset health assessments and extend asset lifecycles. Finally, System Service investments, which support grid expansion and the integration of new technologies, will inherently increase O&M costs due to the greater number of assets and specialized maintenance needs associated with advanced technologies.

As detailed in Section 4.1 - Historical Variance Overview, the 2026-2030 Capital Expenditure Plan follows a period marked by significant disruptions to Hydro Ottawa's business. These disruptions, stemming from global and local external factors, included unprecedented supply chain challenges, a surge in complex customer connections, unforeseen externally-driven projects, increased emergency renewal work due to severe storms and equipment failures, and substantial investments in new stations to address growing electricity demand as identified in the Ottawa Integrated Regional Resource Plan (IRRP) as noted below:

(i) Unprecedented Supply Chain Disruption: The 2021-2025 period witnessed an unprecedented confluence of global events, severely disrupting supply chains and driving inflationary pressures. The COVID-19 pandemic initiated widespread logistical challenges, exacerbated by surging demand for essential electrical equipment. Subsequent economic factors and shipping bottlenecks compounded these issues. Critically, the war in Ukraine also introduced a significant constraint on the availability of grain-oriented electrical steel, a vital component for transformer cores, further impacting material availability and costs. As noted in Schedule 1-2-5 - Impacts of Inflationary Pressure, Canada's inflation rate in the 2020-2024 period as measured by CPI was the highest in 40 years.

(ii) Customer Connections Volume, Complexity, and Cost: an unprecedented increase in the volume and complexity of non-discretionary residential subdivision customer connections due to a combination of residential intensification and a growing demand for electricity

(iii) Unforeseen Externally-Driven Projects: during the Historical Period, Hydro Ottawa was required to execute three major, externally-driven, non-discretionary projects that, despite the existence of a budget for one unforeseen large-scale initiative, these were not specifically anticipated and significantly exceeded budget projections;

(iv) Increased Emergency Renewal Work due to Major Storms and Equipment Failure: Emergency Renewal capital expenditures that significantly exceeded historical levels, due to a combination of the devastating 2022 Derecho (which became the 6th costliest natural disaster in Canada's history), other major storms, and a general increase in the amount and cost of equipment that needed to be replaced on an emergency, reactive basis, and

(v) New Stations Investments to Address Growing Electricity Demand as Identified in the Ottawa Integrated Regional Resource Plan (IRRP): Hydro Ottawa made significant investments in two new Municipal Transformer Stations (MTS) over the historical period (Mer-Bleue MTS and Piperville MTS) in response to the growing demand and need for resiliency identified in the Ottawa Area IRRP, which was released by the Independent Electricity System Operator (IESO) in late 2020. As a consequence of this timing, Mer-Bleue MTS was not included in the 2021-2025 forecasts approved by the OEB, and the actual costs related to Piperville MTS materially exceeded the amounts forecast in the prior application.

In response to these challenges, Hydro Ottawa implemented proactive financial management strategies, notably deferring planned projects, resulting in a budget adjustment of approximately $44.2M. This prioritization, detailed in Section 4.1 - Historical Variance Overview, impacted key capital investments such as Major Station Rebuilds, Voltage Conversions, ERP Upgrades, and Underground Switchgear Renewals. Furthermore, Hydro Ottawa's labor productivity initiatives, as described in Schedule 1-3-4 - Facilitation Innovation and Continuous Improvement, played a crucial role in mitigating the overall financial impact. Without these initiatives, the net capital expenditure variance of $102.8M against the OEB-approved budget would have been considerably higher. It is also worth noting that Hydro Ottawa did not apply for a Z factor during the 2021-2025 period.

2. INTRODUCTION

This document provides a snapshot of Hydro Ottawa's capital expenditures over a 10-year period, encompassing five historical years (2021-2025) and five forecast years (2026-2030). While projects and programs may serve multiple purposes, for this summary, the entire cost of each is allocated to one of four investment categories. These investment decisions are derived from the planning process, as described in Schedule 2-5-4 - Asset Management Process.

Schedule 2-5-6 - System Access Investments through Schedule 2-5-9 - General Plant Investments provides the material investment plans and detailed justification for its proposed capital expenditures over the forecast period. Asset-related Operations and Maintenance (System O&M) expenditures are summarized in Section 6 - Impact on Operation and Maintenance Costs and discussed in more detail in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

The document is outlined under the following structure:

Section 3: Forecast Expenditures Outlines the 2026-2030 Capital Expenditures by Investment Category.

Section 4: Historical and Forecast Expenditure Overview: Outlines the variance between the 2021-2025 actuals and OEB Approved amounts, as well as comparisons to the 2026-2030 Capital Expenditure plan by Investment Category.

Section 5: Capital Expenditure Summary: Outlines the following details by Investment Category, and further divided by Capital Program and Budget Program:

- Analysis of Historical Capital Expenditure Performance: An analysis of Hydro Ottawa's capital expenditure performance during the DSP's historical period is provided. This includes an explanation of variances, comparing actuals to OEB-approved/planned amounts from Hydro Ottawa's last DSP. The variance analysis also includes variances in planned and actual work volume where applicable. Particular attention is given to explaining variances in any given year that significantly deviate from the historical trend.
- Analysis of Forecasted Capital Expenditures**:** An analysis of Hydro Ottawa's capital expenditures for the DSP's forecast period is included.

Section 6: Impact on Operation and Maintenance Costs: Outlines the impacts of capital expenditures on routine System O&M. System O&M expenditures, driven by maintenance, compliance, and increasing work complexity, are essential for reliable electrical distribution, with capital investments influencing these costs.

2.1. CAPITAL EXPENDITURE STRUCTURE

Hydro Ottawa's Capital Expenditure Plan is broken into four Investment Categories in alignment with OEB Chapter 5 filing requirements. Please refer to Section 5.3.1.1 of Schedule 2-5-4 - Asset Management Process.

- **System Access -** Modifications (including asset relocation) to a distributor's system to provide customers (including generator customers) with access to electricity services via the distribution system.
- **System Renewal -** Replacing and/or refurbishing system assets to extend their original service life, maintaining the ability of the distribution system to provide customers with reliable and safe electricity services
- **System Service -** Modifications to the distribution system to ensure that it continues to meet the distributor's operational objectives while addressing anticipated future customer electricity demand and service requirements.
- **General Plant -** Modifications, replacements or additions to a distributor's assets that are not part of its distribution power delivery system; including land and buildings; tools and equipment; rolling stock and electronic devices and software used to support day to day business and operations activities.

Each of the Investment Categories are further broken down into Capital Programs, which are further divided into Budget Programs. Each Budget Program is described for System Access, System Renewal, System Service and General Plant in Tables 7, 14, 26 and 31, respectively, in Section 5 - Capital Expenditure Summary.

2.2. CHANGES SINCE THE LAST DSP

This section outlines the key changes that impact Hydro Ottawa's Capital Investment Structure since the previous DSP submission in the 2021-2025 rate application.

System Access

Investments under System Access are needed to support growth and electrification. Within this investment category, a minor structural adjustment has been implemented related to the associated Capital Programs. Specifically, the Residential, Commercial, and Infill & Upgrade Capital Programs (previously delineated in the 2021-2025 DSP) have been consolidated into the Customer Connections Capital Program. This consolidation is based on the shared forecasting assumptions previously utilized for these programs, resulting in a streamlined approach to the Material Investment Plans and the elimination of redundant information.

System Renewal

System Renewal investments support the renewal of deteriorating infrastructure. Hydro Ottawa has made significant advancements to its asset management framework, including the implementation of predictive analysis, refined inspection programs, and comprehensive asset health indexing. These enhancements, part of Hydro Ottawa's continuous improvement efforts, support a data-driven approach to asset management. This approach uses Predictive Analytics in its asset risk assessment methodology (as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process) to inform program development in this investment category.

Furthermore, the End-of-Life (EOL) Voltage Conversion program has been added to this investment category for 2026-2030 in place of the former 2021-2025 Station Decommissioning Program, which was budgeted in System Service in the Distribution Enhancements program. This program will address the required replacement of 4kV stations through both decommissioning and voltage conversion to support system growth.

System Service

Hydro Ottawa's System Service capital investment category for 2026-2030, is designed to ensure the distribution system's capacity, reliability, resilience, and modernization, effectively addressing evolving energy demands and climate-related challenges.

The main change to the Capacity Upgrades Capital Program is the introduction of the Non-Wires Capacity Upgrade program. This program signifies a commitment to innovative grid enhancement through the implementation of alternative solutions, such as utility-owned battery storage, reflecting a proactive approach to technological advancement.

The Distribution Enhancements Capital Program has been expanded to include new budget programs: the Distribution System Observability program and Distribution System Resilience program. These two programs underscore a dedication to leveraging real-time data for optimized grid management and fortifying infrastructure against increasing climate vulnerabilities.

To reinforce communication infrastructure, the Field Area Network (FAN) capital program has been expanded to incorporate dedicated budget programs for Wireless Communication, Intelligent Electronic Device Management, and OTN Cyber Security. This expansion establishes a robust and secure communication framework essential for advanced grid operations. Furthermore, a dedicated Control and Optimization program has been established, focusing on the enhancement of the Advanced Distribution Management System (ADMS). The integration of the expanded FAN program and the new Control and Optimization program into the 2026-2030 System Service Investments demonstrates a resolute commitment to grid modernization.

Hydro Ottawa remains steadfast in its core objectives, which encompass the fortification of cyber security, the seamless integration of Distributed Energy Resources (DER), and the deployment of advanced grid technologies. Through these strategic adjustments and sustained investments, Hydro Ottawa ensures its infrastructure is robust, adaptable, and capable of meeting the region's future energy requirements.

General Plant

General plant investments are required to support day to day business and operations activities. The capital programs within this investment category have been redesigned since the last DSP to better align with the way the business operates and manages its financial performance. The last DSP presented 9 General Plant capital programs. Of these, 5 have been dissolved and replaced with 6 new capital programs. The projects within the dissolved capital programs have been redistributed to the new capital programs. Additionally, the former “Facilities Management" capital program has been renamed to “Buildings - Facilities” and modified to no longer include the Dibblee and Maple Grove Operations Centres as they have been reclassified to the System

Renewal Investment Category for better alignment with regulatory reporting requirements. Lastly, the capital program formally titled, “Hydro One Payments” has been renamed to “CCRA” to reflect the possibility of connection cost recovery agreements with entities other than Hydro One Networks Inc. (Hydro One). The “Tools Replacement” and “Fleet Replacement” capital programs remain consistent with the last DSP.

The capital programs from the last DSP that have been dissolved are: Enterprise Resource Planning (ERP) System, IT Life Cycle & On-Going Enhancements, Customer Service, and Operation Programs. The new capital programs are Enterprise Solutions, Infrastructure and Cyber Security, Meter to Cash, Customer Engagement Platform, Grid Technology and Data and System Integrations. See Section 5.4 - General Plant Expenditures for descriptions of each capital program.

2.3. NON-DISTRIBUTION ACTIVITIES

In March 2024, the OEB updated its “Non-Wires Solutions Guidelines for Distributors”[1] (previously known as the “CDM Guidelines for Distributors”) to reflect “the fact that Non-Wires Solutions to address system needs can encompass a broader range of solutions than traditional conservation and demand management, including, but not limited to, third-party distributed energy resources such as energy storage and distributed (embedded) generation”. Section 9.2 of Schedule 2-5-4 - Asset Management Process describes Hydro Ottawa’s approach to evaluating and leveraging Non-Wire Solutions.

3. FORECAST EXPENDITURE

The proposed investment plan for 2026-2030 is driven by a comprehensive investment strategy that aligns with customer expectations and addresses the evolving needs of Hydro Ottawa's electricity grid. This incorporates key improvements, including enhanced asset management processes, expanded grid modernization and resilience planning, updated system capacity assessments, and refined long-term forecasting based on customer feedback and system

[1] OEB. (March 28, 2024). Non-Wire Solutions Guidelines for Electricity Distributors [EB-2024-0118].

needs. This process is outlined in Schedule 2-5-4 - Asset Management Process. Hydro Ottawa’s investment strategy is broken down into the following four investment priorities.

1. **Growth & Electrification - Powering the Growing Community**
2. **Renewing Deteriorating Infrastructure**
3. **Grid Modernization - Enabling the Energy Transition**
4. **Enhancing Grid Resilience**

These four investment priorities address Hydro Ottawa's key distribution system planning challenges and opportunities, supported by two foundational focuses: Managing Rising Costs and Investing in the Workforce. Further details on this strategy are explained in Section 1.1 of Schedule 2-5-1 - Distribution System Plan Overview.

Table 1 below outlines the 2026-2030 forecasted expenditures by investment category . Hydro Ottawa’s capital expenditures over the 10-year period can also be found in Appendix 2-AB - Capital Expenditure Summary. Details on the forecasted expenditures are outlined in Section 4.2 - Forecast to Historical Variance Overview.

Table 1 – Capital Expenditure Test Years Summary ($'000s)

Investment Category	Test Years					Average
	2026	2027	2028	2029	2030	2026-2030
System Access	$ 86,169	$ 78,690	$ 66,190	$ 66,978	$ 71,472	$ 73,900
System Renewal	$ 85,348	$ 83,396	$ 80,714	$ 86,903	$ 95,343	$ 86,341
System Service	$ 99,276	$ 125,311	$ 76,050	$ 85,922	$ 86,912	$ 94,694
General Plant	$ 38,325	$ 23,583	$ 33,025	$ 27,872	$ 11,026	$ 26,766
GROSS CAPITAL EXPENDITURES	**$ 309,118**	**$ 310,981**	**$ 255,979**	**$ 267,675**	**$ 264,752**	**$ 281,701**
Capital Contributions	$ (50,947)	$ (50,591)	$ (38,447)	$ (32,197)	$ (41,052)	$ (42,647)
NET CAPITAL EXPENDITURES	**$ 258,171**	**$ 260,390**	**$ 217,532**	**$ 235,478**	**$ 223,700**	**$ 239,054**

System Access

Hydro Ottawa's System Access Capital Investments are strategically allocated across five key programs: Plant Relocation & Upgrade, Customer Connections, System Expansion, Generation Connections, and Metering. This budget was derived through an analysis of historical trends, forecasted growth, regulatory requirements, and customer service demands, ensuring alignment with Hydro Ottawa's mandate for safe, reliable, and sustainable electricity delivery. Refer to Section 5.1 - System Access Expenditures. The Customer Connections program reflects the ongoing expansion of residential and commercial developments. The System Expansion program addresses capacity constraints driven by increasing customer load requests. The Plant Relocation & Upgrade program supports infrastructure adjustments necessitated by third-party projects, primarily the City of Ottawa's development initiatives. The Generation Connections program facilitates the integration of distributed energy resources (DERs), while the Metering program focuses on Suite Metering retrofits. These investments collectively aim to support growth and a sustainable energy future.

Detailed information regarding System Access capital investments can be found within the Material Investment Plans outlined in Schedule 2-5-6 - System Access Investments.

System Renewal

Hydro Ottawa's System Renewal Capital Investments are strategically directed towards five core programs: Stations and Buildings Infrastructure Renewal, Overhead (OH) Distribution Asset Renewal, Underground (UG) Distribution Asset Renewal, Metering Renewal, and Corrective Renewal. This budget was developed through a rigorous process that combines Predictive Analytics, risk assessment modeling, and age-based prioritization to identify and address deteriorating infrastructure. Refer to Section 5.2 - System Renewal Expenditures. Condition-based assets, such as transformers and switchgear, are prioritized using Predictive Analytics and a risk assessment model that considers age, reliability, safety, financial, environmental, and compliance factors. Non-condition based assets, including RTUs and building facilities, are prioritized based on age. These investment programs are designed to proactively address risks by replacing aging and deteriorating infrastructure, ensuring the sustained delivery of safe and reliable electricity

Detailed information regarding System Access capital investments can be found within the Material Investment Plans outlined in Schedule 2-5-7 - System Renewal Investments.

System Service

Hydro Ottawa’s planned System Service capital investments are strategically allocated across six key programs: Capacity Upgrades, Distribution Enhancements, Station Enhancements, Grid Technologies, Field Area Network (FAN), and Control and Optimization (which is a new capital program). Refer to Section 5.3 - System Service Expenditures. This comprehensive budget was derived through a detailed analysis of forecasted demand, grid modernization needs, and climate change impacts, ensuring alignment with Hydro Ottawa's commitment to safe, reliable, and sustainable electricity delivery. The Capacity Upgrades program addresses system capacity needs through station, distribution, and non-wires upgrades. The Distribution Enhancements program focuses on modernizing the grid and enhancing resilience through reliability improvements, DER integration, strategic undergrounding and hardening of critical overhead sections, and enhanced grid observability. The remaining programs, including Station

Enhancements, Grid Technologies, Field Area Network, and the new Control and Optimization, address critical aspects of grid modernization, cyber security, and DER management. These investments collectively aim to increase distribution system capacity, improve reliability and resilience, and advance grid modernization to meet the evolving needs of Hydro Ottawa's customers.

Detailed information regarding System Access capital investments can be found within the Material Investment Plans outlined in Schedule 2-5-8 - System Service Investments.

General Plant

The General Plant category encompasses investments essential for maintaining and advancing Hydro Ottawa's infrastructure, operational capabilities, and customer service excellence. These investments are allocated across ten key programs: Connection and Cost Recovery Agreements (CCRA), Fleet Replacement, Tools Replacement, Buildings - Facilities, Grid Technology, Meter to Cash, Customer Engagement Platform, Enterprise Solutions, Infrastructure and Cyber Security, Data and System Integrations. These programs support strategic goals like grid modernization, sustainability, and workforce readiness while promoting efficiency, innovation, and resilience in Hydro Ottawa's operations.

Investments in CCRAs with Hydro One are included in the System Service planning process. These projects are carefully chosen based on several factors, including recommendations from the IRRP and aligned with supporting distribution and NWSs programs. This ensures that capacity upgrades are implemented strategically and in a way that maximizes benefits for the overall system. General Plant investments in Tools Replacement are projected using historical costs per employee and applied to expected employee levels. Fleet Replacement, and Building - Facilities and the remaining technology, data and infrastructure programs follow a similar approach to the distribution asset management processes. These investments are typically large replacement or enhancement initiatives for assets reaching the end of their useful life. As such, they generally span several years. Therefore, they are initiated and justified with detailed business cases.

Detailed information regarding General Plant capital investments can be found within the Material Investment Plans outlined in Schedule 2-5-9 - General Plant Investments.

4. HISTORICAL AND FORECAST EXPENDITURE OVERVIEW

4.1. HISTORICAL VARIANCE OVERVIEW

4.1.1. Overview of Historical Variance

Hydro Ottawa expects that its net capital expenditures will exceed the OEB-approved budget by approximately $102.8M in aggregate over the 2021-2025 historical period as outlined in Table 2. The variance by year is further detailed by investment category in Table 3.

Table 2 – Capital Expenditure Historical 5 yr Variances (Net) ($'000s)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
System Access	$ 84,300	$ 134,193	$ 49,892	59%
System Renewal	$ 209,978	$ 232,321	$ 22,343	11%
System Service	$ 123,089	$ 161,048	$ 37,959	31%
General Plant	$ 80,193	$ 72,827	$ (7,367)	(9)%
TOTAL CAPITAL EXPENDITURES	**$ 497,561**	**$ 600,388**	**$ 102,827**	**21%**

Table 3 - Capital Expenditure Historical Annual Variances (Net) ($'000s)

Capital Program	2021	2022	2023	2024	2025
	OEB-Approved (Net of Contribution)				
System Access	$ 17,820	$ 17,879	$ 17,720	$ 15,626	$ 15,255
System Renewal	$ 45,421	$ 44,414	$ 40,594	$ 39,436	$ 40,114
System Service	$ 25,436	$ 26,168	$ 23,434	$ 24,654	$ 23,398
General Plant	$ 31,540	$ 10,874	$ 6,208	$ 15,343	$ 16,228
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 120,217**	**$ 99,335**	**$ 87,956**	**$ 95,058**	**$ 94,995**
	Historical Years			Bridge Years	
System Access	$ 21,638	$ 19,723	$ 24,987	$ 32,625	$ 35,220
System Renewal	$ 43,249	$ 65,469	$ 40,266	$ 42,334	$ 41,003
System Service	$ 23,938	$ 13,825	$ 16,585	$ 47,157	$ 59,543
General Plant	$ 23,273	$ 11,262	$ 12,146	$ 13,967	$ 12,179
TOTAL HISTORICAL/BRIDGE NET CAPITAL EXPENDITURES	**$ 112,097**	**$ 110,278**	**$ 93,984**	**$ 136,082**	**$ 147,945**
	Variance ($)				
System Access	$ 3,817	$ 1,844	$ 7,267	$ 16,999	$ 19,965
System Renewal	$ (2,172)	$ 21,054	$ (327)	$ 2,899	$ 889
System Service	$ (1,498)	$ (12,343)	$ (6,849)	$ 22,503	$ 36,145
General Plant	$ (8,267)	$ 388	$ 5,938	$ (1,376)	$ (4,049)
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ (8,120)**	**$ 10,943**	**$ 6,029**	**$ 41,024**	**$ 52,951**

As noted in the Overview Section, the 2021-2025 period presented Hydro Ottawa with a series of unprecedented disruptions. These disruptions, stemming from global and local external factors, included unprecedented supply chain challenges, a surge in complex customer connections, unforeseen externally-driven projects, increased emergency renewal work due to severe storms and equipment failures, and substantial investments in new stations to address growing electricity demand as identified in the Ottawa Integrated Regional Resource Plan (IRRP) as noted below:

I. Unprecedented Supply Chain Disruption

In the 2021-2025 period, Hydro Ottawa faced severe supply chain disruptions caused by a complex interplay of global events that converged to create an unprecedented procurement challenge. The COVID-19 pandemic initiated the crisis with widespread manufacturing shutdowns and severe logistics bottlenecks, disrupting the flow of essential materials and equipment, as detailed in Schedule 1-2-4 - Impact of COVID-19 Pandemic. This was compounded by a surge in global demand for electrical equipment. Further exacerbating the situation, the Russian war in Ukraine introduced significant geopolitical instability, disrupting the supply of critical materials, including grain-oriented electrical steel for transformer cores. Consequently, as detailed in Schedule 1-2-5 - Impact of Inflationary Pressures, Hydro Ottawa also experienced dramatic price increases for essential equipment, including transformers, cables, switchgear, wood poles, and meters, forcing budget adjustments and project deferrals to help mitigate the impact of these external cost factors. The combined effect of these disruptions resulted in longer lead times for procurement, further complicating project execution and necessitating strategic decisions regarding resource allocation and prioritization. As noted in Schedule 1-2-5 - Impacts of Inflationary Pressure, Canada’s inflation rate in the 2020-2024 period was the highest in 40 years.

II. Customer Connections Volume, Complexity, and Cost

Hydro Ottawa faced an unprecedented surge in customer connection requests, escalating from an annual average of 3,190 (OEB-approved budget) to an annual average of 6,067 (over the 2021-2023 period), a consequence of the municipal and provincial policy push towards intensified housing and a pandemic-fueled housing boom. Customer connections over the historical period presented not only a quantitative increase but also a significant qualitative shift, becoming notably more complex and costly. The average cost per connection increased materially, from $934 to $1,350, reflecting the inflationary pressures impacting material and labour costs, as well as the intricate electrical infrastructure demanded by higher-density developments. The impacts of the inflationary pressures on Hydro Ottawa are detailed in Schedule 1-2-5 - Impact of Inflationary Pressures. This surge placed a considerable strain on Hydro Ottawa's resources, stretching beyond initial budget projections. Further details related to the impacts to Hydro Ottawa's workforce and the associated growth requirements are presented in Attachment 4-1-3(C) - Workforce Growth.

III. Unforeseen Externally-Driven Projects

While Hydro Ottawa had budgeted for one major unforeseen project, a series of additional externally-mandated projects caused significant cost pressures, notably the delays of LRT Phase II, the City of Ottawa's Zero Emission Bus initiative, and the DND's Dwyer Hill Road project. These initiatives, despite carrying a budget for one large project, substantially exceeded initial scope projections, and necessitated substantial, unanticipated expenditures. Hydro Ottawa was required to absorb these incremental costs, which were partially offset by deferred expenditures in other programs. Beyond the immediate financial impact, these projects also caused significant strain on internal resources. The cascading effects of these unforeseen projects extended to the company's long-term strategic planning, forcing a reassessment of future infrastructure needs and budgetary allocations. While Hydro Ottawa actively collaborates with stakeholders to align forecasts (refer to Schedule 2-5-2 - Coordinated Planning with Third Parties), the timing and scope of critical projects are ultimately determined by external entities, which can lead to significant budget fluctuations.

IV. Increased Emergency Renewal Work due to Major Storms and Equipment Failure

Hydro Ottawa experienced a significant increase in emergency renewal expenditures, totaling $33M above historical levels, during the period of 2021-2025. This surge was primarily driven by a series of unprecedented weather events, most notably the catastrophic 2022 Derecho storm. This singular event resulted in a $15.3M overspend in emergency renewals, as detailed in

Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report. The storm's extensive damage to critical infrastructure necessitated an immediate and substantial mobilization of resources, exceeding typical operational parameters.

In addition to the Derecho, a sequence of subsequent severe weather events further strained Hydro Ottawa's System Renewal capital program. These Major Event Days, detailed in Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement, contributed to a sustained increase in emergency repair workloads. As a residual effect of the extreme weather, general equipment failures increased due to infrastructure deterioration and heightened system stress, leading to further cost escalation. This confluence of factors created a continuous cycle of emergency repairs, diverting resources from planned maintenance and capital improvement projects. Consequently, the capital investment budget was significantly impacted, and customer outages increased, highlighting the electrical grid's vulnerability to extreme weather and the critical need for proactive infrastructure resilience.

V. New Stations Investments to Address Growing Electricity Demand

Hydro Ottawa made significant investments in two new Municipal Transformer Stations (MTS) over the historical period: Mer-Bleue MTS and Piperville MTS. These investments were in response to the needs related to growth and resilience identified during the Regional Planning Process outlined in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties. As the capacity requirements for the Mer-Bleue MTS project were identified through the regional planning process following the approval of the 2021-2025 OEB budget, the project was not incorporated, resulting in $13.8M of unbudgeted expenditures. Concurrently, the Piperville MTS project, while accounted for in the initial budget, experienced cost overruns attributed to unforeseen escalations in material and labour costs. This discrepancy underscored the volatility of market prices, particularly in specialized electrical equipment, and the challenges of accurately forecasting expenditures over extended periods. The impacts of the inflationary pressures on Hydro Ottawa are detailed in Schedule 1-2-5 - Impact of Inflationary Pressures. These investments, while crucial for bolstering grid resilience and expanding capacity to meet the region's growing energy needs, placed a considerable strain on Hydro Ottawa's financial resources.

4.1.2. Major Contributing Factors to Historical Period Variances

This section examines the major contributing factors leading to the significant financial variances experienced relative to the 2021-2025 OEB-approved budget, which resulted in a net capital expenditure variance of $102.8M. To mitigate these cost pressures, Hydro Ottawa implemented proactive financial management strategies, notably deferring planned projects, resulting in a budget adjustment of approximately $44.2M as noted in Table 4. This prioritization impacted key capital investments such as Major Station Rebuilds, Voltage Conversions, ERP Upgrades, and Underground Switchgear Renewals. Furthermore, Hydro Ottawa's labor productivity initiatives, as described in Schedule 1-3-4 - Facilitation Innovation and Continuous Improvement, played a crucial role in mitigating the overall financial impact. Without these initiatives, the net capital expenditure variance of $102.8M against the OEB-approved budget would have been considerably higher. It is also worth noting that Hydro Ottawa did not apply for a Z factor during the 2021-2025 period.

Table 4 presents a comprehensive overview of the major projects and events that contributed to increased spending and the major deferrals by Investment Category. Refer to Section 5 - Capital Expenditure Summary for further details of the historical variances by Capital Program. It is important to note that Table 4 below has inflation embedded in each of the variances as it is impossible to isolate inflation on every line item budget. As discussed in Schedule 4-1-1 - Operations, Maintenance, and Administration Summary, the level of operations, maintenance and administration (OM&A) included in Hydro Ottawa's rates over the 2021-2025 period was increased by the OEB's inflation factor, less the stretch factor, plus a growth factor. However, with respect to capital costs, the approved plan did not include any amounts forecast for inflation, nor did it include any cost escalation adjustment mechanisms. Essentially, the capital plan assumed that a modest level of inflation would continue and that the impact of any inflation would be offset by productivity and efficiency savings. The revenue requirement for planned capital spending was further reduced by an annual 0.6% capital stretch factor.

1 **Table 4 – Major Variance Contributors ($'000s)**

Projects/Events	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)
Major Overspend Contributors			
Residential Subdivisions	$ 14,930	$ 38,911	$ 23,981
New Commercial Development	$ 9,593	$ 26,491	$ 16,898
Large Externally Driven Projects	$ 21,498	$ 39,483	$ 17,985
SubTotal - System Access	$ 46,021	$ 104,885	$ 58,864
2022 Derecho	-	$ 15,294	$ 15,294
Other Emergency Renewal	$ 24,534	$ 42,219	$ 17,685
Storm Hardening Pole Renewal	-	$ 2,360	$ 2,360
Cable Replacement	$ 44,414	$ 54,318	$ 9,904
SubTotal - System Renewal	$ 68,948	$ 114,191	$ 45,243
Capacity Upgrades	$ 75,849	$ 108,196	$ 32,347
Advanced Distribution Management System	$ 14,928	$ 22,760	$ 7,831
SubTotal - System Service	$ 90,777	$ 130,956	$ 40,179
My Account	-	$ 6,789	$ 6,789
ServiceNow	-	$ 2,669	$ 2,669
Facilities Projects	-	$ 3,640	$ 3,640
SubTotal - General Plant	-	$ 13,097	$ 13,097
Total Major Overspend Contributors	**$ 205,746**	**$ 363,128**	**$ 157,383**
Major Deferrals			
Major Station Rebuild and Voltage Conversion	$ 27,274	$ 3,982	$ (23,291)
Other Distribution Asset Renewal	$ 21,697	$ 16,218	$ (5,479)
SubTotal - System Renewal	$ 48,971	$ 20,201	$ (28,770)
Capacity Voltage Conversion	$ 5,864	$ 1,739	$ (4,125)
SubTotal - System Service	$ 5,864	$ 1,739	$ (4,125)
Meter to Cash AMI Program	$ 1,557	-	$ (1,557)
Enterprise Resource Planning Upgrade	$ 9,740	-	$ (9,740)
SubTotal - General Plant	$ 11,297	-	$ (11,297)
Total Major Deferrals	**$ 66,131**	**$ 21,939**	**$ (44,192)**
Other			
CCRAs	$ 26,658	$ 16,964	$ (9,695)
Remaining Capital Expenditure	$ 199,026	$ 198,357	$ (669)
Total Other	**$ 225,684**	**$ 215,320**	**$ (10,364)**
Total Capital Expenditures	**$ 497,561**	**$ 600,388**	**$ 102,827**

The amounts in “Remaining Capital Expenditure” listed in Table 4 contain all other capital expenditures not categorized as associated with the major contributing factors. The associated variance results in an underspend of $0.7M. It is the result of several overages and underages across various programs. For a comprehensive understanding of the variances within each capital program please refer to Section 5 - Capital Expenditure Summary. Additionally, the ‘Other’ category included the variance on Connection Cost Recovery Agreements (CCRAs), which was largely beyond Hydro Ottawa’s control.

4.1.3. 2021-2025 Major Deferrals

During the 2021-2025 period, Hydro Ottawa faced a series of unprecedented challenges that tested its operational resilience. These included the COVID-19 pandemic and its associated supply chain disruptions, inflationary pressures, a historic Derecho storm in May 2022 that caused extensive damage to the electricity grid, eleven other major weather events requiring emergency response, and an 84-day labor strike in 2023 (following a near strike in 2021).

In response, Hydro Ottawa adopted a flexible and pragmatic approach to capital expenditure management. Faced with significant budgetary pressures from these unforeseen events, the utility strategically deferred certain capital investments to mitigate the impact of unavoidable increases in other programs. These decisions, guided by principles of responsible financial stewardship, represented a deliberate and calculated response to immediate budgetary constraints, aimed at ensuring operational stability and minimizing ratepayer impact. Furthermore, Hydro Ottawa implemented specific cost avoidance measures by evaluating program progress and actively reducing asset replacements across various programs to further mitigate cost impacts.

The identification and prioritization of deferrals and cost avoidance measures were conducted with a focus on maintaining the integrity of the electrical infrastructure. Recognizing the potential implications of delaying critical projects, Hydro Ottawa adhered to a rigorous portfolio optimization process, as detailed in Section 5.3 of Schedule 2-5-4 - Asset Management

Process. This process involved a comprehensive assessment of project criticality, asset condition, and associated risks, ensuring that deferrals were implemented in a manner that judiciously balanced the financial limitations with infrastructure integrity.

4.1.3.1. System Renewal Deferrals ($28.8M)

During the 2021-2025 period, Hydro Ottawa implemented System Renewal capital investment deferrals totaling $28.8M. This encompassed $23.3M in Large Station Rebuild and Voltage Conversion projects, and $5.5M in Other Distribution Asset Renewals. Leveraging asset condition assessments and advanced analytical tools, the company strategically prioritized projects, deferring rebuilds at Rideau Heights and Shillington AD, while pursuing voltage conversions at Fisher AK and Dagmar to address both asset conditions and capacity constraints. Additionally, deferrals were applied to various asset renewal programs, including underground switchgear and metering assets. The following detailed account of these deferrals illustrates Hydro Ottawa's data-driven approach to balancing financial constraints with the imperative of maintaining system reliability and minimizing ratepayer impact.

Large Station Rebuild and Voltage Conversion Projects ($23.3M)

Station project work described below was deferred in order to accommodate budget overruns and to manage cash flow in response to the unforeseen challenges of the historical period. Hydro Ottawa implemented a rigorous assessment process, utilizing enhanced inspection methodologies, to evaluate the feasibility of deferring select infrastructure renewal projects. Employing advanced analytical tools and comprehensive asset condition data, the company made informed, data-driven decisions regarding infrastructure upgrade deferrals. This strategic approach ensured the optimal allocation of capital resources, prioritizing critical projects and minimizing the financial impact on ratepayers while maintaining acceptable levels of system reliability.

- The Rideau Heights station rebuild ($3.2M of budgeted capital investment) was deferred based on a detailed asset condition assessment. This assessment confirmed that the rebuild could be postponed without compromising reliability. Ongoing monitoring and maintenance, combined with proactive O&M, will ensure timely response to any changes. This data-driven, risk-informed approach facilitated an evidence-based decision to defer the capital investment.

- The Shillington AD station rebuild was deferred ($2.5M of budgeted capital investment) following an assessment based on the enhanced inspection of the asset condition. The analysis of the condition data confirmed that it would be possible to delay the project temporarily while maintaining an acceptable level of operational risk. Further, the continuous monitoring of the Shillington AD station through O&M activities ensures that if conditions change, the necessary work can be scheduled promptly.
- The planned rebuild of the Fisher AK station, initially driven by asset conditions, was deferred in favor of a voltage conversion project, resulting in a $5.7M deferral of budgeted capital investment. This decision was based on a re-evaluation of the project in light of emerging capacity constraints. An updated planning analysis demonstrated that 4kV to 13kV voltage conversion would better address immediate capacity needs while also effectively eliminating the original rebuild requirement arising from asset conditions. Consequently, the voltage conversion project has superseded the planned rebuild scope, rather than representing a temporary substitute of the station rebuild scope. The strategic adjustment underscores Hydro Ottawa's commitment to proactive adaptation to evolving operational requirements and optimization of resource allocation. By re-scoping the project, Hydro Ottawa ensures the delivery of essential infrastructure upgrades while minimizing the financial impact on ratepayers, thereby aligning capital investments with long-term strategic objectives.
- The planned rebuild of the Dagmar station, originally necessitated by asset condition, was also deferred in favor of a voltage conversion project, resulting in a $11.9M deferral of budgeted capital investment. This decision followed a comprehensive re-evaluation of the project in response to emergent capacity constraints. An updated planning analysis demonstrated that 4kV to 13kV voltage conversion would better address immediate capacity needs while also effectively eliminating the original rebuild requirement arising from asset

conditions. Consequently, the voltage conversion project has superseded the planned rebuild scope, rather than representing a temporary substitute of the station rebuilt scope. The adjusted project scope is planned execution for 2026-2030. This strategic adjustment underscores Hydro Ottawa's commitment to proactive adaptation to evolving operational requirements and optimization of resource allocation.

Other Distribution Asset Renewal ($5.5M)

Deferrals in various capital programs were implemented following comprehensive risk and condition evaluations. Work in the programs described below was deferred in order to accommodate budget overruns and to manage cash flow in response to the unforeseen challenges of the historical period. Each of these deferrals was made after careful consideration of the asset condition, potential risks, and the overall impact on system reliability. These decisions demonstrate Hydro Ottawa's commitment to dynamically adjusting its capital expenditure plans to minimize the financial impact on ratepayers while maintaining infrastructure integrity, and minimizing incremental system performance risk for customers.

- Hydro Ottawa deferred $5.5M in budgeted capital investments related to Underground Switchgear Renewals, Overhead Switch/Recloser Renewals, Metering Asset Renewals, System Renewal Investments (excluding station investments), and Vault Renewals. Each deferral was predicated on a comprehensive evaluation of asset condition, potential risks, and the overall impact on system performance. This meticulous assessment process ensured that deferrals were implemented prudently, minimizing incremental system performance risk for customers.

4.1.3.2. System Service Deferrals ($4.1M)

Deferrals in System Service investments were implemented in order to accommodate budget overruns and to manage cash flow in response to the unforeseen challenges of the historical period.

Capacity Voltage Conversion ($4.1M)

Hydro Ottawa deferred two planned capacity voltage conversion projects at West 12kV and Navan Road, resulting in a $4.1M deferral. These projects, while essential for long-term capacity enhancement, were deemed suitable for postponement based on current operational conditions and risk assessments.

4.1.3.3. General Plant Deferrals ($11.3M)

For the 2021-2025 period, Hydro Ottawa deferred $11.3M in planned General Plant capital investments. This encompassed the $9.7M Enterprise Resource Planning (ERP) upgrade deferral, attributed to evolving software portfolio requirements, infrastructure spending demands, and external disruptions such as the pandemic and severe weather events. Additionally, $1.6M of the Meter to Cash AMI program was deferred, influenced by pandemic-related resource constraints and a strategic re-evaluation of AMI modernization. The following details provide insight into Hydro Ottawa's strategic resource allocation during a period of significant operational and financial challenges, and the proactive planning for future technology upgrades.

Enterprise Resource Planning Upgrade ($9.7M)

As noted in Section 5.4.2 - Historical Variance below, the deferral of the $9.7M Enterprise Resource Planning (ERP) project deployment was driven by a variety of factors, including evolving requirements for Hydro Ottawa's overall enterprise software portfolio, increased spending demands for critical infrastructure, disruptions from the COVID-19 pandemic, and other unforeseen events, such as the 2022 Derecho and the 2023 strike. In addition, Oracle extended support for the current version. Ultimately, the decision was made to defer the project in order to reduce overall capital expenditure and focus limited resources on maintaining essential services during these challenging periods. While the ERP project was initially proposed for the 2026-2030 timeframe, given competing spend priorities, Hydro Ottawa will continue to leverage its current JD Edwards ERP version for that period, focusing instead on improving Enterprise Asset Management processes and technology as noted in Attachment 4-1-1(A) - Transition to Cloud Computing.

Meter to Cash AMI Program ($1.6M)

$1.6M of the Meter to Cash capital program budget was deferred due to external factors and the evolving AMI landscape. The COVID-19 pandemic and the 2022 Derecho strained resources while the need for enhanced grid modernization capabilities led to a reevaluation of the project's scope and objectives. It was decided to defer investment in the 2021 - 2025 period and prioritize the development of a comprehensive AMI 2.0 Metering Renewal Program for the 2026-2030 period.

4.1.3.4. Cost Containment Measures

To address extraordinary financial pressures, notably the 2022 Derecho storm, Hydro Ottawa implemented strategic cost containment measures during 2021-2025. These measures, detailed below, extended beyond project deferrals to include proactive adjustments in capital expenditure, revisions to cable and pole replacement programs, and productivity enhancements resulting in labor savings.

- Following the unprecedented impact of the 2022 Derecho storm, Hydro Ottawa undertook a comprehensive review of its capital expenditure plans. Recognizing the need to balance immediate recovery efforts with long-term financial sustainability, a strategic decision was made to reduce the overall sustainment (System Service and System Renewal) capital expenditures by $1M per year for the years 2023, 2024, and 2025.
- Hydro Ottawa implemented a strategic adjustment to its cable replacement program for the 2021-2025 period, revising the target from the initially planned 130 km to approximately 74 km. This risk-based decision to adjust the target, supported by the asset condition analysis, was made due to significant unit rate increases in the Cable Replacement Program as detailed in Section 5.2.1 - Historical Expenditures. The revised target was not merely a

risk-based decision to reduce the volume but a calculated adjustment to avoid an estimated $49.5M in capital expenditures.

- Subsequent to the 2022 Derecho which resulted in the unanticipated replacement of over 400 poles, Hydro Ottawa strategically reduced its 2021-2025 pole renewal target from 2,000 to 1,732 poles. It's important to note that the poles replaced due to the Derecho were distinct from those targeted in the planned pole renewal program. This target reduction was taken solely to mitigate cost overruns overall. The decision on which pole replacement projects to defer was a risk-based decision , based on detailed asset conditions as detailed Section 5.2.1 - Historical Expenditures. Separately, Hydro Ottawa implemented productivity measures that resulted in $2.1M in capital savings in the pole renewal program. Specifically, Hydro Ottawa implemented operational changes, including team realignment, dedicated construction technicians, and seasonal shift adjustments, to enhance collaboration, efficiency, and productivity. Additionally, cost containment strategies to manage planned overtime were also deployed. The productivity savings coupled with the strategic decision to reduce the pole renewal target resulted in an estimated $8.6M in avoided capital expenditures.
- The efforts undertaken to achieve the productivity savings in the pole renewal program also translated to labour savings in the remainder of the distribution overhead capital programs. These savings amounted to an additional $14.8M of capital avoidance over the historical period. Further detail of the productivity savings, totaling approximately $14.5M, are summarized in Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement.

4.1.3.5. Commitment to Infrastructure Integrity and Future Planning

Hydro Ottawa prioritized the maintenance of electrical system integrity throughout the 2021-2025 period, even as it implemented strategic deferrals and cost avoidance measures. Recognizing the potential impact of delaying critical projects, the company adhered to a rigorous portfolio optimization process, as detailed in Section 5.3 of Schedule 2-5-4 - Asset Management Process. This process involved a comprehensive, risk-informed assessment of project criticality and asset condition, ensuring that financial limitations were balanced with the imperative of infrastructure integrity.

While the deferrals and cost avoidance measures employed during the 2021-2025 period were implemented as short-term strategies to address budgetary limitations and immediate financial pressures, Hydro Ottawa acknowledges the necessity of addressing deferred work. The company is committed to the reintegration of the deferred work into the 2026-2030 capital expenditure plan, thereby ensuring the long-term reliability and resilience of the electrical infrastructure. This commitment reflects Hydro Ottawa's dedication to balancing immediate economic needs with the sustained integrity of the electrical system. The substantial shifts in spending across all investment categories during the 2021-2025 period underscore the material impact of these strategic decisions and affirm the company's commitment to prudent financial management.

4.2. FORECAST TO HISTORICAL VARIANCE OVERVIEW

This section analyzes the variance in expenditures between the historical period of 2021-2025 and the projected period of 2026-2030. Table 5 presents a comparative overview of expenditures across Investment Categories for both periods. Figure 1 depicts the percent contributions of each investment category to the net total for 2021-2025 and 2026-2030 respectively.

1 **Table 5 – Historical, Bridge and Test Years Expenditures by Investment Category ($'000s)**

Investment Category	2021-2025 Historical/ Bridge	2026-2030 Test Years	Var ($)	Var (%)
System Access	$ 292,570	$ 369,500	$ 76,930	26%
System Renewal	$ 232,333	$ 431,704	$ 199,371	86%
System Service	$ 161,104	$ 473,472	$ 312,368	194%
General Plant	$ 76,405	$ 133,830	$ 57,425	75%
GROSS CAPITAL EXPENDITURES	**$ 762,412**	**$ 1,408,505**	**$ 646,093**	**85%**
Capital Contributions	$ (162,024)	$ (213,234)	$ (51,210)	32%
TOTAL NET CAPITAL EXPENDITURES	**$ 600,388**	**$ 1,195,271**	**$ 594,883**	**99%**

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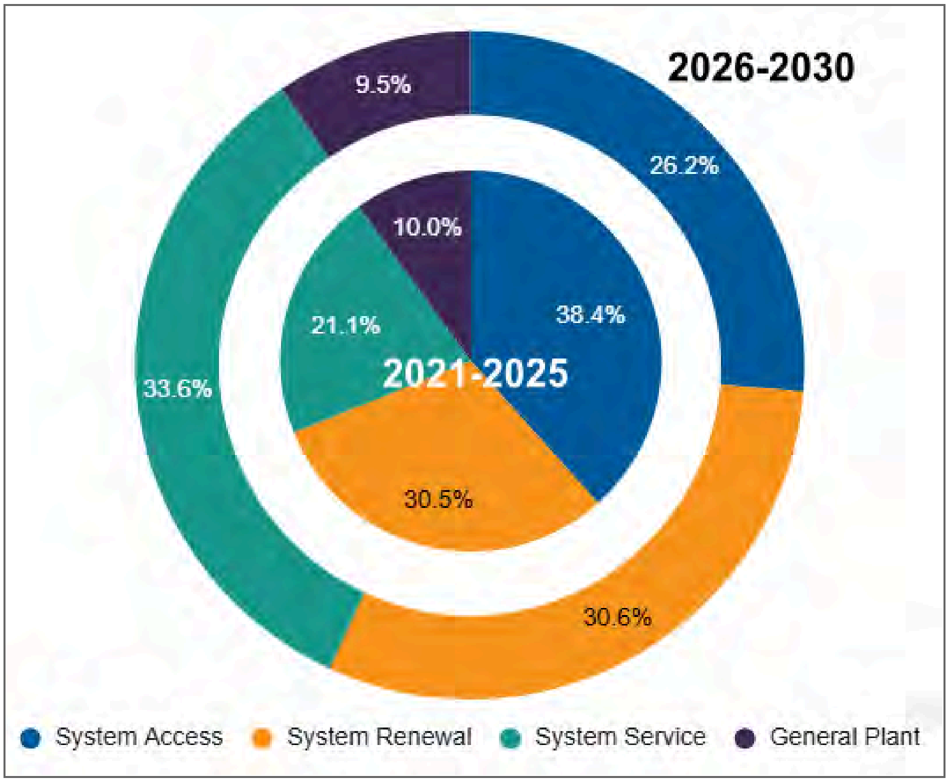
Figure 1 – Percentage Contribution of Investment Categories to Total Expenditures 2021-2025 and 2026-2030



System Access

While System Access shows a 12.2% relative decrease in contributions as a result of the increases in other Investment Categories, the gross expenditures within this category, which are necessary to support growth and electrification, are projected to increase by 26% compared to the 2021-2025 period. Projected capital expenditures are expected to rise from $293M in the 2021-2025 period to $369M in the 2026-2030 period, excluding Capital Contributions as shown in Table 5. This increase is primarily attributed to the growing number and complexity of customer connections, reflected in the higher expenditures for the Customer Connections and System Expansion Capital programs. This growth in expenditures is partially offset by a projected decrease in Plant Relocation costs as a result of the long-standing City of Ottawa LRT project being largely complete. Further details of forecasted System Access expenditures by capital program are provided in Section 5.3.1 - Historical Expenditures.

System Renewal

Expenditures in the System Renewal category are expected to continue to make up approximately 30% of the overall spend and increase by 86%, from $232M in the 2021-2025 period to $432M in the 2026-2030 period. This increase is substantiated by improvements to the asset condition and system risk models through the implementation of Predictive Analytics and updates to failure curves which have provided Hydro Ottawa a much more accurate and thorough understanding of the failure risk due to deteriorating asset condition, as detailed in Section 2.1.1 of Schedule 2-5-4 - Asset Management Process. Specifically, the need for incremental investments is targeted at the renewal of high-risk station assets, followed by underground and overhead. A further breakdown of the forecasted expenditures by capital program is provided in Section 5.2.3 - Forecast to Historical Variance by Capital Program.

System Service

As can be noted from Figure 1 above, System Service makes up a greater proportion of the 2026-2030 DSP compared to the 2021-2025 DSP, rising from 21% to approximately 34%. The associated investment in this category is forecast to increase by 194% from $161M in the 2021-2025 period to $473M in the 2026-2030 timeframe. This reflects Hydro Ottawa's need to expand the capacity of the grid in order to connect new customers and serve customers' growing demand for electricity, as well as the utility's commitment to modernize the grid and make it more resilient to withstand extreme weather. The increase is primarily driven by the Capacity Upgrades program, which addresses growing capacity needs due to customer growth and electrification. Increased spending in the Distribution Enhancements program also contributes, with a focus on two new budget programs for Distribution System Observability and Distribution System Resilience.

Finally, the Field Area Network Program drives further increases with investments in fiber extensions to ensure real-time data sharing from grid-edge devices and wireless communication capabilities necessary to support the enhanced number of automated field devices and metering infrastructure. Further details related to the forecasted expenditures in System Service by capital program are provided in Section 5.3.3 - Forecast to Historical Variance by Capital Program.

General Plant

Expenditures under the General Plant investment category are projected to increase by 75% from $76M in the 2021-2025 period to $134M the 2026-2030 period and remain at approximately 10% of the overall expenditures. The primary factor for this increase is due to increased funding under the CCRA program required to support the increased number of transmission upgrades required to service new and upgraded stations. An increase in the Fleet Replacement program is driven by the need to replace vehicles that have reached end of useful life and for additional vehicles required to support the increase in planned workforce. Further details of the forecasted expenditures by capital program are provided in Section 5.4.3 - Forecast to Historical Variance by Capital Program.

5. CAPITAL EXPENDITURE SUMMARY

5.1. SYSTEM ACCESS EXPENDITURES

System Access investments are mandated by provincial legislation and while Hydro Ottawa makes every effort to ensure projects in this Investment Category are completed as timely and efficiently as possible, the inherent nature of customer-driven and third-party-initiated work means that the project timeline and associated budgets are not entirely within Hydro Ottawa's control. The System Access Investment Category is broken down into five Capital Programs as described in Table 6.

Table 6 - System Access Capital Programs

Capital Program	Description
Plant Relocation & Upgrade	This program relocates and/or upgrades Hydro Ottawa's overhead and underground equipment, including jointly owned assets, to accommodate third-party infrastructure projects and maintain safe clearances around energized facilities.
Customer Connections	This program invests in electrical infrastructure upgrades to connect new residential, commercial, and infill developments to the distribution grid, ensuring capacity for current and projected electricity demands.
System Expansion	This program ensures reliable electrical service to new and upgraded customer connections by strategically upgrading infrastructure like feeders, transformers, and substations to accommodate increased demand from new developments and large loads and support future growth.
Generation Connections	This program facilitates the integration of customer-owned embedded generation projects into the distribution grid, including metering, service connections, and the necessary protection and control systems.
Metering	This program modernizes metering infrastructure in commercial and multi-residential buildings, primarily on residential retrofits, which includes suite metering for both new customer connections and upgrades for existing customers.

Budgeting is informed by historical expenditures, confirmed major projects (including committed customer and large load requests), and evolving government policy, notably the City of Ottawa's intensification policies. The community's continued growth and expanding electricity demand are key drivers, resulting in a sustained increase in customer connection requests. The Capital Programs under System Access are further broken down into Budget Programs described in Table 7 along with the primary driver. The program drivers are detailed in Section 5.3.1.1 of Schedule - 2-5-4 Asset Management Process.

Table 7 – System Access Expenditure Categories

Capital Program	Budget Program	Primary Driver	Description
Plant Relocation & Upgrade	Plant Relocation & Upgrade	Third Party Requirements	• Relocation or upgrade of Hydro Ottawa owned or joint-use overhead or underground equipment; • Equipment relocations or upgrades to ensure safe limits of approach from energized electrical plant is maintained
Customer Connections	Residential Subdivision	Customer Service Request	• To connect new residential subdivisions consisting of townhomes, semi-detached, single, or any combination of housing units; • Includes trunk, primary & secondary distribution infrastructure .
	New Commercial Development	Customer Service Request	• New developments serviced via padmounted equipment (switchgear and/or transformers) or via a vault.
	Infill (Res & Small Com)	Customer Service Request	• Infill service or service upgrade for residential or small commercial developments(i.e. services that do not require pad mounted equipment or vault installations).
	ESA Flash Notice	Mandated Service Obligation	• Corrective actions associated with specific historical grounding configurations
System Expansion	System Expansion Demand	Customer Service Request	• A demand driven expansion/upgrade to the distribution system in response to a customer request (i.e., a line extension).
	Asset Transfer	Third Party Requirements	• Ownership transfer and upgrade of customer-owned equipment
Generation Connections	Embedded Generation	Customer Service Request	• Connection of customer driven embedded generation projects; • Includes metering, service connection and protection and control as required.
Metering	Suite Metering	Customer Service Request	• Retrofit of suite meters (retrofit of bulk meters) for commercial and multi-residential buildings; • Focus of the program is on residential retrofits

5.1.1. Historical Expenditures

The following tables present Hydro Ottawa's System Access Capital Expenditures from 2021 through 2025 compared to the OEB Approved amounts. Table 8 details this spending on a five-year total basis, while Table 10 provides the annual spending and variances.

Because System Access is driven primarily from customer requests, its associated costs are partially covered by customer contributions. Table 9 provides the details on customer contributions compared to OEB approved budgets.

Table 8 - System Access Historical & Bridge Spending versus OEB Approved ($'000s)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
Plant Relocation	$ 37,905	$ 44,584	$ 6,679	18%
System Expansion	$ 48,818	$ 88,680	$ 39,862	82%
Customer Connections	$ 110,591	$ 157,061	$ 46,470	42%
Generation Connections	$ 1,578	$ 525	$ (1,053)	(67)%
Metering	$ 4,767	$ 1,720	$ (3,047)	(64)%
TOTAL GROSS CAPITAL EXPENDITURES	**$ 203,660**	**$ 292,570**	**$ 88,910**	**44%**
Capital Contributions	$ (119,360)	$ (158,377)	$ (39,018)	33%
TOTAL NET CAPITAL EXPENDITURES	**$ 84,300**	**$ 134,193**	**$ 49,892**	**59%**

Hydro Ottawa uses the OEB prescribed economic evaluation methodology to calculate the customer contribution associated with System Access projects. The capital contributions include Contributed Plant (non-cash contributions) and Contributed Capital (cash contributions). Table 9 details historical capital contributions received by Hydro Ottawa, broken down by Capital Program within the System Access Investment Category.

1 **Table 9 - System Access Historical Contributions versus OEB Approved ($’000s)**

Capital Program	2021	2022	2023	2024	2025	2021-2025
	OEB-Approved					Percentage of Gross
Plant Relocation	$ (7,919)	$ (4,241)	$ (4,274)	$ (3,270)	$ (3,256)	61%
System Expansion	$ (13,075)	$ (3,864)	$ (1,740)	$ (1,692)	$ (1,572)	45%
Customer Connections	$ (17,680)	$ (14,886)	$ (13,536)	$ (13,706)	$ (13,780)	67%
Generation Connections	$ (198)	$ (163)	$ (163)	$ (168)	$ (176)	55%
TOTAL OEB- APPROVED CAPITAL CONTRIBUTIONS	**$ (38,872)**	**$ (23,153)**	**$ (19,713)**	**$ (18,836)**	**$ (18,784)**	**59%**
	Historical Years			Bridge Years		
Plant Relocation	$ (5,309)	$ (3,923)	$ (5,213)	$ (4,299)	$ (3,851)	51%
System Expansion	$ (5,724)	$ (7,700)	$ (3,836)	$ (13,017)	$ (16,900)	53%
Customer Connections	$ (14,918)	$ (15,648)	$ (19,364)	$ (18,658)	$ (19,679)	56%
Generation Connections	$ (72)	$ (69)	$ 7	$ (102)	$ (104)	65%
TOTAL HISTORICAL/BRIDGE CAPITAL CONTRIBUTIONS	**$ (26,022)**	**$ (27,340)**	**$ (28,406)**	**$ (36,076)**	**$ (40,533)**	**54%**

Hydro Ottawa primarily reviews and evaluates System Access Capital Programs in terms of net spending as the cost burden of these projects are offset by customer contributions. Table 10 shows net historical spending by Capital Program. Table 10 is divided into three sections with the OEB Approved amounts first, followed by the historical actuals, and then the annual variances.

1 **Table 10 - Net System Access Historical Spending versus OEB Approved (Annual) ($'000s)**

Capital Program	2021	2022	2023	2024	2025
	OEB-Approved (Net of Contribution)				
Plant Relocation	$ 2,216	$ 4,178	$ 4,200	$ 2,180	$ 2,171
System Expansion	$ 7,040	$ 4,821	$ 5,220	$ 5,076	$ 4,717
Customer Connections	$ 7,455	$ 7,799	$ 7,209	$ 7,275	$ 7,265
Generation Connections	$ 162	$ 133	$ 134	$ 138	$ 144
Metering	$ 947	$ 947	$ 958	$ 957	$ 959
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 17,820**	**$ 17,879**	**$ 17,720**	**$ 15,626**	**$ 15,255**
	Historical Years			Bridge Years	
Plant Relocation	$ 4,692	$ 3,681	$ 2,946	$ 5,906	$ 4,765
System Expansion	$ 2,451	$ 2,228	$ 7,446	$ 13,049	$ 16,330
Customer Connections	$ 13,741	$ 13,463	$ 14,426	$ 13,357	$ 13,808
Generation Connections	$ 175	$ (1)	$ 4	$ 3	$ 4
Metering	$ 579	$ 352	$ 165	$ 310	$ 314
TOTAL NET HISTORICAL/BRIDGE CAPITAL EXPENDITURES	**$ 21,638**	**$ 19,723**	**$ 24,987**	**$ 32,625**	**$ 35,220**
	Variance ($)				
Plant Relocation	$ 2,476	$ (497)	$ (1,253)	$ 3,725	$ 2,594
System Expansion	$ (4,590)	$ (2,593)	$ 2,226	$ 7,972	$ 11,613
Customer Connections	$ 6,286	$ 5,663	$ 7,217	$ 6,082	$ 6,543
Generation Connections	$ 13	$ (134)	$ (129)	$ (134)	$ (140)
Metering	$ (368)	$ (595)	$ (793)	$ (647)	$ (645)
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ 3,817**	**$ 1,844**	**$ 7,267**	**$ 16,999**	**$ 19,965**

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5.1.2. Historical Variances

Hydro Ottawa's System Access net capital expenditures for the 2021-2025 period are projected to exceed the OEB-approved 5-year budget by $49.9M (or 59%). On a gross basis the variance is $88.9M (or 44%), and the capital contribution variance is $39.0M (or 33%). These substantial increases are attributed to a confluence of factors that impacted the program's inherent volatility, despite budget planning based on historical trends, planned municipal infrastructure work, and known third-party projects.

The System Access Investments, encompassing Plant Relocation, System Expansion, Customer Connections, Generation Connections, and Metering, experienced varying degrees of growth. While some programs remained relatively stable, others, particularly Customer Connections and System Expansion, saw considerable increases.

Key Contributing Factors:

- **Increased Customer Connections:** A primary factor was the unexpected surge in customer connection requests. The complexity and location of these connections significantly influenced gross expenditure, customer contributions, and ultimately, net expenditure.
- **Inflationary Pressures:** Substantial increases in material and labor costs, driven by inflation, played a crucial role. Specifically, significant price hikes were observed in:
    - Cable (23.7% to 47.3% higher in 2024 than 2020)
    - Transformers (124.0% to 182.4% higher in 2024 than 2020)
    - Switchgear (24.7% to 59.5% higher in 2024 than 2020)
    - Wood poles (53.5% to 120.2% higher in 2024 than 2020)
    - Meters (93.8% higher in 2024 than 2020)
- **Unforeseen System Expansion Requests:** Several large-scale system expansion projects, not anticipated during the 2021-2025 rate application, contributed to the variance.

Detailed explanations of these factors are provided within the specific sections dedicated to each System Access program below, with further information regarding inflationary pressures found in Section 4 of Schedule 1-2-5 - Impact of Inflationary Pressures.

Plant Relocation and Upgrade

Over the 2021-2025 period, the Plant Relocation and Upgrade program experienced significant expenditure variability, primarily due to the timing and scope of major municipal infrastructure initiatives. This resulted in a net overspend of $7M (47%), a gross overspend of $6.7M (18%), and a negligible capital contribution variance based on the OEB-approved budget. This deviation reflects the program's inherent responsiveness to the dynamic nature of Ottawa's municipal infrastructure projects.

Specifically, the LRT Phase II project was budgeted without Plant Relocations in 2021-2025, however due to municipal delays, Plant Relocation projects have persisted during the 2021-2025 period, resulting in a $2.5M increase. The increases related to LRT driven plant relocations were partially offset by underspends in 2022 and 2023 due to MTO driven projects that did not proceed.

A substantial increase in spending occurred in 2024, with expenditures exceeding the budget by $3.7M. This surge was primarily due to the commencement of the City of Ottawa's Bank Street revitalization project, coupled with continued work on the LRT Phase II project and post-LRT Phase I remediation. Similarly, in 2025, continued spending on the Bank Street Revitalization project is expected to result in a $2.6M increase (119%) over the OEB approved budget.

Key factors of these variances include LRT related variances due to post-LRT Phase I rehabilitation work and changes to the LRT Phase II project's timeline and scope, the completion of Montreal Road's revitalization, and the City of Ottawa's Bank Street revitalization project. In summary, the Plant Relocation and Upgrade program's expenditures were significantly influenced by the dynamic nature of Ottawa's municipal infrastructure projects, resulting in a notable deviation from the OEB-approved budget.

System Expansion

The System Expansion program experienced considerable budget variability during the 2021-2025 period, culminating in a net overspend of $14.6M (54%), a gross overspend of $39.9M (82%), and a capital contribution variance of $25.2M (115%) based on the OEB-approved budget. This substantial variance underscores the program's susceptibility to external factors and unforeseen projects. The program's expenditures are inherently non-discretionary and dynamic, driven by variable customer requests, complexity, and the scale and location of required electrical loads. While Hydro Ottawa actively collaborates with stakeholders to align forecasts (refer to Schedule 2-5-2 - Coordinated Planning with Third Parties), the timing and scope of critical projects are ultimately determined by external entities, which can lead to significant budget fluctuations.

The program's financial trajectory highlights the high degree of variability. Initially, in 2021 and 2022, the program saw considerable underspends, $4.6M and $2.6M respectively. However, this trend significantly reversed in 2023, with expenditures exceeding the budget by $2.2M. This upward trajectory is expected to continue with forecasted overspends of $8M in 2024 and $11.6M in 2025. These drastic shifts were primarily driven by three major, externally influenced projects: the LRT Phase II project, the City of Ottawa's Zero Emission Bus project, and the Department of National Defence (DND) Dwyer Hill Road project.

Note that while the 2021-2025 budget included a budget for one large system expansion, it did not anticipate three. The Zero Emission Bus and DND Dwyer Hill Road projects were entirely unanticipated and could not be included in the 2021-2025 rate application process. Consequently, Hydro Ottawa was compelled to absorb significant, unbudgeted expenditures to accommodate these externally mandated system expansions along with the significant inflationary pressures.

External Project Impacts on System Expansion:

- **LRT Phase II Project:** Hydro Ottawa's responsibilities within the LRT Phase II Project included the relocation and protection of conflicting infrastructure, the expansion of the electrical system to accommodate future LRT stations, and the provision of commercial connections. Modifications to the LRT Phase II project resulted in an estimated $5.8M expenditure exceeding the approved budget. Originally scheduled for completion in 2022, the project experienced significant delays. These delays and associated cost increases were attributable to:
    - Unforeseen conflicts between the LRT Phase II construction activities and Hydro Ottawa's existing infrastructure.
    - Repeated infrastructure relocations mandated by design revisions.
    - Significant postponements in the overall LRT project schedule, specifically:
        - The Trillium Line, delayed by two years.
        - The Confederation Line East, delayed to 2025.
        - The Confederation Line West, delayed by 17 months.
    - The inaccuracy of cost estimates that were developed prior to the onset of the COVID-19 pandemic and subsequent inflationary pressures.

While the LRT Phase II Project was identified during the 2021-2025 rate application process, the specific factors contributing to the budget overruns, including the magnitude of infrastructure conflicts, the frequency of design alterations, and the unprecedented impact of the pandemic, were either inherently unpredictable or their financial implications were not accurately quantifiable at that time.

- **City of Ottawa Zero Emission Bus Project:** The Hydro Ottawa scope of work encompasses the provision of the required electrical infrastructure to support the load of an Electric Bus terminal. In February 2021, Hydro Ottawa received a preliminary inquiry regarding a new electrical load to support the proposed OC Transpo electric bus terminal. Subsequently, in April 2024, Hydro Ottawa received a signed Offer to Connect (OTC) and commenced work on the Zero Emissions Bus Project at 1500 St. Laurent. The project's initiation in 2024 resulted in significant deviations from the OEB-approved budget for the 2024 and 2025 fiscal years. This project was not incorporated into the 2021-2025 rate application due to the definition of the load requirements and the executed Offer to Connect (OTC) not being received within the timeframe required for inclusion in the 2021-2025 rate application process.

- **DND Dwyer Hill Road Project:** In September 2020, the Department of National Defence (DND) submitted a request to Hydro Ottawa for an electrical service upgrade at the Dwyer Hill North training campus and a new electrical service to supply the South training campus. Hydro Ottawa's scope of work entails a transformer upgrade at the existing station to support committed large load requests from the DND Dwyer Hill Training Center Upgrade, ensuring both the customer needs are met and system redundancy is maintained. Hydro Ottawa commenced work on the DND Dwyer Hill Road Project in 2024, resulting in $4.9M in unbudgeted System Expansion Expenditure over the 2024 and 2025 fiscal years. This project was not incorporated into the 2021-2025 rate application due to the definition of the load requirements and the executed Offer to Connect (OTC) not being received within the timeframe required for inclusion in the 2021-2025 rate application process.

The System Expansion program's performance highlights the challenges of development and managing budgets in the face of significant external influences. The unpredictable nature of large-scale infrastructure projects and the authority of external parties to dictate project timelines and scope directly translated into substantial budget volatility.

Customer Connections

Over the 2021-2025 period, the Customer Connections program experienced a net overspend of $31.8M (86%), a gross overspend of $46.5M (42%) and a capital contribution variance of $14.7M (20%) based on the OEB-approved budget. The Customer Connections program encompasses the following subprograms: Residential Subdivisions Program, New Commercial Developments Program, and Infill Services Program.

The significant variance was primarily driven by several key factors:

- **City of Ottawa's Intensification Policies & Provincial Housing Mandates:** The City's focus on higher-density housing, coupled with the Province of Ontario's More Homes Built Faster Act[2] significantly increased residential subdivision connections beyond forecasted levels .
- **COVID-19 Pandemic:** The pandemic's impact on housing demand, coupled with historically low interest rates, contributed to a surge in residential connections.
- **LRT Phase II Project Delays:** Delays in the LRT project affected commercial development connections, impacting project timelines and expenditures.
- **Inflationary Pressures:** Increased material and labor costs contributed to higher unit costs for connections across all subprograms.
- **External Project Dependencies:** The program's reliance on external factors, such as municipal planning and project timelines, resulted in forecasting inaccuracies.

The significant expenditure variance within the Customer Connections program underscores the challenges of forecasting and managing expenditures in a dynamic environment influenced by external factors. Hydro Ottawa recognizes the need for enhanced forecasting methodologies and flexible resource allocation to mitigate the impact of unforeseen changes in customer demand and project timelines. The Residential Subdivisions and New Commercial Developments programs were the primary drivers of the overall variance, highlighting the impact of external factors such as municipal policies, economic conditions, and large-scale infrastructure projects. Details regarding the impact of each subprogram are provided below.

[2] Legislative Assembly of Ontario, "Bill 23, More Homes Built Faster Act, 2022," https://www.ola.org/en/legislative-business/bills/parliament-43/session-1/bill-23

Residential Subdivisions:

The Residential Subdivisions program was a primary driver of the overall variance. Actual expenditures are expected to exceed the OEB-approved budget by $24.0M (161%). This significant overspend was primarily due to:

- Connection volume significantly surpassed forecasted levels, increasing from an annual average of 3,835 to 6,067.
- This substantial increase in connection volumes significantly exceeded the budget assumptions, driven by an unforeseen surge in demand resulting from the More Homes Built Faster Act, 2022 and the pandemic-induced housing boom.
- Unit costs per connection increased from $852 to $1,350 due to inflationary pressures and higher-density development complexities.

New Commercial Developments:

The New Commercial Developments program also contributed significantly to the overall variance. Actual expenditures are expected to exceed the OEB-approved budget by $16.9M (176%). This overspend was primarily driven by:

- Delays in the LRT Phase II project, affecting the timing and expenditures of related commercial connections.
- Increased building density and demand, exceeding forecasted levels based on historical averages.
- Inflationary pressures, contributing to higher unit costs for commercial connections.

Infill Services:

The Infill Services program was the sole subprogram within the Customer Connections capital program that did not contribute to the overall overspend during the 2021-2025 period. Actual expenditures are projected to be $9.2M (74%) below the OEB-approved budget. The budget for this program was developed based on historical spending averages available as of 2019.

However, the economic climate during the period significantly impacted customer lead project execution.

It is evident that a noticeable reduction in smaller-scale projects occurred. This could be attributed to the prevailing economic conditions. Starting in early 2022, the Bank of Canada initiated a series of interest rate hikes to combat rising inflation. These hikes substantially increased borrowing costs for both residential and commercial customers. Simultaneously, customers faced significant inflationary pressures, particularly in the cost of materials.

Infill services projects are typically undertaken by smaller developers or individual proprietors, who may lack substantial financial reserves. Consequently, the combined impact of increased borrowing costs and rising material prices led to the postponement or cancellation of numerous projects. This resulted in the observed underspend, as the anticipated volume of infill connection requests did not materialize. Current projections suggest that spending in 2024 and 2025 will remain consistent with recent years, reinforcing the trend of reduced project activity.

Generation Connections

Over the 2021-2025 period, the Generation Connections program experienced an underspend compared to the OEB-approved budget. Actual expenditures were lower than anticipated, resulting in a net underspend of $0.5M (74%), gross underspend of $1.1M (67%) and capital contribution variance of $0.5M (61%) below estimations. This deviation is primarily attributed to lower-than-expected customer-requested generation connections.

The Generation Connections program is inherently driven by customer demand, with expenditures fluctuating based on the volume and type of connection requests. The program's actual expenditures reflect a consistent trend of lower demand than projected during the 2021-2025 rate application. Specifically, in 2021, spending was slightly higher than the approved budget, with a variance of $0.01M (8% overspend). However, from 2022 to 2025, customer demand was significantly lower than the historical projection used to create the budget.

The underspend during the 2022-2025 period showcases a consistent trend of reduced customer demand for generation connections. This reduction can be attributed to the economic climate during this period. Starting in early 2022, the Bank of Canada initiated a series of interest rate hikes to combat rising inflation. These hikes significantly increased borrowing costs for both residential and commercial customers. Simultaneously, customers faced substantial inflationary pressures, leading to increased costs for materials associated with generation connection projects. This combination of higher borrowing costs and increased project expenses likely deterred many potential customers from pursuing generation connection projects, resulting in the observed underspend. Current projections suggest that spending in 2024 and 2025 will remain consistent with recent years, reinforcing this trend.

Metering

Over the 2021-2025 period, the Metering program experienced a significant underspend compared to the OEB-approved budget. Actual expenditures were substantially lower than anticipated, resulting in a total underspend of $3.0M, representing a 64% variance. This deviation is primarily attributed to lower-than-expected customer-requested installations for retrofitted suite metering.

The Metering program, focused on customer-requested suite metering retrofits, is directly tied to the volume and type of these requests. These significant underspends, totaling nearly $3M over the five-year period, indicate a consistent trend of reduced customer demand for suite metering retrofit installations than projected for the creation of the 2021-2025 budget. Annual spending on suite metering has remained consistent in recent years, but at a lower level than budgeted. Current projections indicate that spending in 2024 and 2025 will remain consistent with recent years, reinforcing the trend of lower-than-anticipated demand.

5.1.3. Forecast to Historical Variance by Capital Program

Forecasted investment for 2026 through 2030 is based on historical spending, known large projects (committed customer requests and large load requests) and changes in government policy (City of Ottawa Intensification Policy). Table 11 details the Forecasted Expenditure for

2026-2030 and Table 12 provides the forecasted contributions. Further details can be found in Schedule 2-5-6 - System Access Investments.

Table 11 – System Access Forecast Expenditures Test Year Expenditures by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
Plant Relocation	$ 44,584	$ 34,957	$ (9,627)	$ 8,917	$ 6,991	$ (1,925)
System Expansion	$ 88,680	$ 107,507	$ 18,827	$ 17,736	$ 21,501	$ 3,765
Customer Connections	$ 157,061	$ 221,069	$ 64,009	$ 31,412	$ 44,214	$ 12,802
Generation Connections	$ 525	$ 4,241	$ 3,717	$ 105	$ 848	$ 743
Metering	$ 1,720	$ 1,724	$ 4	$ 344	$ 345	$ 1
GROSS SYSTEM ACCESS	**$ 292,570**	**$ 369,500**	**$ 76,930**	**$ 58,514**	**$ 73,900**	**$ 15,386**
Capital Contribution[3]	$ (158,377)	$ (196,272)	$ (37,895)	$ (31,675)	$ (39,254)	$ (7,579)
NET SYSTEM ACCESS	**$ 134,193**	**$ 173,228**	**$ 39,035**	**$ 26,839**	**$ 34,646**	**$ 7,807**

The annual gross expenditure for System Access is expected to average $73.9M over the 2026-2030 period which is an increase from the $58.5M average annual spend during the 2021-2025 timeframe.

[3] Note that recent updates to Capital Contributions as a result of the OEB's recent policy changes in System Expansion for Housing Developments (EB-2024-0092) have not been incorporated here. For further information on anticipated impacts to Capital Contributions, please refer to Schedules 1-1-4 - Administration and 9-1-1 - Summary of Current Deferral and Variance Accounts.

Table 12 – System Access Test Years Contributions by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
Plant Relocation	$ (22,595)	$ (19,874)	$ 2,721	$ (4,519)	$ (3,975)	$ 544
System Expansion	$ (47,177)	$ (48,279)	$ (1,102)	$ (9,435)	$ (9,656)	$ (220)
Customer Connections	$ (88,267)	$ (123,944)	$ (35,678)	$ (17,653)	$ (24,789)	$ (7,136)
Generation Connections	$ (339)	$ (4,175)	$ (3,836)	$ (68)	$ (835)	$ (767)
TOTAL CAPITAL CONTRIBUTIONS	**$ (158,377)**	**$ (196,272)**	**$ (37,895)**	**$ (31,675)**	**$ (39,254)**	**$ (7,579)**

The average annual capital contributions for System Access is expected to be $39.2M over the 2026-2030 period which is an increase from the $31.7M average annual contributions during the 2021-2025 timeframe, primarily driven by customer connection requests over the 2026-2030 period.

Plant Relocation

The capital investment for this program is detailed in Section 2 of Schedule 2-5-6 - System Access Investments. The Plant Relocation Program is transitioning from a period of high expenditure, characterized by large complex projects, to a historical norm aligned with municipal planned road network expansion initiatives.

During the 2021-2025 period, the program experienced substantial capital expenditures. The average annual net capital expenditure reached $4.4M, while the average annual gross capital expenditure was $8.9M. Additionally, annual capital contributions averaged $4.5M. These elevated figures were primarily driven by the implementation of large-scale municipal infrastructure projects, most notably the Light Rail Transit (LRT) Phase II project. The complexities and dynamic timelines of these projects resulted in significant variances from the originally approved budget.

The 2026-2030 period has a reduction in capital expenditure as the program returns back to a Pre-LRT Phase I & II baseline. The projected average annual net capital expenditure is $3.0M, and the average annual gross capital expenditure is $7.0M. Furthermore, annual capital contributions are expected to average $4.0M. The future investments are budgeted based on the planned road widening projects outlined in the City of Ottawa's Transportation Master Plan[4], specifically along Bank Street, Prince of Wales Drive, and Preston Street.

System Expansion

The capital investment for this program is detailed in Section 4 of Schedule 2-5-6 - System Access Investments. The System Expansion Program is experiencing significant growth, with projected investments for 2026-2030 substantially exceeding historical levels from 2021-2025. This material change is caused by large infrastructure projects and also by electricity demand growth, residential expansion, transportation electrification, and increased adoption of electrified heating.

During the 2021-2025 period, the average annual net capital expenditure reached $8.3M, while the average annual gross capital expenditure was $17.7M. Additionally, annual capital contributions averaged $9.4M. As described in Section 5.1.2 - Historical Variances, Hydro Ottawa was compelled to absorb significant, unbudgeted expenditures to accommodate externally mandated system expansions.

The 2026-2030 forecast anticipates a rise in the average annual net capital expenditure to $11.8M, while the average annual gross capital expenditure is expected to be $21.5M. Additionally, the expected annual capital contributions will average $9.7M. Key drivers include the City of Ottawa’s Zero Emission Bus initiative, the DND Dwyer Hill Training Center Upgrade, and the new Ottawa Hospital, alongside a dramatic surge in large load connection requests (5 MVA and above). The surge in large load connection requests necessitates a shift from a budget based on historical averages to a growth-adjusted budget and underscores a

[4] City of Ottawa, “Transportation Master Plan, Exhibit 7.2: 2031 Affordable Road Network- Project By Phase- https://documents.ottawa.ca/sites/default/files/documents/tmp_en.pdf

commitment to supporting Ottawa's expansion and electrification goals, ensuring reliable and resilient electricity services for the future.

Customer Connections

The capital investment for this program is detailed in Section 3 of Schedule 2-5-6 - System Access Investments. The Customer Connections program capital expenditure is experiencing significant growth in the 2026-2030 period, with projected investments substantially exceeding historical levels from 2021-2025. This increase is driven by robust residential and commercial development, coupled with the ongoing energy transition and city intensification initiatives.

During the 2021-2025 period, the program experienced significant budget variances primarily due to unforeseen residential growth, commercial project delays, and inflationary pressures, as detailed in Section 5.1.2 - Historical Variances. The average annual net capital expenditure reached $13.8M while the average annual gross capital expenditure was $31.4M. Additionally, annual capital contributions averaged $17.6M. The 2021-2025 budget was established using historical averages for residential subdivisions and infill services, and a historical average plus a growth factor for new commercial development.

The 2026-2030 forecast, is projecting the net average annual spending to rise to $19.4M. The expected gross average annual spending to rise to $44.2M, offset by anticipated average annual capital contributions to $24.8M. This growth is attributed to sustained residential subdivision expansion, increased commercial development driven by transit-oriented projects and large load requests, and continued support for infill projects. Key drivers include the City of Ottawa's intensification policies, the energy transition, and large-scale laboratory developments. The 2026-2030 budget was established using a baseline plus a housing growth factor for residential subdivisions and infill services, and a baseline plus an employment growth factor for new commercial development.

Anticipated increases in customer service requests necessitate the infrastructure investments. The substantial overspend observed in the 2021-2025 period has informed a more robust and growth-aligned budget for the upcoming period. This forward-looking approach, incorporating growth factors into the budget calculations, ensures Hydro Ottawa can effectively support the city's development goals and evolving electricity demands, providing reliable connections for a growing customer base.

Generation Connections

The capital investment for this program is detailed in Section 5 of Schedule 2-5-6 - System Access Investments. The Generation Connections program is set to experience a significant increase in investment during the 2026-2030 period, transitioning to a phase of projected growth driven by the rising adoption of distributed energy resources (DERs).

During the 2021-2025 period, the average annual net capital expenditure was $0.04M while the average annual gross capital expenditure was $0.1M. Additionally, annual capital contributions averaged $0.07M. For this period there was a significant underspend, primarily attributed to reduced customer demand due to economic factors, including interest rate hikes and inflationary pressures. The budget for this period was based on historical averages, which did not accurately reflect the market conditions that were experienced.

The proposed budget for the 2026-2030 period reflects a significant increase, with a net average annual investment of $0.01M. Primarily, this growth is observed in gross expenditures, with the projected gross average annual expenditure reaching $0.85M, offset by anticipated average annual capital contributions of $0.84M. This budgetary expansion is predicated on the forecasted accelerated adoption of Distributed Energy Resources (DERs), with a key driver being the connection of large-scale generators (exceeding 500 kW), with an assumption of at least one such connection per year. The IESO's DER Market Vision and Design Project[5] is expected to explore, design and implement foundational participation models for DERs in

[5] DER Market Vision and Design Project, https://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Distributed-Energy-Resources-Market-Vision-and-Design-Project

Ontario's electricity market and other IESO programs, such as the Save On Energy Home Renovation Savings Program[6] and the Save On Energy Retrofit Program[7] now include incentives for DERs. All of these initiatives are expected to contribute to DER growth. The projected trend of accelerated DER adoption is further detailed in Section 9.3.1 of Schedule 2-5-4 - Asset Management Process. The budget methodology incorporates a year-over-year increase of 25%, accounting for the anticipated growth and the assumption of one major transfer trip and reverse power flow project per annum.

The projected growth, particularly in gross expenditures, reflects the evolving energy landscape and the increasing interest in DER integration, with an emphasis on large generation connections . The planned investments ensure Hydro Ottawa can effectively support the growing demand for generation connections, aligning with the broader energy transition.

Metering

The capital investment for this program is detailed in Section 6 of Schedule 2-5-6 - System Access Investments. The Metering program, focused on customer-driven suite metering installations, is characterized by consistent and stable expenditures. Hydro Ottawa does not anticipate any significant changes to recent volumes with regards to customer-requested installations of new and retrofitted suite metering.

As detailed in Section 5.1.2 - Historical Variances, this program had a significant underspend of $3.0M during the 2021-2025 period, primarily due to a shift in customer preferences towards third-party bulk metering services. Consequently, the 2026-2030 forecast anticipates maintaining the current average expenditure level of $0.3M annually, reflecting the sustained lower demand for suite metering installations. This program does not generate capital contributions.

[6] Save On Energy, "Home Renovation Savings Program, "https://www.saveonenergy.ca/For-Your-Home/Home-Renovation-Savings
[7] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

5.2. SYSTEM RENEWAL EXPENDITURES

System Renewal investments include sustainment programs that are focused on managing and mitigating the risk of asset failure within Hydro Ottawa's distribution network by renewing deteriorating asset infrastructure. The System Renewal Investment Category is broken down into five Capital Programs as described in Table 13.

Table 13 – System Renewal Capital Programs

Capital Program	Description
Stations and Buildings Infrastructure Renewal	• Sustainment of discrete stations and station building assets based on condition (Health Index) and prioritization.
Overhead Distribution Assets Renewal	• Sustainment of discrete overhead distribution assets based on assessed condition (Health Index) and prioritization
Underground Distribution Assets Renewal	• Sustainment of discrete underground distribution assets based on assessed condition (Health Index) and prioritization
Corrective Renewal	• Unplanned replacement of failed assets.
Metering Renewal	• Proactive replacement of end-of-life meters to ensure long-term asset performance.

System Renewal capital expenditures are determined through the Asset Investment Strategy presented in Section 5.3.2.2 of Schedule 2-5-4 - Asset Management Process. The Capital Programs under System Renewal are broken down by Budget Program, as shown in Table 14, which includes a description for each Budget Program along with the primary driver. The program drivers are detailed in Section 5.3.1.1 of Schedule 2-5-4 - Asset Management Process.

Table 14 – System Renewal Expenditure Categories

Capital Program	Budget Program	Primary Driver	Description
Stations and Buildings Infrastructure Renewal	Station Transformer Renewal	Failure Risk	• Station transformer refurbishment (life extension), or replacement as guided by the Asset Management Process.
	Station Switchgear Renewal	Failure Risk	• Stations switchgear and relay refurbishment (life extension), or replacement as guided by the Asset Management Process.
	Station Major Rebuild	Failure Risk	• Station major rebuilds driven by multiple end-of-life assets.
	Station P&C Renewal	Failure Risk	• Station protection and control devices refurbishment (life extension) or replacement guided by the Asset Management Process.
	Station Battery Renewal	Failure Risk	• Station battery and charger refurbishment (life extension) or replacement guided by the Asset Management Process
	Station & Building Minor Asset Renewal	Failure Risk	• Station minor assets (such as insulators, arrestors, structures, etc.) refurbishment (life extension) or replacement • Refurbishment or replacement of existing station building or property assets
	EOL Voltage Conversion	Failure Risk	• Addresses need of major Station Assets replacement through voltage conversion due to inability to support future growth, mainly in 4kV regions
OH Distribution Assets Renewal	Pole Renewal	Failure Risk	• Planned replacement or upgrade of Hydro Ottawa owned poles or cross-arms based on condition assessment; • Pole attachments and conductors are considered in scope for replacement along with the poles/cross-arms where they are of the same vintage as the poles
	OH Switch / Recloser Renewal	Failure Risk	• Installation of new or the rehabilitation of overhead equipment (i.e. switches, reclosers, cutouts, or arrestors) based on condition or functional requirements (i.e. upgrade to gang operable switches or automated devices)
UG	Vault Renewal	Failure Risk	• Vault rehabilitation due to condition of equipment or

Capital Program	Budget Program	Primary Driver	Description
Distribution Assets Renewal			removal for consolidation or system betterment; ● Includes replacement of Jack-Bus arrangements; ● Exclusive of work considered under Plant Relocation & Upgrade
	Civil Renewal	Failure Risk	● Rehabilitation or rebuild of underground cable chambers, collars, ducts, and equipment pads due to condition or failure risk; ● Includes installation of pads and vault space under pads; ● Duct extensions considered under Line Extensions
	Cable Replacement	Failure Risk	● Replacement of underground cable based on condition; ● All cable types considered, i.e. PILC, XLPE, butyl rubber, etc.; ● Can include associated distribution transformer replacements based on condition assessment on a case-by-case basis
	UG Switchgear Renewal	Failure Risk	● Replacement, refurbishment or upgrade of Hydro Ottawa owned switchgear based on condition
	UG Transformer Renewal	Failure Risk	● Replacement of underground distribution transformers due to functional, safety or environmental concern (leaks, PCBs, corrosion, failure risk, etc.), or upgrade, including transformer shop testing and commissioning
Corrective Renewal	Damage to Plant	Failure	● Replacement of damaged assets, resulting in the loss of functional use of the asset caused by a third party
	Emergency Renewal	Failure	● Failed equipment typically resulting in an outage but not necessarily.
	Critical Renewal	Failure	● Failed equipment that may still be providing service, but no longer meet their designed requirements for safety, environmental or reliability reasons.
Metering Renewal	Metering Upgrades	Functional Obsolescence	● Proactive replacement of obsolete meters with advanced technology, upgrading data management systems, and ensuring regulatory compliance to enhance grid management and long-term asset performance.

5.2.1. Historical Expenditures

The following tables present Hydro Ottawa's System Renewal Capital Expenditures from 2021 through 2025 compared to the OEB Approved amounts. Table 15 details this spending on a five-year total basis, while Table 16 provides the annual spending and variances.

Hydro Ottawa uses its Capital Expenditure Process (Section 3.5 of Schedule 2-5-4 - Asset Management Process) and portfolio optimization (Section 5.3 of Schedule 2-5-4 - Asset Management Process) to ensure strategic oversight and efficient capital utilization of the System Renewal capital program.

Table 15 - System Renewal Historical Spending versus OEB Approved ($'000s)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
Stations Asset Renewal	$ 47,206	$ 31,433	$ (15,773)	(33)%
OH Distribution Assets Renewal	$ 43,278	$ 43,141	$ (137)	-
UG Distribution Assets Renewal	$ 55,184	$ 63,286	$ 8,102	15%
Corrective Renewal	$ 51,220	$ 82,625	$ 31,405	61%
Metering Renewal	$ 13,091	$ 11,835	$ (1,255)	(10)%
TOTAL NET CAPITAL EXPENDITURES	**$ 209,978**	**$ 232,321**	**$ 22,343**	**11%**

As noted above, Table 16 below provides the annual variance against the OEB Approved for each of the capital programs under System Renewal, the table is divided into three sections with the OEB Approved amounts first, followed by the historical actuals, and then the annual variances.

1 **Table 16 - Net System Renewal Historical Spending versus OEB Approved (Annual) ($'000s)**

Capital Program	2021	2022	2023	2024	2025
OEB-Approved (Net of Contribution)					
Stations Asset Renewal	$ 9,938	$ 12,071	$ 8,444	$ 7,437	$ 9,316
OH Distribution Assets Renewal	$ 7,999	$ 9,197	$ 9,197	$ 8,841	$ 8,044
UG Distribution Assets Renewal	$ 11,082	$ 10,780	$ 11,164	$ 11,079	$ 11,077
Corrective Renewal	$ 11,947	$ 9,805	$ 9,838	$ 9,812	$ 9,817
Metering Renewal	$ 4,455	$ 2,561	$ 1,950	$ 2,266	$ 1,860
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 45,421**	**$ 44,414**	**$ 40,594**	**$ 39,436**	**$ 40,114**
	Historical Years			Bridge Years	
Stations Asset Renewal	$ 9,071	$ 12,045	$ 5,404	$ 4,238	$ 676
OH Distribution Assets Renewal	$ 9,284	$ 8,758	$ 8,832	$ 7,419	$ 8,848
UG Distribution Assets Renewal	$ 10,159	$ 17,806	$ 11,981	$ 11,175	$ 12,165
Corrective Renewal	$ 13,253	$ 26,537	$ 12,702	$ 14,943	$ 15,190
Metering Renewal	$ 1,482	$ 323	$ 1,348	$ 4,559	$ 4,123
TOTAL HISTORICAL/BRIDGE NET CAPITAL EXPENDITURES	**$ 43,249**	**$ 65,469**	**$ 40,266**	**$ 42,334**	**$ 41,003**
	Variance ($)				
Stations Asset Renewal	$ (867)	$ (27)	$ (3,040)	$ (3,199)	$ (8,640)
OH Distribution Assets Renewal	$ 1,285	$ (439)	$ (365)	$ (1,422)	$ 804
UG Distribution Assets Renewal	$ (923)	$ 7,025	$ 817	$ 95	$ 1,088
Corrective Renewal	$ 1,306	$ 16,732	$ 2,864	$ 5,130	$ 5,373
Metering Renewal	$ (2,973)	$ (2,237)	$ (602)	$ 2,293	$ 2,264
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ (2,172)**	**$ 21,054**	**$ (327)**	**$ 2,899**	**$ 889**

2

5.2.2. Historical Variances

Hydro Ottawa forecasts that, over the 2021-2025 historical period, total System Renewal capital expenditures will exceed the approved 5 year forecast by approximately $22M, or 11%. This overall variance is significantly influenced by a $33M overspend in Emergency Renewal, primarily attributable to the unprecedented 2022 Derecho storm and increasing emergency asset replacements, which necessitated extensive infrastructure repairs and immediate resource reallocation.

To mitigate the financial impact of the emergency renewal work that was experienced over the 2021-2025 period, Hydro Ottawa reprioritized and deferred certain projects as detailed in Section 4.1 - Historical Variance Overview, while adhering to the portfolio optimization process outlined in Section 5.3 and Section 5.3.2.4 of Schedule 2-5-4 - Asset Management Process.

Key contributing factors:

- **Devastating 2022 Derecho Storm**: An unprecedented weather event requiring extensive, unbudgeted emergency repairs. Further details about the Derecho storm can be found in Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report.
- **Recurring Severe Weather Events**: Multiple additional major storms necessitating emergency responses and resource reallocation, further impacting planned project timelines and budgets. Refer to Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement for the list of events
- **Increased Equipment Failure Rates**: A general rise in reactive equipment replacements, due to residual effects from the extreme weather events, driving up emergency renewal costs.
- **Inflationary Pressures:** Significant increases in material and labor costs due to inflation (Section 4 of Schedule 1-2-5 - Impact of Inflationary Pressures).

System Renewal and System Service have a combined cumulative asymmetrical capital variance account but given the total overages in this investment category no amounts were recorded in this account. Refer to Schedule 9-1-3 - Group 2 Accounts for further details.

Detailed explanations of program variances that contributed to the overall System Renewal variances are provided below.

Station Assets Renewal

During the 2021-2025 period, Hydro Ottawa decided to defer projects within the Station Assets Renewal program as well as other capital programs in response to emergency spending required for the storm activity as well as the significant inflationary pressures during this period. These decisions resulted in an underspend of $15.8M, or 33% below the OEB-approved budget.

Initially, in 2021 and 2022, the program adhered closely to budget, with a minor $0.9M underspend in 2021. However, beginning in 2023, Hydro Ottawa decided to adjust projects to manage the overall envelope of System Renewal expenditures. Specifically, the conversion of the Fisher Station Rebuild to a Voltage Conversion project, coupled with the deferral of the Dagmar Voltage Conversion project to 2026, and the subsequent deferrals of the Rideau Heights and Shillington Station Rebuild projects, resulted in a cascading effect of underspending. Consequently, underspends of $3M were realized in 2023, $3.2M in 2024, and $8.7M in 2025, reflecting the impact of these multi-year project deferrals. Station Assets Renewal Program deferrals are detailed in Section 4.1.3 - 2021-2025 Major Deferrals.

The impact of these deferrals is evident in Table 17 below which highlights the 2021-2025 Budget vs. Actual Station Renewal Unit Comparison per Station Asset Class. Specifically, deferrals resulted in variances in the completion of station transformer renewals (budgeted 10, completed 5), and station switchgear renewals (budgeted 68, completed 55). Conversely, Hydro

Ottawa exceeded its planned number of station relay renewals, completing 39 compared to a budget of 28. This increase was a result of unplanned relay replacements associated with emergency work related to catastrophic switchgear failures at Overbrook and Lincoln Heights.

Table 17 - 2021-2025 Budget vs. Actual Station Renewal Unit Comparison per Station Asset Class

Station Asset Class	2021-2025 Budget	2021-2025 Actuals	Variance
Station Transformers	10	5	(5)
Station Switchgear	68	55	(13)
Station Batteries	10	9	(1)
Station Relays	28	39	11
Station RTUs	2	2	-

OH Distribution Assets Renewal Program

Over the 2021-2025 period, the OH Distribution Assets Renewal program only had a minor total overspend of $0.1M from the OEB-approved budget. However, given the significant cost increases, this was only achieved through reduction of assets renewed as reflected in Table 18 below which highlights the 2021-2025 Budget vs. Actual OH Asset Renewal Unit Comparison. Pole renewals were reduced to 1732 units (budgeted 2000), and OH Switch/Recloser renewals were 56 units (budgeted 1150), see commentary below on the change for this program. OH Transformers are replaced as required through the Pole Renewal program and therefore the specific number of units are not explicitly budgeted.

Table 18 - 2021-2025 Budget vs. Actual OH Asset Renewal Unit Comparison

OH Asset Class	2021-2025 Budget	2021-2025 Actuals	Variance
Poles	2,000	1,732	(268)
OH Transformers	N/A	309	N/A
OH Switches / Reclosers	1,150	56	(1,094)

In 2021, the program exceeded its budget by $1.3M, primarily due to a 13% increase in the installed cost per pole. This was driven by significant inflationary increases on materials and the complexity of certain pole renewal projects. However, as noted in Section 3.1 of Schedule 1-3-4 - Facilitating Innovation and Continuous Improvement, Hydro Ottawa implemented significant steps to enhance labor efficiency through process standardization, dedicated construction roles, optimized construction season schedules, and a refined project delivery model. Had these initiatives not been undertaken, the cost per pole would have increased by 22% instead of the actual 13% increase. The underspend in 2022, 2023 and 2024, offset by the overspend in 2025 in this program is achieved through these significant productivity efforts accompanied by adjustments to planned pole renewal projects, effectively managing costs and mitigating asset failure risks. OH Distribution Assets Renewal Program deferrals are detailed in Section 4.1.3 - 2021-2025 Major Deferrals.

The original proposed scope for the 2021-2025 OH switch/recloser program considered the replacement of all porcelain insulated cut-outs, overhead switches, in-line switches and re-fusing of adjacent taps. However, Hydro Ottawa does not consider the cut-outs as a major commodity class within the overhead switch inventory and therefore does not track the number of units that are replaced. This tracking discrepancy is causing the large variance in the planned versus actual units for 2021-2025.

UG Distribution Assets Renewal Program

Over the 2021-2025 period, the UG Distribution Assets Renewal program experienced an overspend of $8.1M, or 15% above the OEB-approved budget. This variance reflects the program's response to fluctuating market conditions and project complexities.

Controlled implementation within the UG Asset Renewal program during the 2021-2025 period led to the variances outlined in the Budget vs. Actual Unit Comparison (Table 19). Specifically, UG Switchgear renewals were completed at 15 units (budgeted 20), UG cable renewals at 74km (budgeted 130km), and vault transformer renewals at 18 units (budgeted 125). UG

Transformers were planned to be replaced as required through the Cable Renewal program and therefore the specific number of units were not explicitly forecasted. Additionally, in the historic period, the activities within the Cable Chambers program included a variety of renewal activities that were selected annually based on asset condition data from inspections and was funded at approximately $1.01M annually. As such the type and volume of units was not forecasted for the 2021-2025 period. These variances represent adjustments made to manage expenditures via deferrals and cost avoidance as described in Section 4.1 - Historical Variance Overview while maintaining essential system functionality.

Table 19 - 2021-2025 Budget vs. Actual UG Asset Renewal Unit Comparison

UG Asset Class	2021-2025 Budget	2021-2025 Actuals	Variance
UG Transformers	N/A	360	N/A
UG Switchgear	20	15	(5)
UG Cables (km)	130	74	(56)
Cable Chambers	N/A	23	N/A
Vault Transformers	125	18	(107)
Vault Switchgear	N/A	-	N/A

In 2021, the program underspent by $0.9M (8% below budget), however, 2022 saw a significant overspend of $7M. This substantial increase was attributed to the resumption of cable replacement projects post-COVID-19, which faced significant increases in material costs and higher civil contractor prices. Notably, the actual cost per kilometer of cable reached $0.7M/km, compared to the budgeted $0.3M/km.

The program returned to a moderate overspend in 2023, exceeding the budget by $0.8M. This was achieved through Hydro Ottawa's implementation of strategic cost-control measures and proactive adjustments to project execution, demonstrating a commitment to mitigating further budgetary deviations. UG Distribution Assets Renewal Program deferrals are detailed in Section 4.1.3 - 2021-2025 Major Deferrals.

Despite fluctuations, the overall program performance demonstrates Hydro Ottawa's commitment to balancing essential asset renewal with prudent cost management. The significant overspend in 2022 highlights the challenges faced by the utility sector in navigating post-pandemic economic conditions, while the subsequent moderation in overspending reflects proactive efforts to manage costs and ensure efficient resource allocation.

Corrective Renewal Program

The Corrective Renewal program is necessarily reactive, responding to immediate system needs and unforeseen events that arise throughout the year. This inherent variability is reflected in the program's expenditures, which exceeded the OEB-approved budget by a total of $31.4M over the 2021-2025 period, representing a 61% overspend.

In 2021, the program overspent by $1.3M, primarily due to increased emergency pole replacements and transformer oil spills. This demonstrates the program's responsiveness to immediate system risks identified through inspections and ongoing maintenance.

2022 saw a substantial $16.7M overspend (171%), largely attributed to the devastating Derecho storm. This unprecedented event required extensive emergency repairs, exceeding the original Emergency Renewal budget within the Corrective Renewal Program by $15.1M. For additional information on this devastating storm, refer to Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report. Hydro Ottawa did not file a Z-factor for this storm.

The program continued to exceed budget in 2023 by $2.9M, driven by another severe April ice storm and a higher-than-anticipated volume of transformer oil spills. This further emphasizes the program's role in the reactive response to both weather-related emergencies and underlying system issues.

In 2024 and 2025, the program is projected to exceed the approved budget by $5.1M and $5.4M, respectively. This sustained overexpenditure is primarily due to: emergency replacement of poles projected to exceed the approved budget by $2.9M, emergency underground transformer replacement projected to exceed the approved budget by $4.1M, and the proactive replacement of leaking transformers from a specific manufacturer as defined in Section 6 of Schedule 2-5-7 - System Renewal Investments. Forecasts for 2024 and 2025 emergency pole replacement costs were developed using actual costs from 2021-2023 and data on known assets requiring replacement. These costs reflect a 50% per-pole increase attributed to inflationary pressures and updated estimating methodologies. Emergency underground transformer replacements in 2024 cost as much as $122,481 when remediation and base replacement were required. This was a sharp contrast to the $25,648 average cost for emergency replacement without remediation or base replacements. Though maximum costs increased, total volumes are projected to remain consistent for 2024 and 2025 when compared with 2021-2023. However, leaking transformers are expected to spike in 2024 and 2025 as a result of known deficiencies with a specific manufacturer.

Overall, the Corrective Renewal program demonstrates a consistent pattern of responding to immediate system needs and unforeseen events. The significant overspending, totaling $31M, reflects the program's crucial role in maintaining system reliability and safety, even in the face of unexpected challenges and rising costs.

However, it's important to recognize that emergency renewals are not a substitute for targeted renewal work. While they address urgent failures and prevent immediate system disruptions, they often occur without a comprehensive condition assessment of the asset. This means that repairs are made to address the symptom (the failure) rather than the underlying cause (asset degradation). Consequently, emergency renewals may lead to temporary fixes or like-for-like replacements of already deteriorating assets, potentially resulting in recurring issues and increased long-term maintenance needs. Furthermore, emergency work can impact assets at relatively good condition, as these assets may be damaged in the same event that damaged the older assets. This is especially true when considering that impacts of storms and other unforeseen events can far exceed the design limits of the asset, leading to damage regardless of its age or condition.

Targeted renewals, on the other hand, are driven by condition assessments and Predictive Analytics, allowing for proactive replacements that address the root causes of asset degradation. This approach optimizes asset lifecycles and minimizes future maintenance requirements. While exceeding the approved budget, the Corrective Renewal expenditures underscore Hydro Ottawa's commitment to ensuring a resilient and dependable electricity distribution system, it's crucial to balance these emergency responses with strategic, condition-based renewals to achieve long-term system reliability and cost-effectiveness.

Metering Renewal Program

The Metering Renewal program encountered notable challenges throughout the 2021-2025 period, primarily stemming from delays in Gatekeeper meter acquisition and the subsequent transition to the AMI 2.0 initiative (detailed in Schedule 2-5-7 - System Renewal Investments). Despite these complexities, the program ultimately achieved a total underspend of $1.3M, representing a 10% variance from the OEB-approved budget.

In 2021 and 2022, the program experienced substantial underspending, with actual expenditures ($3.0M) and ($2.2M) below the approved budget, respectively. These variances were directly attributable to delays in acquiring Gatekeeper meters, which impacted the Self-Contained Meter Phone Line Elimination project and the replacement of REX 1 meters.

The underspending trend persisted in 2023, with a 31% budget shortfall, equivalent to $0.6M, due to ongoing supply chain constraints affecting critical components. However, in 2024, the program shifted to a $2.3M overspend. This variance was primarily due to the resolution of prior supply chain issues. For 2025, the program is projected to overspend by $2.3M. This is attributed to the successful resolution of supply chain constraints, enabling the progression of REX 1 meter replacements.

5.2.3. Forecast to Historical Variance by Capital Program

The net annual spend for System Renewal is expected to average $86.3M over the 2026-2030 period which is an increase from the $46.5M average annual spend during the 2021-2025 timeframe.

Table 20 below provides a comparison of the 2021-2025 historical period and the 2026-2030 forecast period, detailing both the five-year totals and annual averages for each program.

Table 20 – System Renewal Forecast Expenditures Test Year Expenditures by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
Stations & Building Infrastructure Renewal	$ 31,433	$ 107,656	$ 76,222	$ 6,287	$ 21,531	$ 15,244
OH Distribution Assets Renewal	$ 43,149	$ 67,800	$ 24,651	$ 8,630	$ 13,560	$ 4,930
UG Distribution Assets Renewal	$ 63,286	$ 103,034	$ 39,747	$ 12,657	$ 20,607	$ 7,949
Corrective Renewal	$ 82,629	$ 66,851	$ (15,779)	$ 16,526	$ 13,370	$ (3,156)
Metering Renewal	$ 11,835	$ 86,364	$ 74,529	$ 2,367	$ 17,273	$ 14,906
TOTAL SYSTEM RENEWAL	**$ 232,333**	**$ 431,704**	**$ 199,371**	**$ 46,467**	**$ 86,341**	**$ 39,874**
Capital Contributions	$ (12)	-	$ 12	$ (2)	-	$ 2
NET SYSTEM RENEWAL	**$ 232,321**	**$ 431,704**	**$ 199,383**	**$ 46,464**	**$ 86,341**	**$ 39,877**

Details on Hydro Ottawa's System Renewal Capital Programs from 2026 through 2030 are included in Schedule 2-5-7 - System Renewal Investments.

Stations and Buildings Infrastructure Renewal

The capital investment for this program is detailed in Section 2 of Schedule 2-5-7 - System Renewal Investments. The Stations and Buildings Infrastructure Renewal program investments are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

Based on the Copperleaf PA assessment, long-term asset condition trends were considered to develop a balanced asset renewal investment plan for 2026-2030, managing the risk of asset failure, the lead time for equipment and the resource requirements to execute the programs. This strategy led to Hydro Ottawa proposing an increase to the station renewal budget relative to the 2021-2025 period, with the objective of managing asset performance while balancing supply chain considerations and maintaining customer affordability.

The annual spend for Stations Asset Renewal is expected to average $21.5M over the 2026-2030 period which is an increase from the $6.3M average annual spend during the 2021-2025 timeframe. This increase is primarily driven by investments in five voltage conversion projects necessitated by the need to replace station transformer assets that have reached their end of typical useful life, three of which are new projects (Church AA, Henderson UN, Vaughan DS) and two of which were deferred during the 2021-2025 period (Dagmar AC and Fisher AK) as part of cost containment efforts. These projects account for over half of the program's allocated expenditure. The remaining increase is attributed to the replacement of switchgear lineups at four stations with a higher risk of failure based on operational trends and recommendations from Copperleaf PA.

Comparison of historical actuals (2021-2025) vs. planned (2026-2030) station asset replacement and removal units under Station and Building infrastructure Renewal Program is provided in Table 21. The five year budget reflects a shift towards targeted, efficient upgrades, particularly in response to increasing obsolescence and technological advancements focusing on:

- **EOL Voltage Conversion Program:** The budget increases by $60.6M and focuses on decommissioning 4kV transformers and switchgear at 5 stations and converting customers to 13kV supply. In the historical period Hydro Ottawa completed a significant portion of the 4kV voltage conversion of Fisher and deferred the Dagmar voltage conversion project. The increased budget reflects the critical need to address the degraded 4kV assets as detailed in Section 2 of Schedule 2-5-7 - System Renewal Investments.
- **Station Transformer Renewal:** The budget reduces by $2.3M and focuses solely on completing the Longfields T2 project. In this rate period, Hydro Ottawa has shifted its station transformer renewal focus to the 4kV transformers under the EOL Voltage Conversion program.
- **Station Switchgear Renewal:** The budget substantially increases by $16.1M and is allocated to replace 45 breakers across four stations, addressing aging infrastructure and incorporating inflation-adjusted material costs. The unit increase is driven by a series of catastrophic failures of metal-clad switchgear in the historical period. A program has been developed to target the replacement of EOL and Air-type switchgear at designated critical stations, based on asset condition information.
- **Station Battery Renewal:** The budget increased by $0.5M to facilitate the replacement of 11 battery banks and the removal of 3 battery banks, reflecting a proactive response to observed trends in emergency replacements and condition assessments.
- **Station P&C Renewal:** The budget significantly increased by $6.4M and prioritizes dedicated P&C renewal projects, addressing critical obsolescence in RTU equipment and modernizing transfer trip installations. This investment enhances grid resilience and operational efficiency through the integration of advanced technologies.
- **Station & Building Minor Assets Renewal:** The proposed budget reflects an increase of $6.1M, primarily allocated to the renewal of Operations Facilities, the mitigation of aging asset risks, and supporting increased electrical demand. The primary drivers are end-of-life status of station minor assets and buildings, coupled with the imperative to support increased electrical load. Note that the transfer of the Maple Grove and Dibblee facilities has

contributed to this budget augmentation. This is further detailed in Section 2 of Schedule 2-5-7 - System Renewal Investments.

- **Station Major Rebuild:** The proposed budget is nil for the 2026-2030 period, representing a decrease of $11.2M compared to the 2021-2025 periods. Through 2021-2025, stations with transformers and switchgears that needed replacement were typically recommended for full station upgrades. However, for the 2026-2030 rate period, all stations requiring major asset replacements are in the 4 kV system, being converted to 13 kV under the EOL Voltage Conversion program.

Table 21 - Station Renewal Unit Comparison per Station Asset Class

Station Asset Class	Historical Actuals	Planned
	2021-2025	2026-2030
Station Transformers	5	11
Station Switchgear	55	83
Station Batteries	9	14
Station Relays	39	252
Station RTUs	2	6

Overhead Distribution Assets Renewal

The capital investment for this program is detailed in Section 3 of Schedule 2-5-7 - System Renewal Investments. The investments in the Overhead Distribution Assets Renewal program are driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

Comparison of historical actuals (2021-2025) vs. planned (2026-2030) overhead (OH) unit asset renewals encompassed within the Overhead Distribution Asset Renewal Program is provided in Table 22. The annual spend for Overhead Distribution Asset Renewal is expected to average

$13.6M over the 2026-2030 period which is an increase from the $8.6M average annual spend during the 2021-2025 timeframe. The major drivers of the increase are related to:

- **Pole Renewal:** The budget increases by $17M and supports the replacement of 395 poles annually, which is in line with the proposed replacement rate of 400 poles in the historical period. $8M of the budget increase is associated with the increased cost per pole experienced in the historical period. The remaining $9M of the budget increase is attributed to incremental budget allocation to allow for resilience improvements to be incorporated into the renewed design. Productivity improvements have maintained cost efficiency, even with increased volume and inflation. Overhead transformer replacement costs are integrated within this program.
- **OH Switch/Recloser Renewal:** The budget increases by $7.7M is in response to the deteriorating infrastructure, which has resulted in increased outages and corrective maintenance costs in the 2021-2025 period as shown in Schedule 2-5-7 - System Renewal Investments. The plan includes the proactive replacement of 340 manual switches and considers an additional budget to upgrade 40 to remote controllable switches, improving operational efficiency and reliability.

Table 22 - OH Unit Asset Renewal Comparison per OH Asset Class

OH Asset Class	Historical Actuals	Planned
	2021-2025	2026-2030
Poles	1,732	1,975
OH Transformers	309	400
OH Switches / Reclosers	56	340

Underground Distribution Assets Renewal

The capital investment for this program, detailed in Section 4 of Schedule 2-5-7 - System Renewal Investments, is driven by asset condition and risk assessments. These assessments are conducted through the distribution asset model within Copperleaf Predictive Analytics (PA), as detailed in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

Comparison of historical actuals (2021-2025) vs. planned (2026-2030) underground unit asset renewals encompassed within the Underground Distribution Asset Renewal Program is provided in Table 23. The budget reflects a substantial increase in investment for underground distribution asset renewal, driven by the need to address deteriorating infrastructure, mitigate reliability risks, and manage escalating costs. The annual spend for Underground Distribution Asset Renewal is expected to average $20.6M over the 2026-2030 period which is an increase from the $12.7M average annual spend during the 2021-2025 timeframe. The major drivers of the five year total increase are related to:

- **Cable Renewal:** The budget increases by $33.9M and considers the replacement of 61km down from 74km replaced in 2021-2025. The cost increase is attributable to the increase in the unit rate compared to the historical period. The 2021-2025 unit rate for Hydro Ottawa's cable renewal program was developed using a limited project subset, which proved inadequate to capture the technical complexity of the Ottawa region. This led to a cost discrepancy: 2021-2023 average costs were $0.71M/km (influenced by underground construction unknowns and inflationary pressures), but individual projects reached $1M/km. This was substantially higher than the $0.3M/km rate that was used in developing the 2021-2025 OEB-Approved budget. As a result of varying project complexity, the 2026-2030 budget reflects the higher end of the range, adjusted for inflation, at $1.4M/km to address increased material and contractor costs. Underground transformer replacements are included in this budget.
- **UG Switchgear Renewal:** The budget increases by $3.4M in response to the increased failure rates of UG Switchgear experienced in the historical period, as described in Section 4.3.3 of Schedule 2-5-7 - System Renewal Investments. The program aims to address the

replacement of 30 UG Switchgear which is an increase from the 15 switchgear replaced in the historical period.

- **Vault Renewal:** The budget increases by $2M in response to the growing risk associated with customer-owned vault equipment, as described in Section 4.3.5 of Schedule 2-5-7 - System Renewal Investments. The program aims to address 90 vault transformers in the 2026-2030 period.
- **Civil Renewal:** The budget increases by $1M. The increase is predominately related to cost increases in the program and also considers a slight increase in the number of cable chambers to be addressed (23 to 30).

Table 23 - UG Unit Asset Renewal Comparison per UG Asset Class

Station Asset Class	Historical Actuals	Planned
	2021-2025	2026-2030
UG Transformers	360	400
UG Switchgear	15	30
UG Cables (km)	74	61
Cable Chambers	23	30
Vault Transformers	18	90
Vault Switchgear	-	30

Corrective Renewal

The capital investment for this program is detailed in Section 6 of Schedule 2-5-7 - System Renewal Investments.

The annual spend for Corrective Renewal is expected to average $13.4M over the 2026-2030 period which is a decrease from the $16.5M average annual spend during the 2021-2025 timeframe. The lower forecasted spending in the 2026-2030 period compared to 2021-2025 expenditure is a result of the substantial variance in expenditure over the 2021-2025 period compared to the OEB-approved budget due to an increased number and severity of Major Event Days (MEDs) during this period. With the assumption that the number and severity of

MEDs experienced in this period were an anomaly, the forecasted expenditure for 2026-2030 is better compared with the OEB-approved budget for the 2021-2025 ($51.2M). Factoring in cost increases and acknowledging the realities of climate change and the associated impacts to the electrical distribution system, a total variance of $15.6M compared to the 2021-2025 OEB-approved budget is observed. While the occurrence of a discrete event of the severity of the 2022 Derecho is not explicitly forecast, the increasing frequency and intensity of severe weather events necessitate sustained and strategic investment in infrastructure resilience which is accounted for in the forecasted expenditure for 2026-2030.

Metering Renewal

The capital investment for this program is detailed in Section 5 of Schedule 2-5-7 - System Renewal Investments.

The annual spend for Metering Renewal is expected to average $17.3M over the 2026-2030 period which is an increase from the $2.4M average annual spend during the 2021-2025 timeframe. The increase is attributed to investments in Hydro Ottawa's Advanced Metering Infrastructure 2.0 (AMI 2.0) initiative. This upgrade is required to address the functional obsolescence of the metering fleet to avoid failure, enhance system capabilities, and support grid modernization efforts. The proposed metering renewal plans to replace 161,000 meters (approximately 43% of the total fleet) over the 2026-2030 period with the remainder of the fleet being replaced in the 2031-2035 period. The functional obsolescence of Hydro Ottawa's fleet of meters all at the same time is due to a previous effort to replace all meters over a 4 year period to remain compliant to regulations stemming from Ontario Bill 21 - Energy Conservation Responsibility Act in 2006.

The renewal of metering assets is crucial to ensure sustained levels of customer service, accurate billing, and regulatory compliance.

Comparison of historical actuals (2021-2025) vs. planned (2026-2030) metering asset unit renewals encompassed within the Metering Renewal Program is provided in Table 24.

Table 24 - Metering Unit Renewal Comparison

	2021-2025 Historical Actuals	2026-2030 Planned
Metering Replacements	8,811	161,000

5.3. SYSTEM SERVICE EXPENDITURES

System Service investments are "modifications to a distributor's distribution system to ensure the distribution system continues to meet distributor operational objectives while addressing anticipated future electricity service requirements" as per Section 5.1.2 of the OEB's Chapter 5 Filing Requirements.

Hydro Ottawa's System Service Investments are broken out into six capital programs as described in Table 25 below.

Table 25 – System Service Capital Programs

Capital Program	Description
Capacity Upgrades	● For relieving system capacity constraints resulting from load growth.
Distribution Enhancements	● A modification to the distribution system to improve system operating characteristics.
Station Enhancements	● A modification to a station to improve system operating characteristics.
Grid Technologies	● Enhancements to the Advanced Distribution Management System and data archival system to improve monitoring and control of the distribution network in real-time.
Control and Optimization	● Enhancements to grid management by integrating advanced systems like DERMS to monitor and adjust electricity flow in real-time, improving efficiency, stability, and responsiveness to changing conditions like outages and fluctuating renewable energy sources.
Field Area Network	● Extend connectivity and add resilience to grid-edge device communications.

Capital Programs under System Service are also broken down by Budget Program. Table 26 provides a description of each Budget Program along with the primary driver. The program drivers are detailed in Section 5.3.1.1 of Schedule 2-5-4 - Asset Management Process.

1 **Table 26 – System Service Expenditure Categories**

Capital Program	Budget Program	Primary Driver	Description
Capacity Upgrades	Stations Capacity Upgrades	Capacity Constraints	• New stations or increased station transformation capacity through transformer upgrades or additions at existing stations as identified through the System Capacity Assessment.
	Distribution Capacity Upgrades	Capacity Constraints	• New distribution capacity projects identified through the System Capacity Assessment including conductor upgrades, and line extensions (Not deemed "System Expansion").
	Non-Wire Upgrades	Capacity Constraints	• New support during peak demand in capacity constrained areas until capacity upgrades are completed to alleviate constraints while also benefiting those customers who are open to adopting distributed energy resources
Distribution Enhancements	Distribution System Reliability	Reliability	• Specific enhancements to particular areas identified as having poor system reliability; typically more complex projects, including line extensions and addition of remote operable switches.
	Capacity Voltage Conversion	Capacity Constraints	• Distribution voltage conversion to increase capacity in areas seeing significant growth; • Typically coincides with the retirement of existing stations or distribution assets due to condition or failure risk
	Distribution Enhancements	Reliability	• Modifications to the existing distribution system made to improve system operating characteristics or operability (e.g. circuit reconfiguration) • Installation of automated equipment for the purposes of improving operability
	Distribution System Observability	Observability	• This initiative will improve system visibility by adding automated devices in strategic locations
	Distribution System Resiliency	Resilience	• This initiative will reduce outage times and improve system reliability using new assets that provide real-time condition data, loading data, and fault-finding capabilities
Station	Stations	Reliability	• Modifications to an existing station that is made to

Capital Program	Budget Program	Primary Driver	Description
Enhancements	Enhancements		improve system operating characteristics.
Grid Technologies	SCADA Upgrades	System Efficiency	• Upgrades to the ADMS platform; both hardware and software upgrades are considered.
	RTU Upgrades	N/A	• A historical Budget Program whereby the scope has been redistributed into the Grid Technologies, as well as Control and Optimization Capital Programs
	Communication Infrastructure	N/A	• A historical budget program which has been redistributed into the Field Area Network budget program.
Control and Optimization	Control and Optimization	Observability & Resilience	• Enhancements to grid management by integrating advanced systems like DERMS to monitor and adjust electricity flow in real-time, improving efficiency, stability, and responsiveness to changing conditions like outages and fluctuating renewable energy sources.
Field Area Network	Physical Fiber Extension	System Efficiency	• Installation of new fiber segments to improve network diversity and resilience.
	Wireless Communication	System Efficiency	• Deployment of infrastructure for testing wireless communication for Grid DA devices.
	Management of Grid-Edge Device	System Efficiency	• Deployment of an Intelligent Electric Device Management system to centrally monitor, configure, troubleshoot and access Intelligent Electronic Devices.
	SCADA Network Cyber Security	System Efficiency	• Installation of threat detection, capabilities to increase cyber security in the SCADA network.

5.3.1. Historical Expenditures

The following Tables present Hydro Ottawa's System Service Capital Expenditures from 2021 through 2025 compared to the OEB Approved amounts. Table 27 details this spending on a five-year total basis, while Table 28 provides the annual spending and variances.

Hydro Ottawa uses its Capital Expenditure Process (Section 3.5 of Schedule 2-5-4 - Asset Management Process) and portfolio optimization (Section 5.3 of Schedule 2-5-4 - Asset Management Process) to ensure strategic oversight and efficient capital utilization of the System Service capital program.

Table 27 - Net System Service Historical Spending versus OEB Approved - 5yr ($'000s)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
Capacity Upgrades	$ 75,849	$ 108,196	$ 32,347	43%
Stations Enhancements	$ 2,739	$ 2,576	$ (163)	(6)%
Distribution Enhancements	$ 29,573	$ 27,515	$ (2,058)	(7)%
Grid Technology	$ 8,859	$ 20,813	$ 11,953	135%
Field Area Network	$ 6,069	$ 1,947	$ (4,122)	(68)%
TOTAL CAPITAL EXPENDITURES	**$ 123,089**	**$ 161,047**	**$ 37,959**	**31%**

As noted above, Table 28 below provides the annual variance against the OEB Approved for each of the capital programs under System Service, the table is divided into three sections with the OEB Approved amounts first, followed by the historical actuals, and then the annual variances.

Table 28 - Net System Service Historical Spending versus OEB Approved - Annual ($'000s)

Capital Program	2021	2022	2023	2024	2025
	OEB-Approved (Net of Contribution)				
Capacity Upgrades	$ 19,791	$ 9,717	$ 14,577	$ 17,799	$ 13,964
Stations Enhancements	$ 905	$ 459	$ 459	$ 459	$ 459
Distribution Enhancements	$ 2,614	$ 11,987	$ 5,579	$ 4,597	$ 4,796
Grid Technology	$ 1,224	$ 2,961	$ 1,775	$ 755	$ 2,145
Field Area Network	$ 902	$ 1,044	$ 1,044	$ 1,044	$ 2,035
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 25,436**	**$ 26,168**	**$ 23,434**	**$ 24,654**	**$ 23,398**
	Historical Years			Bridge Years	
Capacity Upgrades	$ 20,669	$ 6,775	$ 7,941	$ 29,757	$ 43,054
Stations Enhancements	$ 99	$ 1,238	$ 215	$ 661	$ 363
Distribution Enhancements	$ 2,428	$ 3,254	$ 2,816	$ 10,727	$ 8,291
Grid Technology	$ 151	$ 2,604	$ 5,591	$ 5,712	$ 6,756
Field Area Network	$ 591	$ (46)	$ 24	$ 300	$ 1,079
TOTAL HISTORICAL/BRIDGE NET CAPITAL EXPENDITURES	**$ 23,937**	**$ 13,825**	**$ 16,585**	**$ 47,157**	**$ 59,543**
	Variance ($)				
Capacity Upgrades	$ 877	$ (2,942)	$ (6,637)	$ 11,958	$ 29,090
Stations Enhancements	$ (805)	$ 779	$ (244)	$ 202	$ (95)
Distribution Enhancements	$ (187)	$ (8,733)	$ (2,763)	$ 6,130	$ 3,495
Grid Technology	$ (1,073)	$ (358)	$ 3,816	$ 4,957	$ 4,611
Field Area Network	$ (311)	$ (1,090)	$ (1,021)	$ (744)	$ (956)
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ (1,499)**	**$ (12,343)**	**$ (6,849)**	**$ 22,503**	**$ 36,145**

5.3.2. Historical Variances

Hydro Ottawa's System Service capital expenditures for the 2021-2025 period are projected to exceed the OEB-approved budget by approximately $38M, a 31% variance. This significant deviation is primarily attributed to a combination of factors: initial underspending due to COVID-19 related project delays in 2021-2022, followed by escalating costs driven by unforeseen capacity requirements, including the Mer Bleue substation, identified through regional planning, and substantial scope adjustments to the Advanced Distribution Management System (ADMS) initiative. These increases were further compounded by external factors, including inflationary pressures and industry-wide supply chain disruptions, further contributing to cost increases. Details on coordinated planning with external stakeholders can be found in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties, and the impact of inflationary pressures in Section 4 of Schedule 1-2-5 - Impacts of Inflationary Pressures.

Key contributing factors:

- **COVID-19 Pandemic Impact:** Supply chain and resource availability disruptions
- **Evolving Capacity Needs:** Project scope changes identified through regional planning with external stakeholders
- **Inflationary Pressures:** Increased material and labor costs
- **Reprioritization:** Prioritization of critical projects
- **ADMS Scope Adjustments:** Significant modifications to the ADMS initiative

As noted above, System Renewal and System Service have a combined cumulative asymmetrical capital variance account, therefore given the total overage in this investment category and on an annual basis when combined with System Renewal, no amounts were recorded in this account. Refer to Schedule 9-1-3 - Group 2 Accounts for further details.

Detailed explanations of program variances that contributed to the overall System Service variances are provided below.

Capacity Upgrades

Over the 2021-2025 period, the Capacity Upgrades program experienced significant budget increases, culminating in a total overspend of $32.3M or a 43% variance from the OEB-approved budget. This variance was primarily driven by:

- **Material Cost Escalations:** Significant price increases in core commodities and electrical components.
- **Supply Chain Disruptions:** Delays and shortages in critical materials and equipment.
- **Land Acquisition Challenges:** Rising real estate values and environmental assessment delays.
- **Unforeseen Capacity Needs:** The Mer-Bleue station was identified through a collaborative regional planning initiative with external stakeholders.
- **Project Delays and Scope Adjustments:** Leading to schedule adjustments and cost increases.

Initially, the program experienced underspending in 2022 and 2023, with actual expenditures below budget, primarily due to delays in key projects. Notably, the New East Station Capacity Upgrade and the Riverdale Switchgear Upgrade faced setbacks. The New East Station project was delayed due to complexities associated with land acquisition. The Riverdale Switchgear Upgrade was delayed due to necessary scope adjustments required to adhere to capacity planning requirements identified through area planning.

However, 2024 and 2025 saw a shift to significant, unavoidable overspending. The New East Station project faced substantial cost escalations, now projected to be $23.3M (or 163%) over budget. This significant increase is largely due to transformer and high-voltage breaker costs, which more than doubled due to industry-wide material shortages and inflationary pressures. General construction costs also increased in line with industry-average inflation, as generally described in Schedule 1-2-5 - Impact of Inflationary Pressures. Additionally, the collaborative regional planning with external stakeholders identified the need for the Mer-Bleue station capacity upgrade, adding $13.8M in unbudgeted expenditures to the program. Through regional planning, construction of Mer Bleue MTS was determined as the optimal solution to decommission the aging Bilberry TS and transfer loads to a 230 kV supply, relieving pressure on the constrained 115 kV system project, as described in Section 2.3.2.1 of Schedule 2-5-8 - System Service Investments. Despite facing unprecedented external challenges, Hydro Ottawa effectively adapted its Capacity Upgrades program to meet evolving capacity requirements.

Station Enhancement

There were no material variances in the Station Enhancements program, annually or on a total basis. The 5 yr total variance was $0.2M or 6% below the 2021-2025 OEB-approved budget.

Distribution Enhancement

Over the 2021-2025 period, Hydro Ottawa's Distribution Enhancements program experienced budgetary fluctuations, resulting in a $2.0M underspend, a 7% variance from the OEB-approved budget. This variance was primarily driven by strategic investment prioritization and unforeseen external events.

In 2022, Hydro Ottawa underspent by $8.7M due to the strategic deferral of large line extension projects and scope adjustments following the Derecho storm, which facilitated a reassessment and prioritization of distribution enhancements. This trend continued in 2023, with a $2.8M underspend attributed to strategic reprioritization necessitated by the lingering effects of the 2022 Derecho storm, additional 2023 storm activity, and the labor strike. Distribution Enhancement Program deferrals are detailed in Section 4.1.3 - 2021-2025 Major Deferrals.

Conversely, 2024 and 2025 saw substantial overspending: $6.1M in 2024 and $3.5M in 2025. This overspending was primarily due to the execution of four large line extension projects, implemented to address the previously deferred projects from 2022 and 2023.

Hydro Ottawa's strategic reprioritization demonstrates a commitment to maintaining and enhancing distribution network reliability. By leveraging the portfolio optimization process, as detailed in Sections 5.3 and 5.3.2.4 of Schedule 2-5-4 - Asset Management Process, Hydro Ottawa effectively manages investment priorities. The program's adaptability, evidenced by the response to the Derecho storm and project reprioritization, reflects a dynamic and responsive approach to budget management. Hydro Ottawa aligned expenditures with evolving operational needs, ensuring resources were directed to critical priorities. The strategic deferral and subsequent execution of large line extension projects highlight Hydro Ottawa's commitment to responsible financial stewardship and its ability to navigate changing circumstances while maintaining core operational objectives.

Grid Technology

Over the 2021-2025 period, Hydro Ottawa's Grid Technology program experienced significant budgetary fluctuations, resulting in a substantial overspend of $12M (135% variance) from the OEB-approved budget. However, with the reallocation of funds from the underspent Field Area Network program, as noted below, the net variance in this program is $7.8M. This variance was primarily driven by evolving project scope, unforeseen external events, adjustments to project implementation, and inflationary increases impacting professional service fees.

Initially, a $1.1M underspend in 2021 resulted from deferring the Advanced Distribution Management System (ADMS) initiative, which includes SCADA Upgrade, Outage Management System Replacement, Distribution Management System enhancement, and planned integrations. This deferral was due to COVID-19-related disruptions.

In 2022, a further $0.4M underspend occurred as internal resources were redirected to operational tasks following the Derecho storm. When the ADMS initiative resumed, planning revealed significant budget gaps and a lack of internal resources, necessitating a dedicated project resource model, expanded professional services, and schematics map conversion, resource details in Section 3.1 of Attachment 4-1-3(C) - Workforce Growth.

The 2023 labor disruption compounded ADMS initiative delays, requiring additional professional services. These cumulative delays, along with the decision to prioritize ADMS, led to a $3.8M overspend (215% variance).

Hydro Ottawa notes that the ADMS program is currently undergoing a comprehensive review, and therefore, specific details of the Grid Technology budget program, including the capital budget, are subject to significant change. Updated information and supporting documentation related to the program will be filed with the responses to interrogatories. This approach ensures transparency and allows stakeholders to fully assess the program's potential impact and provide informed feedback within the rate application process.

The $12M overspend (or $7.8M after considering the Field Area Network budget reallocation) is a culmination of the initial underspends due to delays, the subsequent increased costs for resources and professional services, and the overall initial budget gaps and scope changes, such as the crucial addition of the schematics map conversion and cyber security requirements.

Field Area Network

Over the 2021-2025 period, Hydro Ottawa's Field Area Network program was underspent by $4.1M, or 68%, from the OEB-approved budget. This variance was driven by regulatory delays, evolving technological challenges, and the decision to prioritize the Grid Technology program.

In 2021, the program underspent by $0.3M due to delays awaiting critical regulatory changes from the CRTC, a prerequisite for deploying and operating wireless communication services. Although the CRTC's regulatory changes were implemented in 2022, the program continued to experience underspending throughout the rate period due to ongoing challenges in obtaining necessary spectrum licenses and the lack of common industry standards for device manufacturers. These issues hindered the procurement and installation of essential equipment, including base stations and cellular-enabled field devices, preventing the program from advancing as planned. Consequently, funds were redistributed to Grid Technology to offset the

ADMS overspend, resulting in underspending of $1.1M in 2022, $1.0M in 2023, $0.7M in 2024 and $1.0M in 2025 from the OEB-approved budget.

5.3.3. Forecast to Historical Variance by Capital Program

The net annual spend for System Service is expected to average $93.8M over the 2026-2030 period which is an increase from the $32.2M average annual spend during the 2021-2025 timeframe.

Table 29 below provides a comparison of the 2021-2025 historical period and the 2026-2030 forecast period, detailing both the five-year totals and annual averages for each program.

Table 29 – System Service Forecast Expenditures by Capital Program ($’000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
Capacity Upgrades	$ 108,244	$ 346,890	$ 238,646	$ 21,649	$ 69,378	$ 47,729
Stations Enhancements	$ 2,576	$ 3,050	$ 474	$ 515	$ 610	$ 95
Distribution Enhancements	$ 27,523	$ 92,786	$ 65,263	$ 5,505	$ 18,557	$ 13,053
Grid Technology	$ 20,813	$ 6,408	$ (14,404)	$ 4,163	$ 1,282	$ (2,881)
Control and Optimization	-	$ 3,586	$ 3,586	-	$ 717	$ 717
Field Area Network	$ 1,947	$ 20,750	$ 18,804	$ 389	$ 4,150	$ 3,761
TOTAL SYSTEM SERVICE	**$ 161,103**	**$ 473,472**	**$ 312,369**	**$ 32,221**	**$ 94,694**	**$ 62,474**
Capital Contributions	$ (56)	$ (4,333)	$ (4,277)	$ (11)	$ (867)	$ (855)
NET SYSTEM SERVICE	**$ 161,047**	**$ 469,139**	**$ 308,092**	**$ 32,209**	**$ 93,828**	**$ 61,618**

Details on Hydro Ottawa's System Service Capital Programs from 2026 through 2030 are included in Schedule 2-5-8 - System Service Investments but a brief overview of the changes in spend between the historical period and the forecast period is provided below.

Capacity Upgrades

The capital investment for this program is detailed in Section 2 of Schedule 2-5-8 - System Service Investments. System capacity needs and required upgrades are determined through the System Capacity Assessment (outlined in Section 9 of Schedule 2-5-4 - Asset Management Process) and Integrated Regional Resource Planning (detailed in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties).

The gross annual spend for Capacity Upgrades is expected to average $69.4M[8] over the 2026-2030 period, which is an increase from the $21.6M average annual spend during the 2021-2025 timeframe. Over the 2026-2030 period, there will be 753MVA[9] of new capacity in construction versus 180MVA during the 2021-2025 timeframe. As a result, 75% of the budget growth is related to capacity investments required to support the committed connection requests driving this new capacity. More specifically, 56% is related to station capacity investments to support forecasted load and 26% is distribution capacity upgrades, enabling full utilization of the station capacity through feeder construction. The remaining 18% of the growth has been allocated to the new Non-Wires Capacity Upgrades program, which involves implementing alternative solutions to traditional infrastructure upgrades to increase capacity and improve grid reliability. This program encompasses investments in utility-owned Battery Energy Storage Systems (BESS) and Non-Wires Customer Solutions. Specifically, Hydro Ottawa plans on deploying approximately 27.5MW of utility-owned BESS at 4 substations over the 2026-2030 period. Further, Hydro Ottawa will offer a portfolio of energy efficiency, generation, and demand response programs that can also leverage customer DERs, to help address system needs, through the Non-Wires Customer Solutions Program. The planned investments, including both

[8] Net of Capital Contributions this program is expected to average $68.5M over the 2026-2030 period.
[9] Station projects- Piperville, Mer Bleue, Kanata North, Greenbank, Upgrades to Bronson DS and Cyrville MTS

BESS and customer solutions, are critical to support growth and electrification in the community by providing additional flexibility and capacity to the distribution system.

Stations Enhancements

The capital investment for this program is detailed in Section 4 of Schedule 2-5-8 - System Service Investments.

The annual spend for Stations Enhancements is expected to average $0.6M over the 2026-2030 period, aligning with the $0.5M average annual spend during the 2021-2025 timeframe. This program covers continued investments in cyber security to safeguard critical infrastructure as well as installation of monitoring equipment at station transformers to improve system reliability, enable proactive maintenance, and facilitate data-driven decision-making. These improvements also support grid modernization, creating improved observability at stations and building the foundation for future grid modernization initiatives.

Distribution Enhancements

The capital investment for this program is detailed in Section 3 of Schedule 2-5-8 - System Service Investments.

The annual spend for Distribution Enhancements is expected to average $18.6M over the 2026-2030 period which is an increase from the $5.5M average annual spend during the 2021-2025 timeframe. This increase is primarily driven by significant investments in two new programs, which account for over 70% of the program's allocated budget:

- **Distribution System Resiliency:** This program focuses on mitigating the impact of adverse weather events through strategic undergrounding of lines, reinforcement of existing infrastructure, reconfiguration of feeders, and relocation of lines to less vulnerable areas.
- **Distribution System Observability:** This program aims to enhance system reliability and reduce outage times by investing in new assets that provide real-time data on system

conditions, loading, and fault locations, enabling proactive maintenance and faster response to issues.

The remaining 30% of the budget is made up of the following programs:

- **Reliability:** Improves efficiency and reliability through feeder reconfiguration and phase balancing.
- **Enhancements:** Supports DER integration through infrastructure upgrades and pilot projects, leveraging federal funding for innovation.

These programs are critical to improve grid resilience to severe weather events, shorten outage times, improve reliability, increase grid flexibility, enhance DER integration, and advance Hydro Ottawa's grid modernization road map.

Grid Technology

The capital investment for this program is detailed in Section 5 of Schedule 2-5-8 - System Service Investments.

The annual spend for Grid Technology is expected to average $1.3M over the 2026-2030 period which is a decrease from the $4.2M average annual spend during the 2021-2025 timeframe. The 2021-2025 spend included a material investment in a new Advanced Distribution Management System, whereas the 2026-2030 period will see minor enhancements and upgrades.

Control and Optimization

As this Control and Optimization Capital Program is new, forecast-to-historical variance analysis is not applicable. Capital investment details are available in Section 7 of Schedule 2-5-8 - System Service Investments.

The annual spend for Control and Optimization is expected to average $0.7M over the 2026-2030 period. This captures a new program under System Service supporting grid modernization efforts by enhancing the Advanced Distribution Management System (ADMS) with new modules like the Distributed Energy Resource Management System (DERMS). These upgrades enable several grid modernization functionality in tandem with observability and controllability devices facilitating the improvement of grid stability, efficiency, and resilience, enabling better grid management and real-time outage restoration.

Field Area Network

The capital investment for this program is detailed in Section 6 of Schedule 2-5-8 - System Service Investments.

The annual spend for Field Area Network is expected to average $4.2M over the 2026-2030 period which is a $3.8M increase compared to the $0.4M average annual spend between 2021-2025. The incremental annual spend is predominantly related to increased reliability and resilience of the communication network, aimed at modernizing and future-proofing Hydro Ottawa's communication infrastructure. The $20.8M investment activity related to this program over the 2026-2030 period will fund four strategic projects that enhance communication reliability, address deteriorating infrastructure, and meet evolving technology requirements. Furthermore, grid modernization is reliant on the deployment of observation devices targeted at collecting real time data of asset use and performance, these devices in turn are extremely reliant on a reliable and expansive communications network.

5.4. GENERAL PLANT EXPENDITURES

General Plant investments are "modifications, replacements or additions to a distributor's assets that are not part of its distribution system; including land and buildings; tools and equipment; rolling stock, electronic devices and software used to support day to day business and operations activities and capital contributions to other utilities" as per Section 5.1.2 of OEB's Chapter 5 Filing Requirements.

Projects and programs in this category are driven by the requirements for capital expenditures to support day-to-day business and operations activities. There are ten capital programs under General Plant which are described in Table 30.

1 **Table 30 – General Plant Capital Programs**

Capital Program	Program Description
CCRA	Connection Cost Recovery Agreements are capital contributions to intangible assets purchased from other utilities such as Hydro One in conjunction with Hydro Ottawa's major station projects.
Fleet Replacement	Acquisition of vehicles to replace end of life vehicles. The program objective is to provide safe, reliable and efficient vehicles to meet the operational requirements.
Tools Replacement	Tools are needed to carry out the distribution maintenance and capital program efficiently and effectively, this program covers replacement of aged tool equipment.
Buildings - Facilities	The program addresses the necessary building improvements for the administrative buildings [10], storage and fleet garage space to ensure employees have a safe and efficient environment to operate within.
Grid Technology	This program addresses the maintenance and upgrade of tools and software that supports modernization of grid operations, integrates new technologies like DERs and supports grid planning. The program focuses on network visualization and management, data collection and archiving, and network modelling and simulation.
Meter to Cash	This program supports critical business functions such as billing, meter reading, collections, and financial reporting. Upcoming upgrades to systems like Oracle's Customer Care & Billing (CC&B) and Advanced Metering Infrastructure (AMI) aim to ensure compliance, improve customer self-service options, and address end of life infrastructure.
Customer Engagement Platform	This program encompasses tools such as MyAccount, outage communication systems, and energy management platforms. It prioritizes enabling intuitive self-service, delivering detailed energy insights, and enhancing customer satisfaction through seamless digital experiences.
Enterprise Solutions	This program focuses on maintaining and upgrading applications such as ERP and IT Service Management systems. These enhancements ensure business continuity, streamline workflows, and reduce cyber security risks.
Infrastructure & Cyber Security	This program invests in strengthening IT systems to protect against cyber threats, maintain data integrity, and support business continuity. The program aims to ensure systems are secure, scalable, and aligned with industry best practices to safeguard critical infrastructure.
Data and System Integrations	This program consolidates fragmented data systems to create an integrated, reliable, and efficient framework. It aims to reduce manual interventions, enable real-time decision-making, and ensure compatibility across platforms to support both operational and strategic initiatives.

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[10] As of January 1, 2026, Dibblee and Maple Grove Operations Centres are reclassified under System Renewal - Stations and Operations to better align with USofA definitions

The Capital Programs under General Plant are categorized by Budget Program, as shown in Table 31, which also identifies the corresponding primary driver. For General Plant, the Capital Program and Budget Program classifications are equivalent. Please refer to Section 5.3.1.1 of Schedule 2-5-4 - Asset Management Process for the driver definitions.

Table 31 – General Plant Expenditure Categories

Capital Program	Budget Program	Primary Driver
CCRA	CCRA	System Investment Support
Fleet Replacement	Fleet Replacement	System Investment Support
Tools Replacement	Tools Replacement	System Investment Support
Buildings - Facilities	Buildings -Facilities	System Investment Support
Grid Technology	Grid Technology	Business Operations Support
Meter to Cash	Meter to Cash	Business Operations Support
Customer Engagement Platform	Customer Engagement Platform	Business Operations Support
Enterprise Solutions	Enterprise Solutions	Business Operations Support
Infrastructure and Cyber security	Infrastructure and Cyber security	Business Operations Support
Data and System Integrations	Data and System Integrations	Business Operations Support

5.4.1. Historical Expenditures

The following tables present Hydro Ottawa's General Plant Capital Expenditures from 2021 through 2025 compared to the OEB Approved amounts. Table 32 details this spending on a five-year total basis, while Table 33 provides the annual spending and variances.

Table 32 - Net General Plant Historical & Bridge Spending versus OEB Approved ($'000)

Capital Program	2021-2025 OEB-Approved	2021-2025 Historical/Bridge	Var ($)	Var (%)
CCRA	$ 26,658	$ 16,964	$ (9,695)	(36)%
Fleet Replacement	$ 16,681	$ 17,598	$ 917	5%
Tools Replacement	$ 2,343	$ 3,161	$ 818	35%
Buildings - Facilities	$ 2,066	$ 6,970	$ 4,904	237%
Grid Technology	$ 1,760	$ 1,952	$ 192	11%
Meter to Cash	$ 6,983	$ 3,582	$ (3,401)	(49)%
Customer Engagement Platform	$ 1,990	$ 7,497	$ 5,507	277%
Enterprise Solutions	$ 12,630	$ 5,706	$ (6,924)	(55)%
Infrastructure and Cyber security	$ 7,474	$ 7,845	$ 371	5%
Data and System Integrations	$ 1,608	$ 1,553	$ (55)	(3)%
TOTAL CAPITAL EXPENDITURES	**$ 80,193**	**$ 72,827**	**$ (7,367)**	**(9)%**

As noted above, Table 33 below provides the annual variance against the OEB Approved for each of the ten capital programs under General Plant, the table is divided into three sections with the OEB Approved amounts first, followed by the historical actuals, and then the annual variances.

1 **Table 33 - Net General Plant Historical Spending versus OEB Approved - Annual ($'000)**

Capital Program	2021	2022	2023	2024	2025
	OEB-Approved (Net of Contribution)				
CCRA	$ 16,918	$ 210	$ 200	$ 5,130	$ 4,200
Fleet Replacement	$ 6,247	$ 4,526	$ 2,220	$ 1,681	$ 2,008
Tools Replacement	$ 474	$ 474	$ 462	$ 465	$ 469
Buildings - Facilities	$ 428	$ 428	$ 403	$ 403	$ 403
Grid Technology	$ 261	$ 427	$ 271	$ 424	$ 376
Meter to Cash	$ 2,529	$ 2,238	$ 605	$ 605	$ 1,008
Customer Engagement Platform	$ 924	$ 423	$ 241	$ 221	$ 181
Enterprise Solutions	$ 1,138	$ 744	$ 302	$ 4,932	$ 5,513
Infrastructure and Cyber security	$ 2,151	$ 1,132	$ 1,176	$ 1,260	$ 1,755
Data and System Integrations	$ 470	$ 272	$ 328	$ 222	$ 316
TOTAL OEB- APPROVED NET CAPITAL EXPENDITURES	**$ 31,540**	**$ 10,874**	**$ 6,208**	**$ 15,343**	**$ 16,228**
	Historical Years			Bridge Years	
CCRA	$ 16,903	$ (2,318)	$ (3,752)	$ 1,730	$ 4,400
Fleet Replacement	$ 1,258	$ 4,654	$ 5,440	$ 3,245	$ 3,002
Tools Replacement	$ 704	$ 564	$ 393	$ 927	$ 574
Buildings - Facilities	$ 555	$ 2,085	$ 2,208	$ 1,599	$ 523
Grid Technology	$ 514	$ 192	$ 443	$ 425	$ 377
Meter to Cash	$ 510	$ 1,383	$ 1,083	$ 252	$ 353
Customer Engagement Platform	$ 551	$ 1,189	$ 2,168	$ 2,589	$ 1,000
Enterprise Solutions	$ 968	$ 1,250	$ 1,795	$ 1,023	$ 670
Infrastructure and Cyber security	$ 1,261	$ 1,934	$ 1,922	$ 1,815	$ 911
Data and System Integrations	$ 49	$ 329	$ 446	$ 361	$ 368
TOTAL HISTORICAL/BRIDGE NET CAPITAL EXPENDITURES	**$ 23,273**	**$ 11,262**	**$ 12,146**	**$ 13,967**	**$ 12,179**
	Variance ($)				
CCRA	$ (15)	$ (2,528)	$ (3,952)	$ (3,400)	$ 200
Fleet Replacement	$ (4,989)	$ 128	$ 3,220	$ 1,564	$ 994
Tools Replacement	$ 230	$ 89	$ (69)	$ 462	$ 105
Buildings - Facilities	$ 127	$ 1,657	$ 1,805	$ 1,196	$ 120

Capital Program	2021	2022	2023	2024	2025
Grid Technology	$ 253	$ (235)	$ 172	-	$ 1
Meter to Cash	$ (2,019)	$ (855)	$ 479	$ (352)	$ (654)
Customer Engagement Platform	$ (374)	$ 766	$ 1,927	$ 2,368	$ 819
Enterprise Solutions	$ (170)	$ 506	$ 1,492	$ (3,909)	$ (4,843)
Infrastructure and Cyber security	$ (890)	$ 802	$ 747	$ 555	$ (844)
Data and System Integrations	$ (421)	$ 57	$ 117	$ 139	$ 52
TOTAL NET CAPITAL EXPENDITURES VARIANCE	**$ (8,267)**	**$ 388**	**$ 5,938**	**$ (1,376)**	**$ (4,049)**

5.4.2. Historical Variances

Over the five-year period, General Plant Net Capital Expenditures were $7.4M, or 9%, below the OEB Approved amount.

It is important to note that the CCRA capital program has a symmetrical Group 2 account[11] due to the sometimes unpredictable nature of costs and timing. Excluding the CCRA Program, the overall General Plant program is projected to exceed the OEB Approved budget by $2.3M, or 4%. This is attributed to several new required initiatives and inflationary pressures, partially offset by deliberate deferrals, such as the ERP Project, to mitigate the overall budget overrun.

General Plant also has an asymmetrical capital variance account, requiring any cumulative underspending to be returned to ratepayers. However, overspending does not result in amounts being recorded in this account. The variances discussed below are based on the total five-year variance by program (Table 32), while Table 33 shows annual variances. These annual variances are largely due to circumstances beyond Hydro Ottawa’s control, including the pandemic, significant supply chain disruptions, severe weather events in 2022 and 2023, and an 84-day strike in 2023. These disruptions during 2021-2023 resulted in underspending recorded

[11] Note: The Group 2 accounts reflect capital additions, while this schedule reflects capital expenditures. For capital additions information, refer to Schedule 2-1-1 Rate Base Overview

in the asymmetrical capital variance account, as noted in Schedule 9-1-3 - Group 2 Accounts. However, it is expected that the cumulative position at the end of 2025 will be a total overspend.

Key contributing factors:

- **Unforeseen Events:** COVID-19 pandemic, severe weather and the strike caused delays in some programs while other programs severe weather required additional spending in Grid Technology and influencing the deferral of the ERP project.
- **Changes in Project Scope or Requirements:** Evolving needs to meet new regulatory obligations and customer requirements.
- **Inflationary Pressures:** Significant increases in materials, outside services, vehicle costs and technology costs due to inflation were observed, for additional details refer to Section 4 of Schedule 1-2-5 - Impact of Inflationary Pressures).

CCRA

The CCRA Program is expected to be $9.7M below the total OEB Approved amount for 2021-2025. The largest contributors to this underage were the Hydro One payments associated with transmission upgrades for Cambrian MTS (the project was $5.6M under budget), and the A6R true-up, which was $2M under budget. As noted above please refer to Sections 2.3 and 2.4 of Schedule 9-1-3 - Group 2 Accounts, for further details on the CCRA deferral and variance accounts. The specific projects in this program during 2021-2025 are shown in Table 34.

Table 34 - 2021 - 2025 CCRA Payments ($'000s)

CCRA Payments	Historical Years			Bridge Years		Total
	2021	2022	2023	2024	2025	2021-2025
Richmond South DS	$ 33	-	-	-	-	$ 33
Cambrian MTS	$ 16,056	$ 113	$ (5,704)	-	-	$ 10,465
A6R Upgrade	-	$ (2,019)	-	$ 730	-	$ (1,289)
Merivale MTS Rebuild	$ (151)	-	-	-	-	$ (151)
Slater T1 Emergency	-	-	$ 504	-	-	$ 504
Limebank MS T4	$ 29	-	-	-	-	$ 29
Overbooke TO Switchgear Upgrade	$ 251	$ 339	$ 6	-	-	$ 595
Riverdale TR	-	-	-	-	$ 400	$ 400
Piperville MTS	-	-	$ 685	$ 1,000	$ 3,000	$ 4,685
Uplands MTS Rebuild	$ 2	$ 58	-	-	-	$ 60
Hawthorne 115 kV	$ 680	$ (891)	-	-	-	$ (211)
Lincoln Heights B2 Bus	$ 4	$ 82	$ 8	-	-	$ 95
Woodroffe TW Metering	-	-	$ 33	-	-	$ 33
Brian Colburn Station	-	-	-	-	$ 1,000	$ 1,000
Terry Fox MTS	-	-	$ 715	-	-	$ 715
TOTAL	**$ 16,903**	**$ (2,318)**	**$ (3,752)**	**$ 1,730**	**$ 4,400**	**$ 16,964**

Fleet Replacement

The Fleet Replacement Program is expected to be $0.9M or 5% above the 2021-2025 OEB Approved level. The cost overage is primarily a result of increased vehicle unit cost due to inflation and also the decision to replace some vehicles with electric or hybrid which typically carry a price premium. Hydro Ottawa received $0.1M in EV rebates on the purchase of E-Transit vans which is included under Capital Contributions. To offset some of the cost, nine vehicles slated for replacement during this period were deferred to a future period.

Tools Replacement

The Tools Program is expected to be $0.8M or 35% above the 2021-2025 OEB Approved level.

This overage is primarily driven by a higher than usual amount of tools with long lifespans reaching the end of their useful lives and requiring replacement. The original estimate was based on historical cost per employee and therefore did not capture the anomalous increase required in this period. The variance is further explained by the purchase of new defibrillators for fleet vehicles and a Customer Battery Pilot program, initiated during the COVID-19 pandemic to ease the burden of customers working from home during planned power outages. This program also experienced a number of general inflationary pressures.

Buildings - Facilities

The Buildings - Facilities Program is expected to be $4.9M or 237% above the 2021-2025 OEB Approved level. Capital expenditures were higher than planned due to the following projects that were not envisioned when the capital plan was developed for the 2021-2025 Custom IR Application:

- Construction of a shared access roadway at the East entrance to the Hunt Club Road facility - this was an externally driven project which was foreseen during the construction of the new facility, but was originally planned for construction after 2025. The third party developer subsequently advanced the construction schedule to 2022. Although ahead of schedule, this new roadway provides a secondary access point to the facility and operations center, which enhances site access and contributes to a safer and more efficient operational environment. The cost of this project was shared with the third party.
- To support the growth of Hydro Ottawa's electric vehicle fleet, charging stations were installed at all Operations Facilities. The decision to accelerate its electric vehicle purchases was driven by advancements in technology, availability, and more attractive pricing. The 2021-2025 application was prepared when suitable electric work vehicles were scarce and largely untested. The installation of charging stations was therefore a prerequisite for transitioning to electric vehicles. Hydro Ottawa received $0.3M in government funding for the charging stations, which is included under Capital Contributions.
- Lastly, two unforeseen health and safety hazards were reported that were required to be addressed in this period. One was a new HVAC/ventilation unit that was installed at the

Bank Street garage to address health and safety concerns and comply with Ministry of Labour standards for garage ventilation. The second was the creation of additional storage space to reduce trip hazards and congestion in the fleet garage, while also providing improved conditions for vehicle servicing and training.

Grid Technology

The Grid Technology - Operations Initiatives is projected to exceed the 2021-2025 OEB Approved level by an amount of $0.2M largely due to inflationary pressures.

Meter to Cash

The Meter to Cash Program is projected to be $3.4M, or 49%, below the 2021-2025 OEB Approved amount, primarily due to underspending on the AMI Analytics & Integration Enablement project.

The AMI Analytics & Integration Enablement project, as detailed in the 2021-2025 rate application, did not reach its planned expenditure due to unforeseen challenges and changing priorities. Significant delays, caused by external factors like the COVID-19 pandemic, the 2022 Derecho, and the 2023 strike, necessitated project scope and timeline adjustments. Concurrently, the evolving AMI landscape and the need for enhanced grid modernization capabilities prompted a reevaluation of the project's objectives.

In 2022, Hydro Ottawa successfully upgraded its critical smart meter data infrastructure from Elster MAS to Honeywell Connexo version 12.2. Originally estimated at $1.2M, the upgrade cost was reduced to $420,000 due to a negotiated discount. While initially planned for early 2021, the upgrade was delayed until March 2022 due to prolonged software product delays. A minor upgrade, typically scheduled every five years to mitigate technology obsolescence, cyber security risks, and escalating support costs, was planned for 2025. However, due to the Honeywell 12.2 product delay, this upgrade has been deferred to 2027 and aligned with the AMI 2.0 program.

Ultimately, Hydro Ottawa prioritized the development of a comprehensive AMI 2.0 Metering Renewal Program, ensuring investments were directed towards a future-proofed solution for long-term grid modernization and customer needs. For more information on the Metering Renewal Program, please refer to Section 5 of Schedule 2-5-7 - System Renewal Investments.

Customer Engagement Platforms

The $5.5M, or 277%, overage is primarily due to professional service fees for developing and enhancing Hydro Ottawa's customer portal, "MyAccount," for web and mobile applications. MyAccount is a key engagement channel, providing all customer classes with self-service tools for managing electricity usage, billing, payments, service requests, outage information, preference management, and moves. The portal had evolved organically over two decades, resulting in an interconnected system of multiple web and mobile technologies, services, and solutions. While this solution served the company well, rapid technological change, increasing customer experience demands, a dynamic energy industry, and Hydro Ottawa's continued growth rendered it unable to scale or adapt, making it inadequate for future needs.

Consequently, Hydro Ottawa opted to redesign its aging customer portal on a unified platform with a refreshed user interface, a new foundational architecture, a modernized technology stack, and a focus on enhanced customer experience. This new architecture will enable seamless integration of future enhancements and adaptation to evolving customer needs. The redesign also included a new administrator portal, improving agent experience and streamlining customer service. A proven implementation partner was selected to assist in the redesign, with scope and priorities overseen by the Customer Experience (CX) Steering Committee. This initiative, identified as a significant need after the 2021-2025 rate application filing, was not budgeted. The original budget only covered minor enhancements and support for the legacy platform and did not account for the redesign.

The stated scope was further expanded due to emerging regulatory obligations and necessary customer self-service enhancements. Examples include the implementation of Ultra-Low Overnight (ULO) rate options, Net Metering, Green Button, Equal Monthly Payment Plan

(EMPP) automation, Autopay registration, and Move In Move Out (MIMO) automation. This investment has positioned Hydro Ottawa to better meet customer needs, adapt to unforeseen disruptions, and demonstrates the company's commitment to continuous customer experience and engagement enhancement

Enterprise Solutions

Enterprise solutions are expected to be $6.9M or 55% below the OEB approved level primarily due to the deferral of the new Enterprise Resource Planning (ERP) system.

After careful consideration, Hydro Ottawa decided to defer its ERP program as initially planned over the 2021-2025 term. The original plan called for selection of new ERP software in 2023, design and execution in 2024 with a go-live launch at the end of 2025. Like many organizations, the global pandemic shifted priorities, caused supply chain challenges, cost constraints and more. Further, Hydro Ottawa experienced an unusual number of climate events including the May 2022 Derecho that had devastating impacts across the community necessitating a whole-of-company response shifting priorities once again. Additionally, in March 2023, collective bargaining talks broke down resulting in approximately 390 unionized staff commencing legal strike action a few months later, which lasted 84 days and shifted priorities once again. This, coupled with the findings on the asset management side that necessitated an Enterprise Asset Management (EAM) system which was not originally scoped in during the preliminary planning in 2018, alongside significant inflationary pressures in the technology space since COVID, would have resulted in a significant overrun on this project. Finally, Oracle announced that JD Edwards EnterpriseOne ERP (version 9.2) support would be extended to at least December 2035 (note that Oracle has been extending the support announcements since April 2017 when support was to be terminated in October 2028). Based upon all of these factors, coupled with the overspends in the other investment categories, management decided to defer the project.

Initially the ERP project was proposed for the 2026-2030 timeframe; however, given competing priorities it was decided Hydro Ottawa would continue to leverage its current JD Edwards ERP version for the 2026-2030 period but will focus on improving Enterprise Asset Management processes and technology (refer to Attachment 4-1-1(A) - Transition to Cloud Computing for additional details on the EAM system).

Offsetting this is a $2.7M investment in IT Service Management (Service Now) which includes subscription and professional services fees for three modules: ITSM, ITOM, and SPM. IT Service Management (ITSM) aimed to improve IT Helpdesk productivity and employee experience through a unified cloud and mobile solution. IT Operations Management (ITOM) focused on reducing cyber risk via centralized asset and configuration management. Strategic Portfolio Management (SPM) aimed to streamline IT business demand management and enhance project portfolio visibility. This investment modernized IT service management capabilities by replacing an aging on-premise ticketing system with the ServiceNow cloud platform, a need identified after the 2021-2025 rate application filing.

Infrastructure & Cyber Security

The Infrastructure & Cyber Security program is expected to be $0.4M or 5% above the OEB Approved amount for 2021-2025. The main drivers for the variance are due to inflationary costs of software licenses, computer equipment (laptops and mobile devices), network appliances including firewalls, switches, wireless access points and data center. License true-up costs related to Microsoft and other software also contributed to the increase.

Data and System Integrations

Data and System Integrations spending is not expected to have a material variance from the OEB Approved level.

5.4.3. Forecast to Historical Variance by Capital Program

The annual spend for General Plant is expected to average $26.8M (gross) over the 2026-2030 period, which is an increase from the $15.3M average annual spend during the 2021-2025 timeframe.

Table 35 below provides a comparison of the 2021-2025 historical period and the 2026-2030 forecast period, detailing both the five-year totals and annual averages for each program.

Table 35 – General Plant Forecast Expenditures Test Years Expenditures by Capital Program ($'000s)

Capital Program	Total			Average Annual		
	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance	2021-2025 Historical / Bridge Years	2026-2030 Test Years	Variance
CCRA	$ 16,964	$ 45,859	$ 28,895	$ 3,393	$ 9,172	$ 5,779
Fleet Replacement	$ 17,698	$ 40,593	$ 22,894	$ 3,540	$ 8,119	$ 4,579
Tools Replacement	$ 3,161	$ 4,878	$ 1,717	$ 632	$ 976	$ 343
Buildings - Facilities	$ 7,295	$ 6,551	$ (744)	$ 1,459	$ 1,310	$ (149)
Grid Technology	$ 1,952	$ 4,296	$ 2,345	$ 390	$ 859	$ 469
Meter to Cash	$ 3,582	$ 8,850	$ 5,268	$ 716	$ 1,770	$ 1,054
Customer Engagement Platform	$ 7,497	$ 2,522	$ (4,975)	$ 1,499	$ 504	$ (995)
Enterprise Solutions	$ 5,706	$ 1,429	$ (4,277)	$ 1,141	$ 286	$ (855)
Infrastructure and Cyber security	$ 10,999	$ 15,370	$ 4,371	$ 2,200	$ 3,074	$ 874
Data and System Integrations	$ 1,553	$ 3,482	$ 1,929	$ 311	$ 696	$ 386
TOTAL GENERAL PLANT	**$ 76,405**	**$ 133,830**	**$ 57,425**	**$ 15,281**	**$ 26,766**	**$ 11,485**
Capital Contributions[12]	$ (3,579)	$ (12,629)	$ (9,050)	$ (716)	$ (2,526)	$ (1,810)
NET GENERAL PLANT	**$ 72,827**	**$ 121,201**	**$ 48,375**	**$ 14,565**	**$ 24,240**	**$ 9,675**

Details on Hydro Ottawa's General Plant Capital Programs from 2026 through 2030 are included in Schedule 2-5-9 - General Plant Investments but a brief overview of the changes in spend between the historical period and the forecast period is provided below.

CCRA Payments

The annual spend for CCRA payments is expected to average $9.2M over the 2026-2030 period, which is an increase from the $3.4M average spend during the 2021-2025 timeframe. As

[12] Capital Contributions for Test Years 2026 and 2027 also include additions for PILS Contributions of $5,066 and $4,096 respectively. Please see Schedule 9-1-4 (section 7) and Schedule 6-1-1 (section 4) for further explanation.

with the previous, application, Hydro Ottawa has requested continuance of the deferral and variance account for this program, please refer to Schedule 9-1-3 - Group 2 Accounts.

This increase is primarily driven by the increased number of transmission upgrades required to service new and upgraded stations to support the growing community.

Fleet Replacement

The annual spend for Fleet Replacement is expected to average $8.1M over the 2026-2030 period which is an increase from the $3.5M average annual spend during the 2021-2025 timeframe. This increase is driven by two key factors: First, the need to support additional staff as detailed in Attachment 4-1-3(C) - Workforce Growth, requires additional vehicles. Second, a significant portion of the existing fleet is required to be replaced based on deteriorating condition as detailed in Section 11 of Schedule 2-5-9 - General Plant Investments.

Tools Replacement

The annual spend for Tools Replacement is expected to average $1.0M over the 2026-2030 period which is an increase from the $0.6M average annual spend during the 2021-2025 timeframe. This increase is driven by additional tool requirements to supply additional staff across the organization as indicated in Attachment 4-1-3(C) - Workforce Growth.

Buildings - Facilities

The annual spend for Buildings - Facilities is expected to average $1.3M over the 2026-2030 period which is a slight decrease from the $1.5M average annual spend during the 2021-2025 timeframe. Although on a net basis there is very little change on an annual basis, as the 2021-2025 average annual gross spend excludes $0.3M in government funding received to subsidize the cost of electric vehicle chargers. The Dibblee and Maple Grove Operations Centres were reclassified to the System Renewal Investment Category for better alignment with regulatory reporting requirements. Buildings - Facilities spending for 2026-2030 is driven by: interior improvements for new staff, sewer connection for the Bank St. facility, and electrical service upgrades for decarbonization and energy efficiency.

Grid Technology

The annual spend for Grid Technology is expected to average $0.9M over the 2026-2030 period which is an increase from the $0.4M average annual spend during the 2021-2025 timeframe. This increase is driven by a need to digitize and augment key functions like planning and design through data management, analytics, system integration, and grid simulation capabilities.

Meter to Cash

The annual spend for Meter to Cash is expected to average $1.8M over the 2026-2030 period which is an increase from the $0.7M average annual spend during the 2021-2025 timeframe. This increase is due to planned AMI critical infrastructure upgrades in 2027 and an upgrade to Hydro Ottawa's CC&B CIS system in 2028. For more information on the AMI 2.0 Metering Renewal Project, refer to Section 5 of Schedule 2-5-7 - System Service Investments. For more information on the AMI system and CC&B CIS upgrades, refer to Section 2 of Schedule 2-5-9 - General Plant Investments.

Customer Engagement Platform

The annual spend for Customer Engagement Platform is expected to average $0.5M over the 2026-2030 period which is a decrease from the $1.5M average annual spend during the 2021-2025 timeframe. This decrease is anticipated because the majority of the work required to redesign Hydro Ottawa's Customer Portal "MyAccount" was completed in the 2021-2025 timeframe.

Enterprise Solutions

The annual spend for Enterprise Solutions is expected to average $0.3M over the 2026-2030 period which is a decrease from the $1.1M average annual spend during the 2021-2025 timeframe. This decrease is anticipated because the majority of the work required to implement IT Service Management "ServiceNow" was completed in the 2021-2025 timeframe and as noted above the new ERP project was reprioritized beyond 2030.

Infrastructure and Cyber Security

The annual spend for Infrastructure and Cyber Security is expected to average $2.4M over the 2026-2030 period which is an increase from the $1.6M average annual spend during the 2021-2025 timeframe. These averages are net of the $3.2M and $3.5M Scientific Research and Experimental Development (SRED) tax incentive totals from the 2021-2025 and 2026-2030 periods, respectively. This increase is due to the expanded infrastructure footprint for both IT and Operational Technology (OT) as more technologies are required to support the current and future initiatives. See Section 2.3.4 of Schedule 2-5-1 - Distribution System Plan Overview for references to the National Cyber Threat Assessment 2025-2026 published by the Canadian Centre for Cyber Security and discussion supporting the need to combat increased cyber threats, particularly in areas of critical infrastructure such as the energy sector[13].

Data and System Integrations

The annual spend for Data and System Integrations is expected to average $0.7M over the 2026-2030 period which is an increase from the $0.3M average annual spend during the 2021-2025 timeframe. This increase is predominantly due to escalating requirements to connect IT/OT cloud and on-premise systems, to manage future data needs in support of grid modernization, customer experience initiatives and finally automations which drive productivity and operational efficiencies.

[13] Canadian Centre for Cyber Security, "National Cyber Threat Assessment 2025-2026," https://www.cyber.gc.ca/sites/default/files/national-cyber-threat-assessment-2025-2026-e.pdf

6. IMPACT ON OPERATION AND MAINTENANCE COSTS

6.1. OVERVIEW

System Operations and Maintenance (System O&M) expenditures are crucial for ensuring the reliable and safe operation of the electrical distribution system. The primary factors for these expenditures are asset and system maintenance needs, compliance obligations, and the resource requirements to handle a higher volume and greater complexity of work.

Capital investments, such as those for new equipment and upgrades, have an impact on System O&M costs. Table 36 presents the Total Gross Capital Expenditure and System O&M by Program. This table allows for a broad understanding of how capital spending and System O&M costs are distributed across various utility programs.

The programs encompassing system operations and maintenance costs for the 2021-2026 period are discussed at length in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs and this section should be read in conjunction with that schedule. Table 36 reflects System O&M costs only of these programs while the program costs in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs are total program costs including administrative costs. Note that the total in Table 36 below is also reflected in the Appendix 2-AB as System O&M and also the Operations and Maintenance subtotal in Appendix 2-JA. To provide a high-level overview of the relationship between capital expenditures and System O&M costs, the total gross capital expenditures are also reflected in Table 36 with System O&M shown as a percentage of the total gross capital expenditures. The percentage fluctuates largely due to storm activity and major event days and the reactive unplanned nature of those expenses.

1 **Table 36 – Total Gross Capital Expenditure and System O&M by Program ($'000s)**

Program	Historical Years			Bridge Years		Test Year
	2021	2022	2023	2024	2025	2026
Engineering & Design	$ 5,420	$ 5,861	$ 6,456	$ 7,549	$ 7,129	$ 13,232
System Ops & 24/7	$ 4,612	$ 9,323	$ 8,029	$ 5,976	$ 6,640	$ 6,423
Vegetation Management	$ 3,811	$ 6,720	$ 6,257	$ 6,430	$ 5,822	$ 6,149
Facilities	$ 4,946	$ 5,472	$ 4,753	$ 6,039	$ 6,223	$ 6,750
U/G Locates	$ 3,273	$ 3,538	$ 3,389	$ 4,666	$ 5,285	$ 6,027
Distribution Support	$ 251	$ 2,528	$ 3,922	$ 6,420	$ 4,789	$ 4,670
Distribution O/H & U/G Maintenance	$ 2,110	$ 2,591	$ 8,085	$ 3,070	$ 3,016	$ 2,714
Stations Maintenance	$ 2,670	$ 2,710	$ 2,888	$ 3,454	$ 4,167	$ 5,033
Testing, Inspection & Maintenance	$ 1,470	$ 1,433	$ 1,555	$ 2,221	$ 2,820	$ 8,894
Metering	$ 1,594	$ 1,910	$ 1,487	$ 1,876	$ 1,890	$ 1,970
Minor Maintenance	$ 1,297	$ 1,317	$ 1,250	$ 846	$ 990	$ 1,669
Other	$ 342	$ 377	$ 13	$ 72	$ 92	$ 259
Total System O&M	**$ 31,798**	**$ 43,779**	**$ 48,082**	**$ 48,619**	**$ 48,864**	**$ 63,790**
Total Gross Capital Expenditure	**$ 138,635**	**$ 137,808**	**$ 123,132**	**$ 173,403**	**$ 189,435**	**$ 309,118**
Total System O&M as a Percentage of Total Gross Capital Expenditure	22.9%	31.8%	39.0%	28.0%	25.8%	20.6%

The relationship between capital investments and ongoing System O&M is influenced by several key factors:

- **Scheduled Maintenance:** A portion of maintenance activities, as mandated by regulatory requirements such as the Distribution System Code, are performed on a predetermined schedule and are largely unaffected by capital investment decisions.
- **Asset Expansion:** An increase in the asset base typically results in a corresponding increase in System O&M requirements, including but not limited to, testing and inspections.

- **Technological Advancement:** The implementation of modern technologies may initially result in increased System O&M expenditures. However, these advancements can yield long-term System O&M efficiencies through features such as remote monitoring and diagnostic capabilities.

- **Asset Replacement and Lifecycle Management:** While the replacement of deteriorating assets with newer models generally results in reduced maintenance requirements, particularly during the initial phase of their lifecycle, the continuous cycle of asset replacement leads to a consistent influx of assets progressing through their respective lifecycles. Additionally, Hydro Ottawa's proposed asset replacement rate does not maintain pace with the rate at which assets are reaching their typical useful life. Consequently, as assets age and reach conditions of poor or very poor state, the volume of testing and inspection activities may increase to support the growing risk associated with the aging population. This dynamic reflects the ongoing management of an asset portfolio with varying stages of deterioration.

6.2. SYSTEM O&M ANNUAL VARIANCES

System O&M variances are also detailed and included in the overall program variances as detailed in Schedule 4-1-2 - Operating, Maintenance & Administration Program Costs and this section should be read in conjunction with that section.

During the 2021-2025 period, fluctuations in System O&M expenditures were primarily driven by factors such as the impacts of the COVID-19 pandemic, including the highest inflation Canada had seen in 40 years, the May 2022 Derecho storm, a series of other weather events, the 84-day labor strikes, investments in technology and other changes to distribution maintenance programs. For more information on the inflationary pressures over the 2021-2025, refer to Schedule 1-2-5 - Impacts of Inflationary Pressures.

- 2022 Actuals vs. 2021 Actuals
  - System O&M Expenditures were $12.0M higher in 2022 compared to 2021, largely due to the reactive maintenance costs and emergency vegetation following the May Derecho storm, as well as increases in distribution maintenance, and inflationary pressures.
- 2023 Actuals vs. 2022 Actuals
  - Expenditures were $4.3M higher in 2023 compared to 2022. While a portion of the previous year costs were non-recurring (May Derecho), numerous other weather events also occurred again in 2023 (April ice storm, summer lightning storms, tornadoes) increasing unplanned maintenance costs. Several storms, including the tornadoes, occurred during the labour strike, requiring the use of contracted resources and management to complete work.
- 2024 Bridge Year vs. 2023 Actuals
  - Expenditures are expected to be relatively unchanged from 2024 to 2023 on a total basis.
- 2025 Bridge Year vs. 2024 Bridge Year
  - Expenditures are expected to be relatively unchanged from 2025 to 2024 on a total basis.
- 2026 Test Year vs. 2025 Bridge Year
  - Expenditures are expected to increase $14.9M in the 2026 Test Year relative to the 2025 Bridge Year due to increased spend in the Testing, Inspection, & Maintenance program as Hydro Ottawa implements more comprehensive inspections, maintenance of Non-Wires Solutions, and asset refurbishments designed to extend typical useful life. For additional details, refer to Schedule 4-1-2 - Operating, Maintenance & Administration Program Costs. In addition, the development of a cloud-based Enterprise Asset Management solution also increases Engineering &

Design spending in 2026 (Refer to Attachment 4-1-1(A) - Transition to Cloud Computing for more details on this project).

6.3. 2026-2030 CAPITAL PROJECT IMPACTS ON SYSTEM O&M

Capital investment projects have varying impacts on System O&M costs depending on their nature. System Access, System Renewal, System Service and General Plant initiatives each present unique operational demands, sharing some common impacts on maintenance but also diverging in their specific requirements. For instance, while all capital projects might necessitate increased asset maintenance through expansion of the asset base, System Access drives O&M through new customer connections leading to increased service calls and underground locates, whereas System Renewal focuses on managing deteriorating infrastructure, leading to a rise in inspection and testing activities. The following sections provides a high level overview of the System O&M impacts by investment category:

6.3.1. System Access

The significant increase in System Access net capital investments, with an average annual expenditure of $39.2M (up from $31.7M in 2021-2025), is expected to drive increases in System O&M costs. Primarily, the rise in customer connection requests is expected to lead to higher System O&M expenditures through increased meter maintenance, more frequent service calls, and the need for additional locates. The expansion of the system, driven by large infrastructure projects and demand growth, will also necessitate higher System O&M due to the increased number of assets requiring testing, inspection and maintenance. Specifically, new generation connections will require ongoing maintenance of connection equipment, and the growth in metering installations will directly increase meter maintenance and testing costs. Plant relocation projects, while transitioning to a lower expenditure phase, will still contribute to System O&M through the maintenance of newly relocated or upgraded facilities. Overall, the significant growth in customer connections and system expansion will place upward pressure on System O&M costs.

6.3.2. System Renewal

Hydro Ottawa's renewal strategy faces a critical challenge: the rate of asset aging outpaces the pace of replacement, driving a significant increase in System O&M as shown in Table 36 above. Even with substantial renewal investments, the sheer volume of aging infrastructure demands more frequent and thorough inspections. While some aspects of the renewal program, such as station transformer and switchgear replacements, aim to reduce future maintenance needs, the overall portfolio of aging assets continues to expand. This expansion compels Hydro Ottawa to allocate more resources to proactive System O&M.

More specifically, the increasing number of aging poles and underground cables, even with ongoing replacements, significantly increases the need for rigorous inspection and data collection. This data is critical to pinpoint the most critical assets requiring immediate renewal. Without sufficient System O&M investment, the risk of unexpected failures and subsequent outages rises dramatically.

The focus is now on proactive data-driven maintenance. This involves more frequent inspections, advanced diagnostics, and detailed asset condition assessments. The goal is to gather comprehensive data that allows Hydro Ottawa to strategically deploy its limited renewal funds, targeting the assets that pose the greatest risk. This approach allows for intervention before failures occur, minimizing disruptions to customers.

Hydro Ottawa is adapting to a reality where the rate of asset aging outpaces the rate of replacement. This adaptation requires a strategic increase in System O&M funding, enabling more frequent inspections and data collection. This proactive approach ensures the system's reliability and allows for the most efficient use of renewal dollars, ultimately safeguarding the continuity of power for Ottawa's residents and businesses.

6.3.3. System Service

The significant increase in System Service net capital investments, averaging $93.8M annually (up from $32.2M in 2021-2025), is also expected to increase System O&M. Capacity upgrades, driven by demand growth and electrification, will lead to higher costs associated with the increased System O&M requirements of higher-capacity equipment. Distribution and station enhancements, including investments in system resilience and observability, will also increase System O&M through the maintenance of new assets and the implementation of advanced monitoring systems. The addition of Battery Energy Storage Systems (BESS) will increase System O&M costs primarily due to the specialized upkeep related to the systems. The need for regular software updates, robust cyber security monitoring, and specialized IT support for sophisticated control systems further contributes to rising OM&A expenses. Safety and environmental compliance demands dedicated safety systems and adherence to regulations, while continuous monitoring and data analysis for optimal performance require specialized expertise and tools, often involving third-party contracts. The integration of BESS into existing grid operations adds operational complexity, demanding specialized training and adjustments. Furthermore, the necessity of service contracts to monitor and maintain these complex systems must also be accounted for. The expansion of the field area network and the implementation of control and optimization systems will also increase System O&M through the maintenance of communication infrastructure and the operation of advanced grid management tools. Overall, the substantial investments in system service will drive a significant increase in System O&M costs, reflecting the need to support a more complex and technologically advanced electrical grid.

6.3.4. General Plant

The increase in General Plant gross capital investments, averaging $26.8M annually (up from $15.3M annually in 2021-2025), is expected to have a modest impact on System O&M costs. The increased number of fleet vehicles will incur a higher amount of maintenance and fuel costs, although the addition of electric vehicles and the pooling of vehicles (discussed in Schedule 2-5-9 - General Plant Investments) are expected to offset a portion of these costs.

6.4. OTHER SYSTEM O&M FACTORS

Beyond the direct impacts of capital investments, several other factors also influence the overall level of System O&M costs. These include evolving inspection and maintenance practices, vegetation management strategies, and the operational demands of underground locate services. Each of these elements introduces unique cost considerations and operational complexities that contribute to the comprehensive picture of System O&M expenditures. Further details are provided in Schedule 4-1-2 - Operating, Maintenance & Administration Program Costs.

6.4.1. Inspections and Maintenance

Hydro Ottawa is enhancing its Testing, Inspection, and Maintenance (TIM) program to proactively address deteriorating infrastructure and evolving environmental conditions. The program will leverage advanced data collection and analysis techniques, including drone inspections and comprehensive asset health indexing, to transition from time-based to condition-based maintenance. This data-driven approach allows for more accurate condition assessments and targeted interventions, extending the useful life of assets and mitigating reliability risks.

Key initiatives include:

- **Comprehensive Inspection Programs:** Implementing detailed thermographic inspections and advanced techniques for underground cables (Very Low Frequency Tan-Delta, Partial Discharge, and Time Domain Reflectometry) to identify vulnerabilities.
- **Data Collection Enhancements:** Capturing detailed visual and infrared scan information of asset components, including pole-mounted transformers, switches, and vault equipment.
- **Innovation through Technology:** Piloting drone inspections and exploring the use of artificial intelligence for enhanced condition assessment.
- **Asset Intervention/Refurbishment Strategies:** Implementing proactive maintenance for targeted replacement of degrading components, such as bushings, insulators, and splices.

The increased investments in the TIM program will improve asset health data. The transition to a condition-based maintenance program, supported by an Enterprise Asset Management (EAM) solution, will optimize asset lifecycle management and enable data-driven decision-making and further improve the advanced analytics from Copperleaf PA.

6.4.2. Vegetation Management

Hydro Ottawa will leverage Overstory, a software solution that uses AI and remote sensing, to optimize vegetation management practices. This will enhance reliability and cost-effectiveness by enabling data-driven decisions to prioritize routine tree-trimming based on current conditions, mitigating the risks posed by hazardous trees and thereby reducing both reactive maintenance and the number of outages caused by tree contact. System O&M costs for vegetation management are not expected to decrease in the 2026-2030 rate period, as Hydro Ottawa contends with the long-term impacts of the 2022 and 2023 storms. These storms compromised tree health, which contributed to an elevated level of spending to address the damage.

6.4.3. Underground Locates

Bill 93, the Getting Ontario Connected Act, 2022, has increased Hydro Ottawa's operational expenditures to meet legislated timelines. The limited number of qualified service providers in the region creates a less competitive market for underground locate services, impacting pricing. However, using a third-party clearing house to verify underground infrastructure presence has reduced on-site visits and yielded significant cost savings. Despite these savings, System O&M costs are still increasing significantly due to inflation, rising contractor costs driven by mandated timelines, and increased volume.

Attachment 2-5-5 (A) - OEB Appendix 2-AA - Capital Programs Table

(Refer to the attachment in Excel format)

Attachment 2-5-5 (B) - OEB Appendix 2-AB - Capital Expenditure Summary

(Refer to the attachment in Excel format)

SYSTEM ACCESS INVESTMENTS

1. SUMMARY

Hydro Ottawa's planned System Access Capital Investments for 2026-2030 total $173.2M, focusing on five key programs designed to enhance grid reliability, accommodate growth, and support a sustainable energy future. These investments are fundamental to ensuring the safe and reliable delivery of electricity, while delivering tangible benefits to customers, supporting new developments, facilitating renewable energy integration, and enhancing metering accuracy.

System Access Capital Programs:

Section 2. Plant Relocation & Upgrade ($15.1M):

This program funds the relocation or upgrade of Hydro Ottawa-owned or joint-use overhead or underground equipment for third-party infrastructure projects, primarily by the City of Ottawa. This is driven by road widening and other development projects that conflict with existing Hydro Ottawa infrastructure. The program aims to meet regulations, improve system efficiency, and enable economic development.

Section 3. Customer Connections ($97.1M):

This program ensures new and modified customer connections, including residential subdivisions (townhomes, semi-detached, singles, or mixed), commercial developments (underground or vault equipment service), and infill services, are seamlessly integrated into the distribution grid, fulfilling mandated service obligations. The program involves installing transformers, lines, switchgear, and metering infrastructure, and may require roadwork and civil works.

Section 4. System Expansion ($59.2M):

System expansions are initiated when capacity constraints in Hydro Ottawa's infrastructure necessitate upgrades or additions to accommodate new customers or support existing customer service upgrades. Investments may involve upgrading feeders, transformers, or substations to ensure reliable power supply. Driven by customer service requests, particularly the growing number of large load requests, and Hydro Ottawa's legal obligation to fulfill connection requests, this program aims to ensure timely and efficient customer connections.

Section 5. Generation Connections ($0.1M):

Hydro Ottawa's Generations Connections program facilitates integrating customer owned Distributed Energy Resources (DERs) into the distribution grid, complying with regulations and ensuring system reliability and safety. The program covers infrastructure upgrades and streamlined connection processes.

Section 6. Metering ($1.7M):

Hydro Ottawa's Metering Program invests in metering technology, including Suite Metering for multi-unit buildings.

These investments are fundamental to achieving the following benefits to Hydro Ottawa's customers:

- **Enhanced Reliability:** Investing in grid expansion will result in a more robust and resilient electricity grid.
- **Support for Growth & Development:** Facilitating new customer connections and upgrades ensures that businesses and residents have access to the essential electricity services needed to thrive, contributing to a vibrant and prosperous community.
- **Enabling a Cleaner Energy Future:** By supporting the integration of renewable energy sources, Hydro Ottawa empowers customers to participate in the transition to a more sustainable energy future, reducing greenhouse gas (GHG) emissions and fostering environmental responsibility.
- **Improved Accuracy & Transparency:** The deployment of advanced metering infrastructure will enhance the accuracy and transparency of electricity measurement, providing customers with greater insights into their energy consumption patterns and enabling them to make informed decisions about their energy use.

Hydro Ottawa acknowledges the challenges inherent in implementing these investment programs, including the need to modernize deteriorating infrastructure, manage increasing electricity demand, navigate the complexities of integrating renewable energy sources, and mitigate the impacts of climate change on grid resilience. This document provides a detailed overview of each program and outlines how Hydro Ottawa will proactively address these challenges to deliver safe, reliable, and sustainable electricity service to the residents and businesses of the City of Ottawa and the Municipality of Casselman.

2. PLANT RELOCATION & UPGRADE

2.1. PROGRAM SUMMARY

Investment Category: System Access

Capital Program Costs:

2021-2025: $22.0M

2026-2030: $15.1M

Budget Program: Plant Relocation and Upgrades

Main Driver: Third Party Requirements

Secondary Driver: Capacity Constraints

Outcomes: Public Policy Responsiveness, Operational Effectiveness

Hydro Ottawa's Plant Relocation and Upgrade program includes projects to relocate existing plant equipment to enable infrastructure projects undertaken by third party agencies (e.g. the City of Ottawa and Municipality of Casselman, Ministry of Transportation of Ontario, National Capital Commission). Relocations are required when conflicts exist between existing utility infrastructure and proposed third party capital projects. To maximize construction efficiencies and minimize future service disruptions, utility equipment upgrades are sometimes prioritized over like-for-like relocations.

Third-party requests for relocations are primarily the result of City of Ottawa infrastructure projects. Due to these projects being entirely dependent on third-party plans and schedules, expenditure forecasting is challenging, as Hydro Ottawa does not control the timing and scope. However, Hydro Ottawa collaborates with the City of Ottawa to understand their infrastructure plans and develops a Plant Relocation and Upgrade program forecast that aligns with those plans. For example, Hydro Ottawa reviews development applications (e.g. site plans and zoning amendments) within city rights-of-way and participates in the monthly Utility Coordinating Committee (UCC) to discuss joint planning of development projects. Hydro Ottawa also collaborates with large developers to gain information on development of large commercial, government, or industrial facilities with building footprints which can result in relocations.

Critically, transportation development projects such as the Ottawa Light Rail Transit (LRT) expansion requires significant infrastructure upgrades and relocations of Hydro Ottawa infrastructure, which are factored into the Distribution System Plan (DSP), including load growth projections, infrastructure upgrades, and budget forecasts for this program, see more details in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties. Hydro Ottawa also forecasts for this budget program to align with road widening projects laid out in the City of Ottawa Transportation Master Plan as part of the "Affordable Road Network"[1] initiative. As such, spending in this category is based on historical averages, the scope and timing of larger City of Ottawa projects, and appropriate inflation adjustments.

In total, Hydro Ottawa proposes to invest $15.1M in plant relocation in the 2026-2030 rate period compared to Historical and Bridge Year spending of $22M in the 2021-2025 period. The decline in the required investment in relocation projects is largely driven by the completion of the LRT Phase 2 project.

2.2. PERFORMANCE OUTCOMES

The following outcomes are expected to be achieved through the Plant Relocations and Upgrades program, as outlined in Table 1 below.

Table 1 - Plant Relocations and Upgrades Program Performance Outcomes

OEB Performance Outcomes	Outcome Description
Public Policy Responsiveness	Meet Regulatory Compliance by conforming to Public Service Work on Highways Act[2] (PSWHA) mandates and City of Ottawa regulations
	Identified public safety concerns will be addressed in the scope of work for plant relocation
Operational Effectiveness	Improve system efficiency by upgrading equipment that is being relocated when applicable

[1] City of Ottawa, *Transportation Master Plan*, Exhibit 7.2 2031 Affordable Road Network- Project By Phase (November 2013). Page 70
[2] Public Service Works on Highways Act of Ontario, R.S.O. 1990, c. P.48.

2.3. PROGRAM DRIVERS AND NEED

2.3.1. Drivers

Primary Driver: Third Party Requirements

Under the PSWHA, Hydro Ottawa is mandated to work with public entities requesting infrastructure relocations and respond in a timely manner to facilitate the maintenance and improvement of public infrastructure. Consequently, the primary driver for Hydro Ottawa's relocation work stems from the statutory framework established by this Act.

The 2026-2030 Plant Relocation and Upgrade program is a direct result of the planned road widening projects identified in the City of Ottawa's Transportation Master Plan as part of the "Affordable Road Network" initiative[3]. The following infrastructure projects, forecast by the City of Ottawa for completion during the 2026-2030 rate period, have been identified as impacting Hydro Ottawa's infrastructure:

- **Bank Street -** Planned road widening from two to four lanes between the Earl Armstrong Rd. extension and Rideau Rd.
- **Prince of Wales Drive -** Planned road widening from two to four lanes between Hunt Club Road and Merivale Road
- **Preston Street -** Planned road extension of the existing two-lane urban roadway from Albert Street to Vimy Place (at Kichi Zībī Mīkan)

Secondary Driver: Asset Condition and Lifecycle Optimization

Beyond mandated relocations, Hydro Ottawa proactively addresses asset condition and lifecycle during relocation projects. When a project necessitates a relocation, it presents an opportunity to assess the existing infrastructure's condition and potential for optimization. Each relocation project is evaluated to determine if efficiencies can be achieved by increasing asset capacity, upgrading the infrastructure, or implementing lifecycle improvements, rather than simply replacing assets in kind.

[3] City of Ottawa, *Transportation Master Plan*, Exhibit 7.2 2031 Affordable Road Network- Project By Phase (November 2013). Page 70

For example, several significant projects during the 2026-2030 period anticipated to require plant relocation in conjunction with necessary system expansion include:

- The OC Transpo's Zero Emission Bus Project [4]
- Department of National Defence (DND) Dwyer Hill Training Center Upgrade Project [5]
- The Ottawa Hospital's New Campus Project [6]

Where an upgrade or lifecycle improvement yields a benefit or efficiency, Hydro Ottawa will contribute capital towards the relocation project costs. This approach ensures that relocations serve not only to address immediate needs, but also to enhance the long-term performance and sustainability of Hydro Ottawa's infrastructure.

2.3.2. Current Issues

The City of Ottawa's growth has led to a greater volume of infrastructure relocation requests for Hydro Ottawa. In recent years, Hydro Ottawa has received pole relocation requests for projects such as LRT Phase 2, Montreal Road revitalization, and post-LRT Phase I rehabilitation work on Slater Street and Albert Street. Going forward into the 2026-2030 period, the main sources for relocation work is expected to come from road widening projects as well as large developments in Hydro Ottawa's service territory.

2.4. PROGRAM BENEFITS

2.4.1. System Operation Efficiency and Cost Effectiveness

Integrating capacity upgrades with mandated plant relocations enhances system reliability, improves operational flexibility, and maximizes cost efficiencies. This approach minimizes operational constraints for system operators during planned and emergency switching.

[4] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/our-services/vehicles/zero-emission-bus/
[5] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/
[6] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/

2.4.2. Customer Benefits

This program will minimize disruption to Hydro Ottawa customers by providing timely and coordinated execution of Hydro Ottawa infrastructure relocations requested by third parties.

2.4.3. Coordination and Interoperability

This program prioritizes coordination and interoperability through proactive stakeholder engagement, data sharing, and adhering to industry standards. This collaborative approach ensures efficient project delivery, minimizes disruptions, and enhances safety for both workers and the public.

2.4.4. Economic Development

This program will enable economic development by addressing infrastructure conflicts that necessitate the relocation of Hydro Ottawa plant for third-party capital projects.

2.5. PROGRAM COSTS

The annual costs for the Plant Relocation and Upgrade program is expected to average $3.0M per year over the 2026-2030 period which is a decrease from the $4.4M average annual costs during the 2021-2025 timeframe. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to be $15.1M compared to $22.0M in the 2021-2025 period. Between 2021 and 2025, program spending was higher than usual due to the utility relocation work associated with the City of Ottawa's LRT Phase 2 project. These relocation costs were significantly above historical averages for Hydro Ottawa. Looking ahead, expenditures are projected to normalize for the 2026-2030 period.

Table 2 presents the Historical, Bridge and Test Year expenditures for the Plant Relocation and Upgrade program.

Table 2 - Historical, Bridge and Test Year Plant Relocation Costs ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Plant Relocation & Upgrades - Gross	$ 10.0	$ 7.6	$ 8.2	$ 10.2	$ 8.6	$ 6.6	$ 6.7	$ 7.1	$ 7.2	$ 7.4
Contributed Capital	$ (5.8)	$ (3.9)	$ (5.2)	$ (4.3)	$ (3.9)	$ (3.8)	$ (3.8)	$ (4.0)	$ (4.1)	$ (4.2)
Contributed Plant	$ 0.5	-	-	-	-	-	-	-	-	-
ANNUAL TOTAL	**$ 4.7**	**$ 3.7**	**$ 2.9**	**$ 5.9**	**$ 4.8**	**$ 2.8**	**$ 2.9**	**$ 3.1**	**$ 3.1**	**$ 3.2**
5-YEAR TOTAL					**$ 22.0**					**$ 15.1**

The Plant Relocations and Upgrade program cost has been forecasted assuming customer contributions (i.e. contributed capital) remain at 66% of gross project cost based on the Historical contribution averages from 2021 to 2023. Likewise, the gross expenditure cost has been calculated based on average project volumes (excluding discrete planned projects) for the 2024 and 2025 years, with addition of discretely planned projects in the 2026-2030 period such as:

- Bank Street - Planned road widening from two to four lanes between the Earl Armstrong Rd. extension and Rideau Rd.
- Prince of Wales Drive - Planned road widening from two to four lanes between Hunt Club Road and Merivale Road
- Preston Street - Planned road extension of the existing two-lane urban roadway from Albert Street to Vimy Place (at Kichi Zībī Mīkan)

While future growth is expected, it is not anticipated to have the same concentrated impact on the Plant Relocations and Upgrade program as LRT Phase 2. The cost factors detailed in Section 2.5.1 below may cause deviations from this forecast. Hydro Ottawa will continue to monitor changes to infrastructure programs to ensure electrical infrastructure development keeps pace with the city's evolving needs.

2.5.1. Cost Factors

- Large unplanned infrastructure projects which require relocation of Hydro Ottawa assets
- Cancellation of discrete planned infrastructure projects driven by third parties
- Project complexity
- Technical challenges
- Skilled labour availability
- Material and equipment costs

2.6. ALTERNATIVES EVALUATION

2.6.1. Alternatives Considered

Alternative One: Do Nothing

The "do nothing" alternative is not viable. Hydro Ottawa is legally obligated under the PSWHA to cooperate with public entities requesting infrastructure relocations. This Act mandates a timely response to facilitate the maintenance and improvement of public infrastructure. Therefore, regardless of other considerations, Hydro Ottawa must relocate infrastructure when required by public projects, making some level of investment unavoidable.

Alternative Two: Project-specific Relocations in Response to Third-Party Requirements

Hydro Ottawa will implement relocations as required by specific third-party projects. This approach ensures that relocations are carried out in direct response to identified needs, aligning with regulatory obligations.

However, recognizing potential opportunities for system improvement, Hydro Ottawa will evaluate each relocation project on a case-by-case basis to determine if targeted upgrades can be efficiently integrated. If an opportunity arises where an upgrade can yield significant benefits, Hydro Ottawa will consider incorporating it into the relocation plan.

2.6.2. Evaluation Criteria

The alternatives were evaluated on the basis of:

- **Regulatory Compliance:** The program must consistently meet all legislative and regulatory requirements. This criterion assesses how well each alternative adheres to all applicable laws, regulations, and industry standards. This includes, but is not limited to, the PSWHA which mandates cooperation with public entities for infrastructure relocations, and any other relevant provincial or federal mandates governing utility operations and infrastructure adjustments. As a regulated utility, Hydro Ottawa must prioritize compliance to ensure legal operation and maintain public trust. Failure to comply with regulations can result in legal challenges, fines, and reputational damage.
- **Economic Development:** The program should contribute to the City of Ottawa's growth and sustainability. This criterion evaluates the program's contribution to the economic growth and sustainability of the City of Ottawa. This includes supporting development projects, enabling business expansion, and fostering stable and reliable electrical infrastructure that attracts investment and supports job creation. A robust and adaptable electrical grid is essential for economic development. Infrastructure relocations and upgrades can facilitate new construction, business operations, and the expansion of services, contributing to the overall economic health and vitality of the city.
- **Environmental Sustainability:** The program should promote environmental sustainability by supporting electrification, renewable energy integration, and energy efficiency. This criterion examines the program's impact on environmental sustainability, including its support for electrification (transitioning to electric vehicles (EV) and electric heating systems), renewable energy integration (connecting solar and wind power to the grid), and energy efficiency initiatives. Hydro Ottawa has a responsibility to contribute to a cleaner environment. By considering these factors in relocation projects, the program can help reduce GHG emissions, promote the use of clean energy sources, and improve overall energy efficiency.
- **Community Benefits:** The program should enhance community well-being through grid resilience and support for sustainable development initiatives. This criterion assesses the program's contribution to community well-being, focusing on grid resilience (ability to withstand and recover from disruptions), reliability of service (minimizing outages), and

support for sustainable development initiatives that enhance quality of life, such as community energy projects or initiatives that promote equitable access to reliable electricity. A reliable and resilient electrical grid is vital for community well-being. It ensures essential services remain operational, supports community initiatives, and enhances the overall quality of life for residents.

Evaluating the alternatives against these criteria will ensure that the program effectively meets its objectives, contributes to the City of Ottawa and Municipality of Casselman's growth and provides reliable and efficient electrical service to customers.

2.6.3. Preferred Alternative

Alternative one fails to meet the Regulatory Compliance criterion. By not participating in relocation projects, Hydro Ottawa would be in violation of the PSWHA and potentially other legal requirements, leading to penalties and reputational damage. It also does not contribute to Economic Development, Environmental Sustainability, or Community Benefits.

Alternative two fully satisfies the Regulatory Compliance criterion by ensuring that Hydro Ottawa fulfills its legal obligations. It supports Economic Development by enabling infrastructure adjustments necessary for construction and expansion projects. While primarily reactive in nature, it allows for potential Environmental Sustainability benefits by considering targeted upgrades that could support electrification or renewable energy integration. Similarly, it contributes to Community Benefits by maintaining reliable service and considering upgrades that enhance grid resilience.

Based on the evaluation criteria, Alternative two: Project-Specific Relocations in Response to Third-Party Requirements is the preferred alternative. It balances the need to meet regulatory requirements with the flexibility to pursue upgrades that enhance the grid's capacity, resilience, and sustainability. This approach allows Hydro Ottawa to respond effectively to relocation requests while also contributing to the economic, environmental, and social well-being of the City of Ottawa.

2.7. PROGRAM EXECUTION AND RISK MITIGATIONS

2.7.1. Implementation Plan

All plant relocation work will adhere to PSWHA-mandated timelines and will be processed sequentially, based on the order in which requests are received.

2.7.2. Risks To Completion and Risk Mitigation Strategies

The Plant Relocation and Upgrade program, being contingent upon third-party projects, presents several potential risks to Hydro Ottawa. Table 3 provides a summary of these key risks and the corresponding mitigation strategies.

1 **Table 3 - Plant Relocation and Upgrade Program Key Risks and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to third party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies, and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

3. CUSTOMER CONNECTIONS

3.1. PROGRAM SUMMARY

Investment Category: System Access

Capital Program Costs:

2021-2025	$68.8M
2026-2030	$97.1M

Budget Program: Residential Subdivisions, Commercial Developments, Infill Services

Main Driver: Customer Service Request

Secondary Driver: Mandated Service Obligations

Outcomes: Customer Focus

The Customer Connection program comprises the following budget programs, designed to address the needs of specific customer load types:

Residential Subdivision Program – This program addresses connections for new residential subdivisions, encompassing a range of housing types, including townhomes, semi-detached units, and single-family homes. These connections are essential for supporting residential growth and development.

Commercial Developments Program – This program addresses connections for commercial developments, which are characterized by their scale and complexity, necessitating substantial electrical infrastructure. Projects under this program are typically served using pad-mounted or vault equipment to accommodate their higher energy demands. The use of this specialized equipment contributes to the higher project costs.

Infill (Residential & Small Commercial) Program – This program encompasses projects to accommodate service connections and service upgrades for residential or small commercial developments located within established urban areas. These projects typically do not necessitate the installation of pad-mounted or vault equipment.

The Customer Connection Program includes investments required by Hydro Ottawa to facilitate customer access to its distribution system in response to the growth projections for the City of Ottawa. This program is required to ensure new and modified load connections are seamlessly integrated into the distribution grid. Hydro Ottawa's program is structured to meet its mandated service obligations as set out in the Distribution System Code (DSC), *Electricity Act, 1998* (Electricity Act), Ontario Energy Board Act 1998 (OEB Act), and Hydro Ottawa's Conditions of Service (COS). These investments enable Hydro Ottawa to meet its commitments for reliable, safe, and efficient access to its distribution system, supporting customer growth and development. The program addresses evolving customer demands and ensures that the necessary infrastructure is in place to support both current and forecast load requirements. Customer Connection projects are customer driven and may include a customer contribution. The determination of these contributions is guided by the OEB's prescribed economic evaluation methodology, which is designed to assess the financial implications and ensure equitable cost-sharing between the utility and the customer.

In total, Hydro Ottawa plans to invest $97.1M in the Customer Connections program in the 2026-2030 period, compared to $68.8M during the 2021-2025 period. The projected increase in investment in the Customer Connections program is primarily attributable to the growing volume and complexity of connection requests, necessitated by continued community growth and development. Growth in residential connections is driven by projected population increases and the associated expansion of housing and employment opportunities. Commercial connection growth is driven by the City of Ottawa's transit-oriented development strategy, including its planned transition to a fully electric bus fleet. This transition involves targeting 354 electric buses by 2027 and achieving complete electrification by 2036. An increase in confirmed customer commitments to large load requests (5 MVA and above) and the broader energy transition, which is increasing demand for EV charging stations and transit infrastructure, such as new warehouses, are also contributing factors. The volume of infill projects is driven by the City of Ottawa's intensification plans, which promote development within existing urban areas. For details refer to Section 6.5 of Schedule 2-5-4 - Asset Management Process.

3.2. PERFORMANCE OUTCOMES

The Customer Connections program expenditures are necessary for Hydro Ottawa to fulfill its mandated service obligations, as defined in Section 7.2 - Customer Connections of the DSC, the Electricity Act, and the OEB Act .

The following outcomes are expected to be achieved through the Customer Connections program, as outlined in Table 4 below:

Table 4 - Customer Connections Program Performance Outcomes

OEB Performance Outcomes	Outcome Description
Customer Focus	This program directly contributes to Hydro Ottawa's customer focus objectives by efficiently fulfilling customer service requests and ensuring compliance with mandated service obligations, as well as Hydro Ottawa’s COS and Electricity Distribution License. Specific mandated service obligations, as tracked by the Utility Scorecard, are detailed in Attachment 1-3-3(C) - Electricity Utility Scorecard Benchmarking Analysis. Successful execution of this program is essential for maintaining high levels of customer satisfaction and meeting regulatory requirements.

3.3. PROGRAM DRIVERS AND NEED

3.3.1. Drivers

Primary Driver: Customer Service Request

Demand requests made by customers constitute the primary reason for new development connections to the distribution grid. Each project, encompassing residential subdivisions, commercial developments, or infill services, presents distinct requirements with respect to electricity load, infrastructure, and connection timelines. These requirements are specified by the customer to ensure alignment with their respective development plans and schedules.

Hydro Ottawa anticipates an increase in customer connection (service) requests, linked to Ottawa's ongoing growth and development initiatives. From 2021 to 2023, Hydro Ottawa experienced annual averages of 6,067 residential customer connections, 143 commercial customer connections, and approximately 3,628 infill related service requests (encompassing new service connections and service upgrades). Notably, a single request can involve multiple services or accounts, particularly for residential subdivisions, multi-unit residential buildings, and commercial developments.

Looking ahead, customer connection requests are projected to increase further in correlation with Ottawa's continued growth, spurred by development initiatives, large load requests, intensification efforts, and electrification trends. As detailed in Section 2.3.1 of Schedule 2-5-1 - Distribution System Plan Overview, since 2018 Hydro Ottawa has observed a significant increase in connection requests and inquiries from large-load customers (5 MVA and above).This upward trend is corroborated by historical data on the conversion rate of initial customer requests and inquiries into confirmed customer commitments (Signed Offers to Connect), as detailed in Section 9.4.1.1 of Schedule 2-5-4 - Asset Management Process.

Key factors contributing to this anticipated increase include:

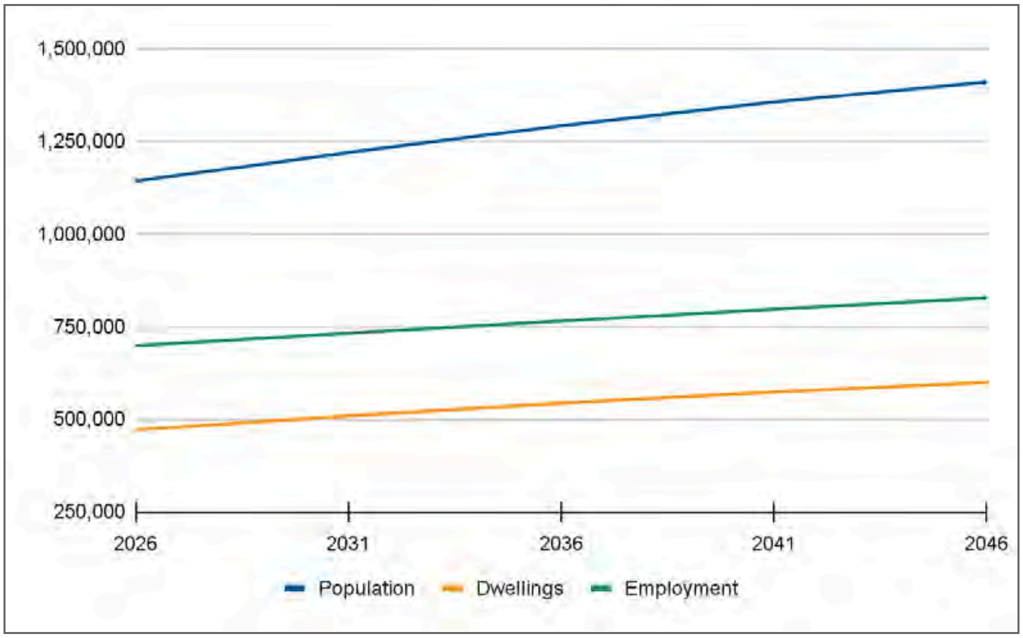
- **Residential Growth:** Driven by forecasted population increases, the resulting expansion of housing and employment opportunities is expected to fuel a rise in residential connection requests. This trend is visually represented in Figure 1, which illustrates the City of Ottawa's population projections[7].
- **Commercial Developments:** The City of Ottawa's transit-oriented development strategy, including its plan to transition to a fully electric bus fleet (354 electric buses by 2027, full electrification by 2036), is a key driver of growth in commercial connections. Further contributing to this growth are the rising number of large load requests (5 MVA and above) and the broader energy transition, which is fueling demand for EV charging stations and transit infrastructure.

[7] City of Ottawa, "Growth projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93

- **Infill Development:** The City of Ottawa's intensification plans, which encourage development within existing urban areas, drive new infill connections. These plans promote higher-density development and the efficient use of existing infrastructure, leading to increased demand for infill service connections and upgrades.

For further details refer to Section 6.5 of Schedule 2-5-4 - Asset Management Process.

Figure 1 - City of Ottawa Growth Projections



Secondary Driver: Mandated Service Obligation

Hydro Ottawa is obligated, under the DSC, the Electricity Act , the OEB Act , and Hydro Ottawa's COS, to fulfill connection requests or provide an offer to connect to any customer within its service territory.

3.3.2. Current Issues

Hydro Ottawa faces several key challenges in managing new and modified customer connections, impacting its ability to efficiently and effectively serve the growing City of Ottawa:

- **Electrification and Emerging Technologies Challenges:** Hydro Ottawa faces significant challenges due to the increasing electrification of Ottawa, driven by national and municipal climate targets, and the emergence of new energy technologies. These trends are significantly increasing electricity demand, particularly in transportation and space heating, straining existing infrastructure and requiring substantial upgrades. The Customer Connection program includes necessary investments to facilitate customer access to the distribution system and seamlessly integrate new and modified load connections, but these upgrades are further complicated by the added demands of electrification. The rise of EV charging infrastructure adds further complexity, demanding strategic planning and load management. Integrating DERs requires advanced grid management capabilities. These converging trends necessitate proactive planning and strategic investment in the grid to ensure continued reliable service. Without a proactive approach, Hydro Ottawa risks falling behind, potentially leading to service disruptions, increased costs, and hindering Ottawa's transition to a sustainable energy future.
- **Responding to Changing Customer Needs:** Responding to changing customer requests presents a significant challenge to Hydro Ottawa's efficient and effective service delivery in a growing city. While the Customer Connection program facilitates customer access to the distribution system and integrates new and modified load connections, modifications to customer load requirements or energization dates necessitate costly redesigns of infrastructure plans, impacting equipment needs, labor, and project schedules. These changes create project management complexities, requiring a highly flexible and responsive planning process within the Customer Connection program framework. The resulting cost increases, due to redesigns, material changes, and potential project acceleration or delays, impact the program costs. Effectively managing these evolving customer needs within the Customer Connection program is crucial to ensure efficient resource allocation, minimize cost impacts, and maintain timely project completion, ultimately supporting the city's continued growth.

3.4. PROGRAM BENEFITS

A robust Customer Connections program ensures that new developments are seamlessly integrated into the grid while promoting operational efficiency, safety, and economic growth. Hydro Ottawa's Customer Connections program is structured to optimize grid performance, meet growing energy demands, and foster long-term community development. The following sections are the key benefits of the Customer Connections Program.

3.4.1. Customer

Reliable and Safe Access: The program ensures reliable and safe access to Hydro Ottawa's distribution system for all customers. This access is fundamental and is maintained through strict adherence to industry regulations and standards, ensuring a dependable connection to the power grid.

Timely Connections: The Customer Connection program leverages the strategic planning and proactive infrastructure upgrades of the System Access program, to provide timely connections for new developments. Timely connections enable customers to begin operations or occupy new homes without delays, helping them avoid potential costs associated with project delays and ensuring their energy needs are met according to their development timelines. The program's focus on preparedness aims to streamline the connection process, meet DSC requirements, and minimize delays.

3.4.2. System Operation Efficiency and Cost Effectiveness

Optimized Infrastructure Utilization: The program's planning process considers both current and forecasted load requirements, ensuring that infrastructure investments are aligned with actual needs. This helps to avoid overbuilding or underutilization of assets, maximizing the return on investment and improving the overall efficiency of the system.

Economies of Scale: The program's integrated planning and bulk purchasing strategies allow Hydro Ottawa to achieve economies of scale. By coordinating projects and procuring materials in bulk, the utility can reduce the per-unit cost of infrastructure development, leading to more cost-effective upgrades and expansions.

3.4.3. Economic Development

Growth and Investment: The program supports the City of Ottawa's economic development strategy, driving growth and attracting investment by providing the essential electrical infrastructure required for residential, commercial, and infill development projects. These new customer connections stimulate local job creation across construction, maintenance, and utility sectors, while simultaneously attracting new businesses seeking to establish operations within a city offering reliable power access. The program's commitment to ensuring reliable and sufficient electrical capacity, including a robust and adaptable grid infrastructure capable of supporting substantial investments and diverse economic activities, positions Ottawa as a prime destination for businesses and developers, thereby fostering economic prosperity and long-term, sustainable growth. Enhancements to infrastructure further contribute to increased property values, incentivizing real estate investment and stimulating additional commercial ventures.

Empowering Business Success: The Customer Connection program empowers businesses of all sizes to thrive in Ottawa. By providing reliable and sufficient power, the program enables commercial operations, supports innovation, and facilitates business expansion, including entrepreneurial activities and new enterprises, contributing to a dynamic and competitive economic environment.

Adapting to Evolving Energy Needs: The program accounts for evolving customer energy needs. By identifying infrastructure investments that support both current and future load requirements, the program ensures the grid can accommodate increasing demands, including the growing adoption of EVs, transition to electric buses, and other electrification initiatives.

Supporting Growth and Development: The program actively supports the growth and development of Ottawa by providing the essential electrical infrastructure needed for new connections and increased electricity demands. This program is a key enabler for residential subdivisions, commercial projects, and infill developments, facilitating the city's expansion and economic progress.

3.4.4. Environment

Enabling a Cleaner Transportation Future: The Customer Connection program supports Ottawa's transition to a cleaner transportation future by providing the essential electrical infrastructure needed for the growing adoption of EV and the electrification of public transit. This program is a key enabler of reduced GHG emissions and improved air quality.

Supporting Sustainable Urban Growth: The program contributes to more sustainable urban development by facilitating infill projects and intensification within established areas. By connecting developments within existing urban boundaries, the program helps to minimize urban sprawl and its associated environmental impacts.

Modernizing the Grid for Energy Efficiency: The program supports the modernization of Ottawa's electrical grid, enabling the implementation of advanced energy management technologies. This includes support for demand response programs and smart meters, which empower customers to optimize their energy usage and contribute to overall energy consumption reduction.

Building a Foundation for a Green Economy: The program's support for electrification, sustainable development, and renewable energy integration creates a foundation for a green economy in Ottawa. By providing the necessary electrical infrastructure, the program attracts businesses focused on clean technologies and supports the development of a sustainable energy sector.

Contributing to a Low-Carbon Ottawa: The program plays a vital role in helping Ottawa achieve its climate change targets and transition to a low-carbon future. By enabling electrification in transportation, supporting sustainable development patterns, and facilitating the integration of renewable energy and smart grid technologies, the program contributes to reducing the city's overall carbon footprint and building a more sustainable future for all.

3.5. PROGRAM COSTS

The annual costs for the Customer Connections program is expected to average $19.4M per year over the 2026-2030 period which is an increase from the $13.8M net average annual costs during the 2021-2025 timeframe. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to reach $97.1M, compared to $68.8M in the 2021-2025 period. This capital program has three major budget programs: Residential Subdivisions, Commercial Development, Infill Services. A minor fourth budget program, ESA Flash Notice, was created for the 2021-2025 rate period, but has been discontinued for the 2026-2030 period due to the completion of all required work.

Table 5 presents the Historical, Bridge and Test Year expenditures by the underlying budget programs, as a part of the Customer Connections program. The program costs for the underlying budget programs are detailed in Sections 3.5.1 to 3.5.3.

Table 5 - Historical, Bridge and Test Year Program Costs - Net of Contributed Capital ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Residential Subdivisions	$ 8.7	$ 8.0	$ 8.0	$ 7.1	$ 7.2	$ 8.4	$ 8.8	$ 9.4	$ 10.0	$ 10.5
Commercial Developments	$ 4.4	$ 5.2	$ 5.5	$ 5.6	$ 5.9	$ 5.8	$ 12.0	$ 9.8	$ 9.0	$ 10.1
Infill Services	$ 0.7	$ 0.3	$ 1.0	$ 0.6	$ 0.7	$ 0.5	$ 0.6	$ 0.7	$ 0.7	$ 0.7
ESA Flash Notice	$ 0.1	$ 0.0	$ 0.0	$ 0.0	$ 0.0	-	-	-	-	-
ANNUAL TOTAL	**$ 13.7**	**$ 13.5**	**$ 14.4**	**$ 13.4**	**$ 13.8**	**$ 14.8**	**$ 21.4**	**$ 19.9**	**$ 19.6**	**$ 21.4**
5-YEAR NET TOTAL					**$ 68.8**					**$ 97.1**

3.5.1. Residential Subdivisions

The annual costs for the Residential Subdivision program, as a part of the Customer Connections Program, is expected to average $9.4M per year over the 2026-2030 period which is an increase from the $7.8M average annual costs during the 2021-2025 timeframe. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to reach $47.2M, compared to $38.9M in the 2021-2025 period.

While the costs associated with the Residential Subdivisions program are primarily driven by customer-initiated requests, a significant portion is offset through customer contributions (i.e. contributed capital and/or contributed plant), determined in accordance with the OEB prescribed economic evaluation methodology. Additionally, in the case of large subdivisions infrastructure is sometimes built by the developer and transferred to Hydro Ottawa offsetting the contributed capital, this is accounted for as contributed plant (in-kind contributions).

Hydro Ottawa evaluates these programs based on net spending, reflecting the balance between project costs and customer contributions. Forecasts for these contributions are derived from historical data, justifying the net investment required from Hydro Ottawa.
Table 6 presents the Historical, Bridge and Test Year costs for the Residential Subdivisions program, as a part of the Customer Connections program, capital contributions include Contributed Plant (non-cash contributions) and Contributed Capital (cash contributions).

Table 6 - Historical, Bridge and Test Year Residential Subdivision Program Costs ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Residential Subdivisions - Gross	$ 12.2	$ 12.5	$ 12.4	$ 11.9	$ 12.3	$ 13.1	$ 13.8	$ 14.7	$ 15.5	$ 16.4
Contributed Plant	$ 21.6	$ 7.4	$ 12.2	$ 12.6	$ 12.6	$ 13.9	$ 14.6	$ 15.6	$ 16.5	$ 17.4
Contributed Capital	$ (25.1)	$ (12.0)	$ (16.6)	$ (17.4)	$ (17.6)	$ (18.6)	$ (19.6)	$ (20.9)	$ (22.1)	$ (23.3)
ANNUAL NET TOTAL	**$ 8.7**	**$ 8.0**	**$ 8.0**	**$ 7.1**	**$ 7.2**	**$ 8.4**	**$ 8.8**	**$ 9.4**	**$ 10.0**	**$ 10.5**
5-YEAR NET TOTAL					**$ 38.9**					**$ 47.2**

Test Year costs for the Residential Subdivisions program were formulated by extrapolating from the 2021-2023 average connection volume, with subsequent adjustments based on the City of Ottawa's projected residential development growth from 2026-2030[8]. Contributed plant values are expected to be 52% of total gross cost, in line with the average contributed plant portion of gross costs over the 2018-2023 period. Contributed capital payments are assumed to remain at 69% of total gross cost in line with the average contribution capital portion of gross costs in the Historical Years.

The Residential Subdivisions program necessitates continued and increased investment during the 2026-2030 period due to a variety of factors including: City of Ottawa intensification plans[9], City of Ottawa growth trajectory[10], and increasing residential electrical demand. Changes in city intensification plans, changes in housing growth, changes in residential electrical demand trends, project complexity, technical challenges, skilled labour availability, and material and equipment costs may cause deviations from this forecast. Hydro Ottawa will continue to monitor housing

[8] City of Ottawa, "Growth Projections for Ottawa: 2018-2046,"
[9] Intensification plans in City of Ottawa's Official Plan
[10] City of Ottawa, "Growth Projections for Ottawa: 2018-2046,"

growth trends and residential electrical demand trends to effectively support the City's development objectives, and ensure the provision of reliable electrical service to all residents.

3.5.2. Commercial Developments

The annual costs for the Commercial Developments program, as a part of the Customer Connections program, is expected to average $9.3M per year over the 2026-2030 period which is an increase from the $5.3M average annual cost per year during the 2021-2025 timeframe. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to reach $46.8M, compared to $26.4M in the 2021-2025 period. During the Historical and Bridge Years, a consistent trend of increasing expenditures in this program was observed, representative of the growth in commercial development.

While costs associated with the Commercial Developments program are primarily driven by customer-initiated requests, a significant portion is offset through contributed capital, determined in accordance with the OEB prescribed economic evaluation methodology.

Hydro Ottawa evaluates these programs based on net capital costs, reflecting the balance between gross project costs and contributed capital. Test Year contributions are derived from Historical data and known planned projects with confirmed customer commitment, further justifying the net investment required from Hydro Ottawa.

Table 7 presents the Historical, Bridge and Test year costs for the Commercial Developments program, as a part of the Customer Connections program.

Table 7 - Historical, Bridge and Test Year Commercial Developments Program Costs ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Commercial Developments - Gross	$ 13.1	$ 13.0	$ 17.9	$ 16.7	$ 17.7	$ 19.0	$ 33.4	$ 25.0	$ 23.8	$ 26.8
Contributed Capital	$ (8.7)	$ (7.8)	$ (12.5)	$ (11.1)	$ (11.9)	$ (13.2)	$ (21.3)	$ (15.2)	$ (14.8)	$ (16.6)
ANNUAL NET TOTAL	**$ 4.4**	**$ 5.2**	**$ 5.4**	**$ 5.6**	**$ 5.9**	**$ 5.8**	**$ 12.0**	**$ 9.8**	**$ 9.0**	**$ 10.1**
5-YEAR NET TOTAL	**$ 26.4**					**$ 46.8**				

Test Year costs for the Commercial Developments program were formulated by extrapolating from the 2021-2023 (excluding discrete planned projects) average connection volume, with subsequent adjustments based on the City of Ottawa's predicted employment growth[11] from 2026-2030 and the addition of discrete planned projects such as:

- Canadian Food Inspection Agency (CFIA) Connection
- Public Service and Procurement Canada(PSPC)/National Research Council (NRC) Connection

Annual contributed capital payments are assumed to remain at 64% of gross cost, in line with the average contribution capital proportion of gross costs in the Historical Years.

The Commercial Developments program requires continued increases in investment to sustain commercial development growth in Ottawa over the 2026-2030 timeframe. Changes in commercial development growth trends, increased commercial growth to support housing growth (multi-unit residential buildings), changes to commercial electricity demand, project complexity, technical challenges, skilled labour availability, and material and equipment costs are factors which may drive deviations from this forecast. Hydro Ottawa will continue to monitor commercial growth trends and commercial electrical demand trends to effectively support commercial growth targets and maintain access to stable electricity for commercial customers.

[11] City of Ottawa, "Growth Projections for Ottawa: 2018-2046,"

3.5.3. Infill Services

The annual costs for the Infill Services program, as a part of the Customer Connections program, is expected to average $0.6M per year over the 2026-2030 period, which is generally inline with the $0.6M per year average annual costs during the 2021-2025 timeframe. Hydro Ottawa expects the investment needs in this program to remain the same at $3.2M in both the 2026-2030 and 2021-2025 periods. The Historical and Bridge Years have relatively consistent request volumes for infill services connections due to the City of Ottawa's intensification plans[12], which actively supports urban infill developments.

While the costs associated with the Infill Services program are primarily driven by customer-initiated requests, a significant portion is offset through customer contributions, determined in accordance with the OEB prescribed economic evaluation methodology. The timing of Infill Service projects, and consequently, the actual costs, are influenced by third parties and are not directly controlled by Hydro Ottawa.

Hydro Ottawa evaluates these programs based on net spending, reflecting the balance between gross project costs and contributed capital. Test Year contributions are derived from historical data and known planned projects that have confirmed customer commitment, further justifying the net investment required from Hydro Ottawa.

Infill services customer connections continue to remain consistent, largely due to the City of Ottawa's intensification plans, which actively supports urban infill developments.

Table 8 presents the Historical, Bridge and Test Year costs for the Infill Services program, as a part of the Customer Connections program.

[12] Intensification plans in City of Ottawa's Official Plan - https://engage.ottawa.ca/8204/widgets/36458/documents/62522

Table 8 - Historical, Bridge and Test Year Infill Services Program Costs ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Infill Services - Gross	$ 3.3	$ 3.6	$ 3.5	$ 3.4	$ 3.5	$ 3.6	$ 3.7	$ 3.9	$ 4.1	$ 4.3
Contributed Capital	$ (2.7)	$ (3.3)	$ (2.5)	$ (2.8)	$ (2.8)	$ (3.0)	$ (3.1)	$ (3.3)	$ (3.5)	$ (3.6)
ANNUAL NET TOTAL	**$ 0.7**	**$ 0.3**	**$ 1.0**	**$ 0.6**	**$ 0.7**	**$ 0.5**	**$ 0.6**	**$ 0.7**	**$ 0.7**	**$ 0.7**
5-YEAR NET TOTAL					**$ 3.2**					**$ 3.2**

Test Year costs for the Infill Services program were formulated by extrapolating from the 2021-2023 average connection volume, with subsequent adjustments based on the City of Ottawa's projected residential development growth from 2026-2030[13]. Contributed capital is assumed to remain at 88% of gross cost in line with the average contribution capital portion of gross costs over the 2021 to 2023 period.

The Infill Services program depends on consistent investment in the 2026-2030 period to support ongoing urban infill development within the City of Ottawa. Changes in housing growth trends, changes in City of Ottawa policy direction for intensification, changes in residential electrical demand, project complexity, technical challenges, skilled labour availability, material and equipment costs, or third party build schedules may drive deviations in the Test Year costs. Hydro Ottawa will continue to monitor demand for infill connections to support the City of Ottawa's development objectives, and ensure the provision of reliable electrical service to all residents.

[13] City of Ottawa, "Growth Projections for Ottawa: 2018-2046," https://ottawa.ca/en/living-ottawa/statistics-and-demographics/growth-projections-ottawa-2018-2046#section-26e79cf6-0a3c-4ab0-92fe-6a0c44150b93

3.5.4. Cost Factors

Residential Subdivisions

- City intensification plans
- Changes in housing growth trends
- Changes in residential electrical demand trends
- Project complexity
- Technical challenges
- Skilled labour availability
- Material and equipment costs

Commercial Developments

- Changes in commercial development growth trends
- Changes to working models (work from home and hybrid work)
- Increased commercial growth to support housing growth
- Changes to commercial electricity demand
- Project complexity
- Technical challenges
- Skilled labour availability
- Material and equipment costs

Infill Services

- Changes in housing growth trends
- Changes in City of Ottawa policy direction for intensification
- Changes in residential electricity demand
- Project complexity
- Technical challenges
- Skilled labour availability
- Material and equipment costs
- Third party build schedules

3.6. ALTERNATIVES EVALUATION

3.6.1. Alternatives Considered

Alternative One: Do Nothing

The "do nothing" alternative, characterized by the refusal of new customer connection requests, represents an untenable option for Hydro Ottawa. This approach would constitute a direct violation of fundamental regulatory obligations as stipulated in the DSC, the Electricity Act, the OEB Act, Hydro Ottawa's COS and Electricity Distribution License. Furthermore, it would severely impede economic development within the City of Ottawa and Municipality of Casselman by preventing new residential, commercial, and infill development projects from accessing the electrical grid.

Alternative Two: Enable Customer Connection (Recommended)

Hydro Ottawa must invest in the Customer Connections Program to enable new customer connections and accommodate the communities and Hydro Ottawa Customer's evolving energy needs. This investment is crucial for several key reasons:

- **Ensuring Regulatory Compliance:** The program ensures adherence to regulatory requirements mandated by the DSC and other relevant legislation, enabling Hydro Ottawa to fulfill its obligations.
- **Driving Economic Development:** By providing the necessary electrical infrastructure for new residential, commercial, and infill developments, the program directly fuels economic development and supports the City of Ottawa's ongoing growth and expansion. This attracts businesses requiring reliable connections, enables existing businesses to expand and create jobs, facilitates housing construction, and enhances the city's economic competitiveness, attracting further investment.
- **Adapting to Evolving Energy Needs:** The program enables Hydro Ottawa to adapt to the changing energy landscape, including the increasing demand associated with electrification initiatives. This includes supporting the adoption of EVs, the transition to an electric bus fleet, and other emerging technologies that contribute to a more sustainable energy future.

In essence, the Customer Connections program represents a proactive and necessary investment in Hydro Ottawa's customers' future, enabling the City of Ottawa and Municipality of Casselman to grow and thrive economically while ensuring a robust and reliable electrical grid that can adapt to evolving energy needs and support a sustainable energy transition.

3.6.2. Evaluation Criteria

Given that the Customer Connections Program is essential and has no viable alternatives, the primary evaluation criterion is Regulatory Compliance.

- **Regulatory Compliance:** The program must consistently meet all legislative and regulatory requirements, including those mandated by the DSC, the OEB and Hydro Ottawa's COS. This ensures Hydro Ottawa fulfills its obligations to provide safe and reliable electricity services to its customers

While the necessity of the Customer Connections Program is inherent, its implementation can be assessed for its alignment with broader strategic goals:

- **Economic Development:** To the extent possible within regulatory constraints, the program should contribute to the City of Ottawa's growth and sustainability.
- **Environmental Sustainability:** The program should promote environmental sustainability by facilitating customer connections that enable electrification, renewable energy integration, and energy efficiency upgrades.
- **Community Benefits:** Where possible, the program should enhance community well-being through grid resilience and support for sustainable development initiatives.

Evaluating the program against these criteria, within the constraints of regulatory obligations, will ensure that Hydro Ottawa effectively supports the growing community it serves while adhering to its mandated responsibilities.

3.6.3. Preferred Alternative

Hydro Ottawa's evaluation of alternatives for the Customer Connections program definitively selects Alternative 2: Enable Customer Connections as the only viable and recommended course of action, based on its alignment with the established evaluation criteria.

Regulatory Compliance:

- The “Do Nothing” alternative (Alternative One) is immediately rejected due to its direct violation of the regulatory mandates from the DSC, Electricity Act, OEB Act, and Hydro Ottawa's COS and Electricity Distribution License.
- Alternative 2 ensures Hydro Ottawa fulfills its mandated obligations to provide safe, reliable and efficient access to its distribution system , directly meeting the primary evaluation criterion of Regulatory Compliance.

Economic Development:

- The “Do Nothing” alternative would hinder the City of Ottawa’s economic growth by preventing necessary electrical connections for new developments.
- Alternative Two actively supports economic development by providing essential infrastructure for new connections, fostering growth and advancement, aligning with the economic development criterion.

Environmental Sustainability and Community Benefits:

- The “Do Nothing” alternative fails to support evolving energy needs, including electrification and renewable energy integration, hindering environmental sustainability efforts.
- Alternative Two enables Hydro Ottawa to adapt to these needs, supporting sustainable energy transition and facilitating community-driven sustainability and resilience, thus addressing both Environmental Sustainability and Community Benefits criteria.

In conclusion, Alternative Two: Enable Customer Connections is the preferred alternative as it meets regulatory requirements, supports economic growth, and facilitates environmental sustainability and community benefits, ensuring Hydro Ottawa fulfills its obligations and contributes to a sustainable future for the community.

3.7. PROGRAM EXECUTION AND RISK MITIGATIONS

3.7.1. Implementation Plan

Hydro Ottawa's Customer Connections program implementation plan encompasses the management of new and/or modified customer connection requests, ensuring compliance with regulatory requirements, supporting the city's growth, and maintaining system reliability. Additionally each connection request is reviewed and processed in accordance with the DSC and OEB regulations, ensuring fairness and compliance to timelines and requirements. The implementation plan includes:

- **Customer Relationship Management (CRM):** Leveraging the CRM system, streamlining processes, prioritizing requests, and maintaining transparent communication with customers.
- **Project Planning and Design:** Conducting thorough capacity assessments, developing detailed engineering plans, optimizing resource allocation, and managing project risks.
- **Construction and Implementation:** Overseeing construction activities, ensuring safety and quality, and coordinating with stakeholders.
- **Customer Connection and Support:** Completing connections, providing ongoing support, and monitoring customer satisfaction.

3.7.2. Risks To Completion and Risk Mitigation Strategies

Hydro Ottawa encounters several risks in managing its Customer Connections program, particularly as new developments and evolving customer demands place increasing pressure on the electricity distribution grid. Furthermore, the program's reliance on third-party projects introduces additional potential risks. Table 9 provides a summary of these key risks and the corresponding mitigation strategies that Hydro Ottawa will employ as needed.

1 **Table 9 - Customer Connection Key Risks and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to third party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Capacity and Infrastructure	Existing infrastructure may not support increased load, particularly with deteriorating assets or in areas nearing capacity limits. System reconfigurations, upgrades, or expansions may be required, posing a risk to program delivery schedule and cost.	Thoroughly assess infrastructure and implement timely upgrades. Develop long-term infrastructure plans and allocate resources efficiently to manage costs and timing of system modifications, minimizing financial impacts.
Customer & Stakeholder Management	Adjustments in customer requests, failure to meet expectations, or communication issues could pose a risk to program delivery budget and schedule.	Maintain flexibility in project designs and budgets, engage with customers regularly to anticipate changes, and ensure transparent communication and prompt response to concerns.
Regulatory & Financial	Non-compliance with changing regulations could pose a risk to program delivery cost and schedule.	Keep abreast of regulatory requirements and engage with stakeholders early. Develop detailed budgets with contingencies and closely monitor financial performance.
Technology & Process Improvement	Inefficient processes or inadequate technology may hinder program effectiveness and responsiveness.	Implement planned CRM enhancements and process optimization measures, including standardized processes, centralized intake, and proactive customer communication.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework

Category	Risk	Mitigation
		will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

4. SYSTEM EXPANSION

4.1. PROGRAM SUMMARY

Investment Category: System Access
Capital Program Costs:
2021-2025: $41.5M
2026-2030: $59.2M
Budget Program: System Expansion
Main Driver: Customer Service Request
Secondary Driver: Mandated Service Obligation
Outcomes: Customer Focus

Hydro Ottawa's System Expansion program is crucial for accommodating growth and ensuring reliable electricity service to the community and its customers. This program facilitates the connection of new customers and supports service upgrades for existing customers by investing in necessary infrastructure expansion to the electrical distribution system. The program identifies and addresses potential constraints by triggering system expansions projects that may include upgrading feeders, transformers, and substations. These system expansions guarantee sufficient capacity for current and projected load requirements, maintaining system reliability and service quality. By adhering to regulatory requirements and the COS, Hydro Ottawa fulfills its commitment to providing safe and efficient access to its distribution system, supporting community development and meeting evolving customer needs. The program's approach ensures that the electrical grid can seamlessly integrate new loads while upholding Hydro Ottawa's service obligations.

Hydro Ottawa employs the OEB prescribed economic evaluation methodology to assess proposed system expansion projects. This evaluation compares the total cost of a project with the projected future revenue generated by the new customer(s) over a defined period. Projected revenue includes the expected number of new connections and anticipated average electricity consumption/demand. In accordance with DSC Section 3.2.1, if the projected future revenue is sufficient to cover the capital and ongoing maintenance costs of the expansion, no capital contribution is required from the customer. Conversely, if a revenue shortfall is projected, the customer will contribute a portion of the expansion costs. This approach ensures long-term planning, financial sustainability, and the efficient connection of new customers to the distribution grid.

Hydro Ottawa's planned investment in its System Expansion program for the 2026-2030 period is $59.2M, an increase from the $41.5M invested in the 2021-2025 period. This increase is primarily due to the growing volume and complexity of system expansion projects necessitated by continued growth and development of the community that Hydro Ottawa serves. Key factors contributing to the Test Year costs include:

- **Large Load Requests and Energy Transition:** Increased confirmed customer commitments for large load requests (5 MVA and above) and the broader energy transition, with its associated demand for EV charging stations and related infrastructure (e.g., new warehouses), are also contributing factors.
- **Residential Growth:** Projected population increases and the associated expansion of housing and employment opportunities are driving growth in residential connections.
- **Commercial Growth:** The City of Ottawa's transit-oriented development strategy, including its planned transition to a fully electric bus fleet (354 buses by 2027 and complete electrification by 2036), is a major driver of commercial connection growth.

Further details can be found in Sections 6.5 and 9.4.1.1 of Schedule 2-5-4 - Asset Management Process.

While Historical spending (2021-2023) was largely driven by the LRT Phase 2 project, the focus has now shifted to major infrastructure projects that began in 2024 which require station builds or upgrades to support the size of the connection request. These include the construction and electrical infrastructure connections for two stations (one new station and one upgraded station) serving Ottawa's ZEB project and the DND, as well as electrical infrastructure development for the new Ottawa Hospital. These projects underscore the increasing complexity and scale of distribution system expansion necessary to meet the community’s growing electricity needs.

Depending on future large load requests, the expenditure can increase but will be determined on an as needed basis.

4.2. PERFORMANCE OUTCOMES

The following outcomes are expected to be achieved through the System Expansion program, as outlined in Table 10 below:

Table 10 - System Expansion Program Performance Outcomes

OEB Performance Outcomes	Outcome Description
Customer Focus	Contributes to Hydro Ottawa's customer focus objectives by fulfilling customer service requests and meet mandated service obligations as laid out in Sections 7.2 (customer connections) of the DSC, Electricity Act, and OEB Act; and Hydro Ottawa's COS and Electricity Distribution License. Specific mandated service obligations, as tracked by the Utility Scorecard, are detailed in Attachment 1-3-3(C) - Electricity Utility Scorecard Benchmarking Analysis. Successful execution of this program is essential for maintaining high levels of customer satisfaction and meeting regulatory requirements.

4.3. PROGRAM DRIVERS AND NEED

4.3.1. Drivers

Primary Driver: Customer Service Request

To ensure the continued delivery of reliable and resilient electricity services to a growing customer base, Hydro Ottawa must strategically expand grid capacity to accommodate unprecedented demand as detailed in Section 6.5 of Schedule 2-5-4 - Asset Management Process. This increased demand is driven by several converging factors, including residential growth, transportation electrification, and the increasing adoption of electrified space heating.

Since 2018, Hydro Ottawa has observed a significant increase in connection requests and inquiries from large-load customers (5 MVA and above), with a further surge in electricity demand beginning in 2023. This upward trend is corroborated by Historical data on the conversion rate of initial customer requests and inquiries into confirmed customer commitments (signed Offer to Connect), as detailed in Section 9.4 of Schedule 2-5-4 - Asset Management Process.

Large customer connections (5 MVA or greater) totaled 110 MVA between 2010 and 2023. By 2030, confirmed customer commitments represent another 113 MVA, with an additional 199 MVA in requests and inquiries. If all requests are realized, large customer connections will increase by 312 MVA by 2030, tripling the capacity added in the previous 14 years.

A few key examples of the projects driving these large load requests are:

- The Ottawa Hospital's New Campus[14]
- OC Transpo's Zero Emission Buses[15]
- Department of National Defence Dwyer Hill Training Center Upgrade[16]
- New laboratory facilities for the Regulatory and Security Science Main Project[17], located at the existing CFIAs Ottawa Laboratory
- TerraCanada National Capital Area project located at the National Research Council of Canada facilities[18]

Details regarding supply plans for these projects can be found in Section 9.1 of Schedule 2-5-4 - Asset Management Process.

Hydro Ottawa continues to collaborate with developers and the City of Ottawa through various working groups including the UCC, Energy Evolution and the Decarbonization Working Group,

[14] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/
[15] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/news/article/oc-explained-zero-emission-bus-project/
[16] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/
[17] Government of Canada, "Government of Canada invests in laboratories to support science in Canada." https://www.canada.ca/en/public-services-procurement/news/2024/03/
[18] Government of Canada,"Government of Canada announces milestones for new science facilities in National Capital Area" https://www.canada.ca/en/public-services-procurement/news/2024/07/government-of-canada-announces-milestones-for-new-science-facilities-in-national-capital-area.html

please refer to Schedule 2-5-2 - Coordinated Planning with Third Parties to develop well-informed grid capacity enhancement plans and to ensure the continued provision of reliable electricity services to a dynamic and expanding community. This strategic approach aims to support ongoing residential and commercial development, facilitate urban intensification initiatives, and enable major infrastructure projects within the community in a cost-effective manner.

Secondary Driver: Mandated Service Obligation

Hydro Ottawa is obligated, under the DSC, the Ontario Electricity Act , the OEB Act, and Hydro Ottawa's COS, to fulfill connection requests or provide an offer to connect to any customer within its service territory.

4.3.2. Current Issues

The key challenges Hydro Ottawa faces in managing the System Expansion program include large load connections, limitations in the 4kV and 8kV systems, and distribution system upgrade challenges further detailed below.

4.3.2.1 *Large Load Connections*

Hydro Ottawa received large electrification load requests in the 2021-2025 period ranging from 5 MVA to 57 MVA. The main driver for the majority of large load requests was electrification of space heating, water heating, and transportation in order to align with municipal and federal decarbonization goals. Refer to Section 9.4 of Schedule 2-5-4 - Asset Management Process for more details. The size of the large load requests has required Hydro Ottawa to invest in station upgrades primarily to support capacity requirements of these large load customers. There are currently two station upgrade projects being executed under the System Access investment category which is primarily driven by customer requests as detailed below.

OC Transpo's Zero Emission Buses[19]

A new 230kV to 44kV substation in the east region is being built to support the power supply requirements of OC Transpo's Zero Emission Bus project (ZEB) and has a planned energization in 2027. Figure 2 shows the three existing 44kV stations in Hydro Ottawa's service territory along with the Hydro Road TS under construction and the large load.

Figure 2 - 44kV Stations

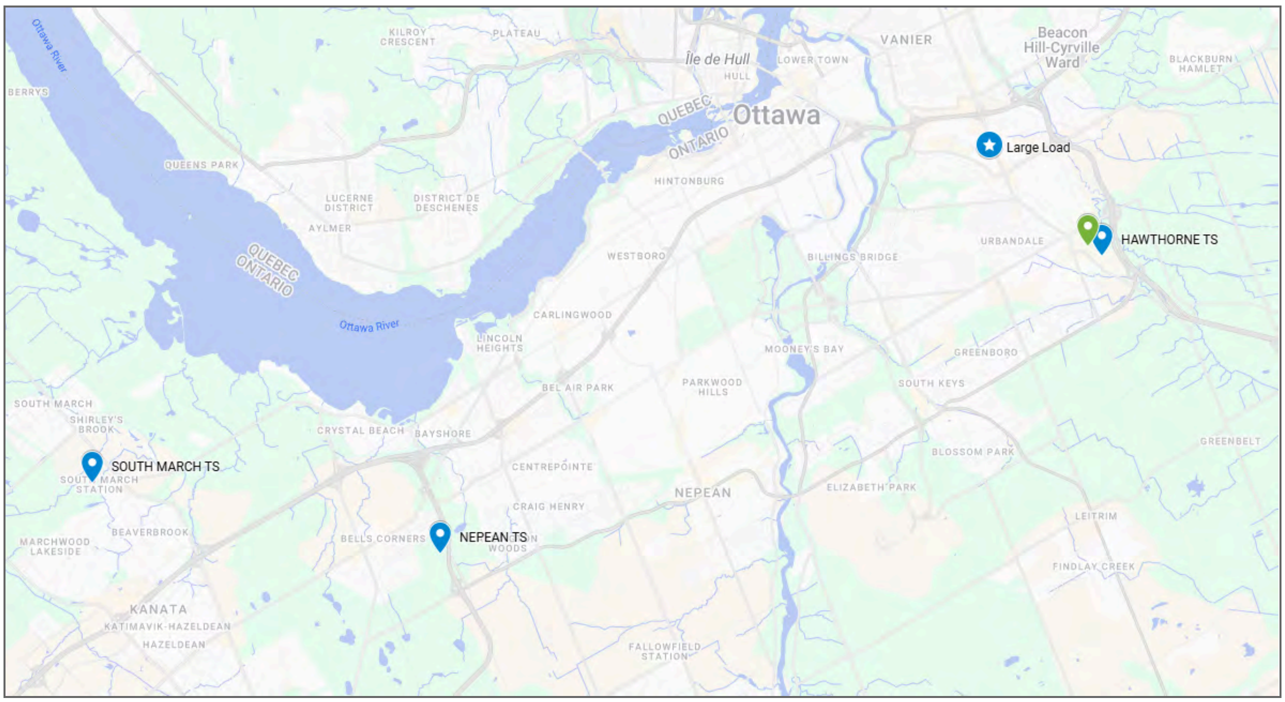
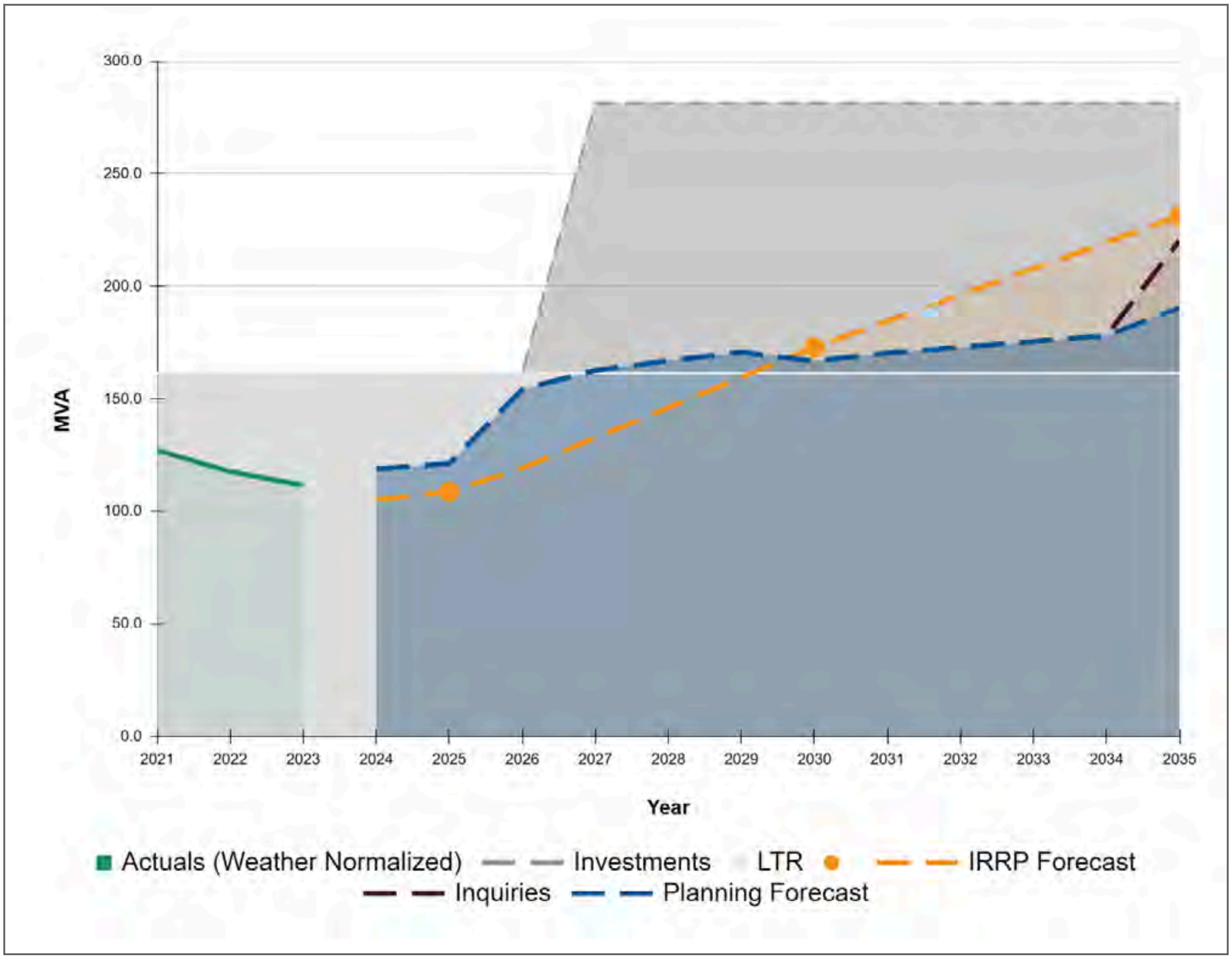


Figure 3 presents the load forecast against planned capacity (LTR), factoring the energization of Hydro Road TS in 2027, which will increase the 44kV Eastern region's capacity to 280 MVA. The figure compares the Integrated Regional Resource Plan IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages.

[19] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/news/article/oc-explained-zero-emission-bus-project/

Figure 3 - 44kV Eastern Region Forecast (Hawthorne TS + Hydro Road TS)



The issues the new Hydro Rd TS helps address are elaborated below.

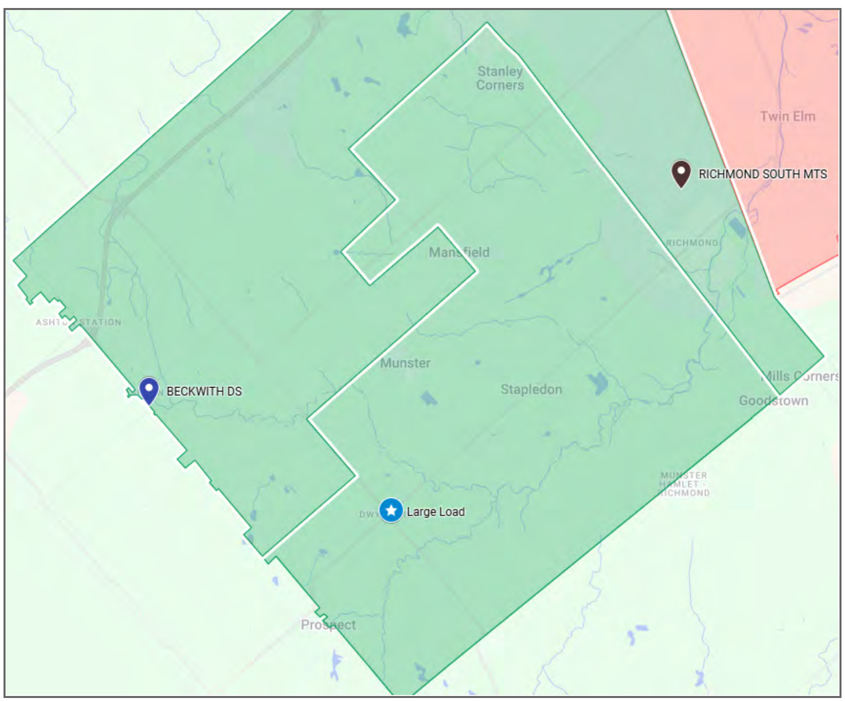
- Due to the size of the ZEB large load request, a 44kV supply option is the only feasible solution in terms of feeder capacity.
- Given the ZEB large load's geographical location, neither Nepean TS nor South March TS are viable connection options. Hawthorne TS, due to its proximity, is the only feasible option. However, it lacks sufficient capacity to meet the load requirements and would exceed its planned capacity by 2027.

- Currently, Hawthorne TS has only one tie to Nepean TS, which is not sufficient to offload the station during contingency scenarios. Building the new 44kV station would improve reliability through inter-station ties between Hawthorne TS and Hydro Road TS.
- Hence building a new 44kV station is the most optimal solution to service this large load.

Department of National Defence- Dwyer Hill Training Centre[20]

Addition of a second transformer at Hydro Ottawa's Richmond South MTS is currently under construction to support the power supply requirements of DND and has a planned energization in 2027. Figure 4 shows the existing Richmond South MTS, Beckwith DS and the large load.

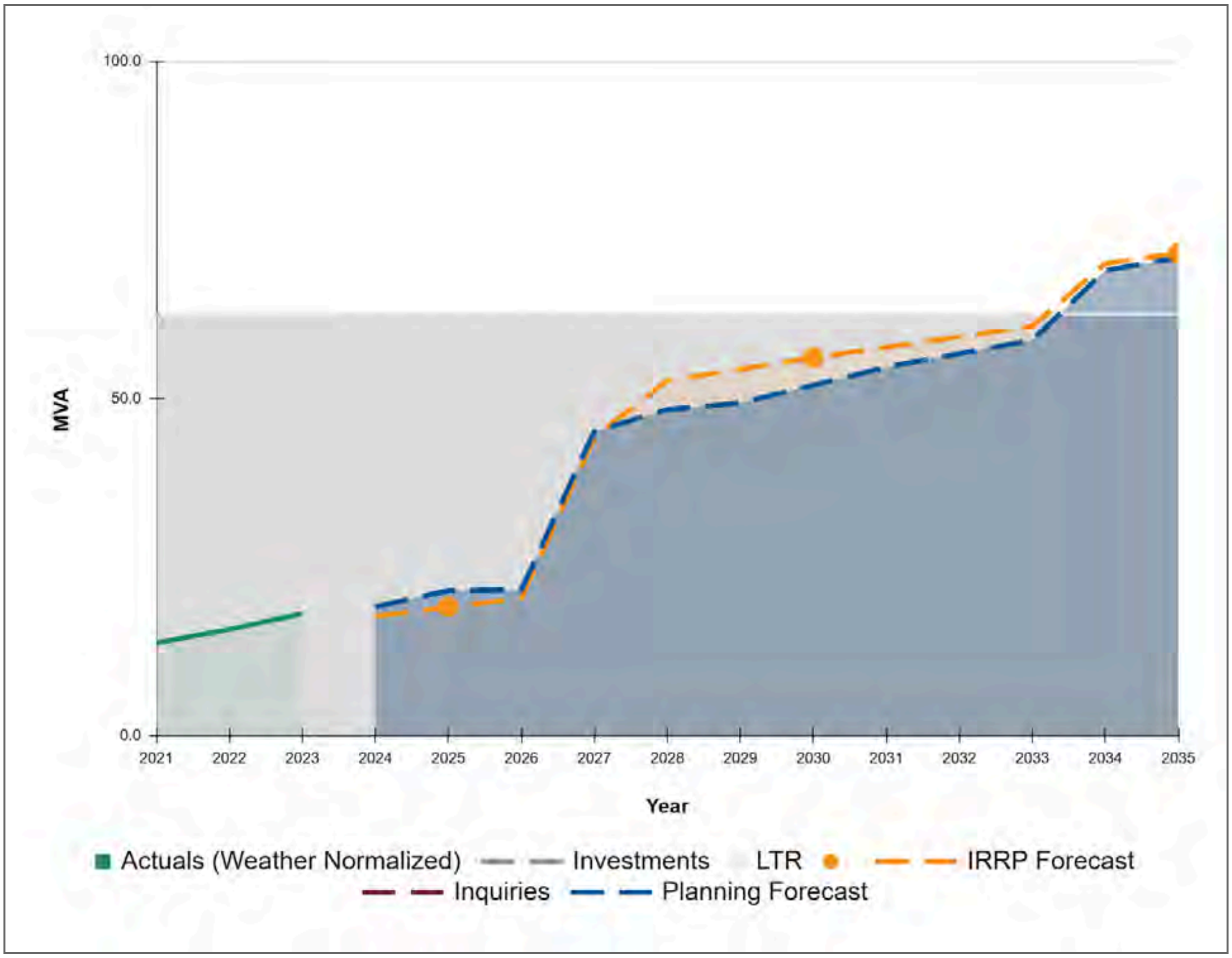
Figure 4 - West 28kV (Southern Region)



[20] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/

Figure 5 presents the load forecast against planned capacity (LTR) of Richmond South MTS. The figure compares the IRRP Forecast, Planning Forecast factoring in the forecasted demand requirements of the large load.

Figure 5 - Richmond South MTS Forecast



The issues the second transformer at Hydro Ottawa's Richmond South MTS helps address are elaborated below.

- Richmond South MTS historically has operated with a single transformer with support from inter-station ties during N-1 contingency scenarios. With the forecasted demand of DND, the inter-station ties will no longer be sufficient to provide support during an N-1 contingency, resulting in stranded load.

- The only other station in close proximity to the large load is Beckwith DS, owned by Hydro One Networks Inc. (Hydro One). Hydro Ottawa owns a single feeder BECK-F2 that supplies this region which is already running above its planning rating. As discussed in Section 2.3.2.3 of Schedule 2-5-8 - System Service Investments, there are limited options to address the loading constraints at BECK-F2 and therefore the addition of incremental load from DND is not an option in the long term. BECK-F2 will support part of the new load until the station upgrade is completed at Richmond South MTS.
- The only viable option to support the large load is to upgrade Richmond South MTS with a second transformer to provide full redundancy during N-1 contingency and extend two new 28kV feeders. Note that the addition of this second transformer is to meet N-1 planning criteria as a result does not show an increase to the planning capacity of the region, further described in Section 5.2.2 of Schedule 2-5-4 - Asset Management Process.

4.3.2.2 Limitations in the 4kV and 8kV systems

Some of the developed areas of Hydro Ottawa's service territory that are seeing growth due to intensification, transit oriented development and electrification are supplied by the 4kV and 8kV system. These systems have limitations compared to the 13kV and 28kV systems as listed below:

- Compared to 28 kV/13kV, the 4kV/8kV systems are less efficient for long-distance power distribution, leading to greater losses and voltage drop issues.
- The maximum capacity that a 4kV/8kV feeder can carry is low compared to higher voltage systems significantly limiting the ability to accommodate the large load requests. The maximum capacity of a 4kV feeder is 2.3MVA and 8kV feeder is 3.6MVA compared to 9.7 MVA on 13kV or 16.4 MVA on 28kV.
- Some of the 4kV and 8kV stations are heavily loaded, hindering new or upgraded customer connections. The increasing number of new load connections or service upgrades require connections/voltage conversions to 13kV and 28kV systems.

4.3.2.3 Distribution System Upgrade Challenges

Expanding the electricity grid to accommodate growth can present significant challenges for Hydro Ottawa. Connecting new customers may require upgrading and reconfiguring the existing system such as long feeder extensions to service new load requests with limited capacity in the lie-along infrastructure.

4.4. PROGRAM BENEFITS

4.4.1. Customer

Reliable and Accessible Electricity Service: The System Expansion program ensures a consistent and reliable supply of electricity, minimizes disruptions, and provides faster, more efficient connections, particularly for new developments. This translates to greater convenience and peace of mind for customers.

Support Economic Growth and Energy Transition: By enabling new customer connections and service upgrades, the program enables new residential, commercial, and industrial developments, supporting economic growth and job creation. It also supports the adoption of EVs and electrified transportation.

Financial Advantages: The System Expansion program's use of economic evaluations can lead to cost offsets for customers, lowering upfront customer costs and promoting affordability. This, coupled with the long-term cost management benefits of proactive upgrades, contributes to greater cost stability and predictability for customers.

4.4.2. Economic Development

Growth and Investment: By extending and upgrading its electrical distribution network, Hydro Ottawa's System Expansion program plays a vital role in promoting regional economic development. It enables residential, commercial, and industrial growth by providing reliable and scalable access to electricity, attracting new businesses and industries to the area. The program supports the City of Ottawa's economic development strategy, driving growth and attracting investment by providing the essential electrical infrastructure required.

Empowering Business Success: The program empowers businesses of all sizes to thrive in Ottawa. By providing reliable and sufficient power, the System Expansion program enables commercial operations, supports innovation, and facilitates business expansion, including entrepreneurial activities and new enterprises, contributing to a dynamic and competitive economic environment.

Adapting to Evolving Energy Needs: The program accounts for evolving energy needs of the customer by identifying infrastructure investments that support both current and future load requirements including growing adoption of EVs and other electrification initiatives.

4.4.3. System Operation Efficiency and Cost Effectiveness

Reduced Energy Losses: Upgrading infrastructure not only increases capacity to serve the customer needs but also improves the efficiency of energy delivery by reducing losses across the network. This contributes to lower operating costs and a more sustainable energy system.

Optimized Resource Allocation: Through economic evaluations, the program ensures optimal financial planning, aligning system investments with future revenue from new customers. This approach minimizes the risk of over-investment, while improving the distribution systems's long-term reliability and efficiency.

Minimized Emergency Repairs and Maintenance Costs: By proactively addressing capacity constraints the program reduces the likelihood of equipment failures due to overloaded equipment and the need for costly emergency repairs. This contributes to lower maintenance costs and improved system reliability.

4.4.4. Coordination and Interoperability

Enhanced Coordination: The program fosters enhanced coordination both internally, between Hydro Ottawa's departments, and externally, with stakeholders such as municipalities, developers, and other utilities. This collaboration ensures that system expansions are efficiently integrated with existing infrastructure and future development plans.

Interoperability with Future Technologies: Collaboration and planning also help ensure that system expansions are compatible with future technological advancements, such as smart grid technologies and DERs. This promotes innovation and allows the grid to adapt to evolving energy needs.

Standardized Equipment and Processes: By standardizing equipment and processes, Hydro Ottawa streamlines long-term system maintenance and operations. This reduces complexity, improves efficiency, and ensures a consistent approach to managing the expanded grid.

4.4.5. Environment

Facilitating Clean Energy Adoption: The program facilitates the adoption of EVs, electric buses, and electrified space heating by ensuring sufficient grid capacity. In turn, the transition away from fossil fuels reduces GHG emissions, improves air quality, and contributes to a cleaner energy mix.

Improving Energy Efficiency: By upgrading infrastructure and implementing smart grid technologies, the System Expansion program improves the overall efficiency of the electricity distribution system, reducing energy waste and minimizing environmental impact. This also supports the development of energy-efficient buildings and sustainable transportation options.

Enabling a Cleaner Transportation Future: The System Expansion program supports Ottawa's transition to a cleaner transportation future by providing the essential electrical infrastructure needed for the growing adoption of EVs and the electrification of public transit, including the city's electric bus fleet. This program is a key enabler of reduced GHG emissions and improved air quality.

4.5. PROGRAM COSTS

The annual costs for the System Expansion program is expected to average $11.8M per year over the 2026-2030 period which is an increase from the $8.3M average costs per year during the 2021-2025 timeframe. In the Test Year period Hydro Ottawa expects the investment needs in this program to reach $59.2M, compared to $41.5M in the Historical and Bridge Year period.

During the 2021-2025 period a consistent trend of increasing expenditure in the System Expansion program was observed, driven by increasing customer demand, as well as the escalating complexity and scale of required infrastructure upgrades. Notably, major investments during the Historical and Bridge Years included infrastructure enhancements to support the LRT Phase 2 expansion and the initial phases of OC Transpo's bus fleet electrification.

While costs associated with the System Expansion are primarily driven by customer-initiated requests, a significant portion is offset through customer contributions (i.e. contributed capital), determined in accordance with the OEB prescribed economic evaluation methodology.

Table 11 presents the Historical, Bridge and Test Year costs for the System Expansion program.

Table 11 - Historical, Bridge and Test Year System Expansion Costs ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
System Expansion - Gross	$ 8.2	$ 9.9	$ 11.3	$ 26.1	$ 33.2	$ 42.9	$ 20.1	$ 14.3	$ 15.0	$ 15.2
Contributed Capital	$ (5.7)	$ (7.7)	$ (3.8)	$ (13.0)	$ (16.9)	$ (18.6)	$ (9.0)	$ (8.7)	$ (2.7)	$ (9.3)
ANNUAL NET TOTAL	**$ 2.5**	**$ 2.2**	**$ 7.4**	**$ 13.0**	**$ 16.3**	**$ 24.3**	**$ 11.0**	**$ 5.6**	**$ 12.4**	**$ 6.0**
5-YEAR NET TOTAL					**$ 41.5**					**$ 59.2**

Test Year costs for the System Expansion program were formulated by extrapolating from the 2021-2023 average volumes (excluding discrete large load requests), with subsequent adjustments based on the observed increase in project complexity and scale, as well as the addition of discrete large load requests. The System Expansion program considers the following discrete projects:

- The construction of the Hydro Road substation to support OC Transpo's transition to a zero-emission bus fleet.
- The upgrade of the Richmond South substation to accommodate the increased load requirements of the DND Dwyer Hill Training Center Upgrade.
- Feeder expansions and other system enhancements required for the new Ottawa Hospital campus.

2026-2030 contributed capital is expected to be 64% of gross cost in line with the average contribution capital proportion for the 2018 to 2022 period.

The System Expansion Program requires continued increases in investment to support the increasing complexity and scale of projects to support the evolving energy needs of the community.

4.5.1. Cost Factors

- Costs of material and equipment
- Skilled labour availability
- Changes in community infrastructure programs
- Project complexity
- Technical challenges of the project
- Location of the project
- Interest rates
- Cancellation or scope changes of infrastructure projects

4.6. ALTERNATIVE EVALUATION

4.6.1. Alternatives Considered

Alternative One: Do Nothing

- The "do nothing" alternative, characterized by the refusal of new customer connection requests due to insufficient capacity, represents an untenable option for Hydro Ottawa.
- This approach would constitute a direct violation of fundamental regulatory obligations as stipulated in the DSC, Ontario Electricity Act, the OEB Act, and Hydro Ottawa's COS and Electricity Distribution License.
- Furthermore, it would severely impede economic development within the City of Ottawa by preventing development projects from accessing the electrical grid due to capacity limitations of the system.

Alternative Two: Enable Customer Connections (Recommended)

- Hydro Ottawa must invest in the System Expansion program to ensure sufficient capacity to accommodate new customer connections and satisfy the evolving electricity demands of the community that Hydro Ottawa serves.
- This investment is required to ensure adherence to regulatory obligations, including those mandated by the DSC and other legislation, enabling Hydro Ottawa to fulfill its statutory duty to provide electricity service to all customers meeting the established connection criteria.

4.6.2. Evaluation Criteria

Given that system expansion is often non-discretionary, driven by the need to meet regulatory obligations for customer connections, the primary evaluation criterion is Regulatory Compliance**.**

- **Regulatory Compliance:** The program must consistently meet all legislative and regulatory requirements, including those mandated by the DSC and the OEB. This ensures Hydro Ottawa fulfills its obligations to provide safe and reliable electricity services to its customers.

While the necessity of system expansion may be driven by regulatory requirements, its implementation can still be assessed for its alignment with broader strategic goals:

- **Economic Development:** To the extent possible within regulatory constraints, the program should contribute to the City of Ottawa's growth and sustainability.
- **Environmental Sustainability:** Where feasible, the program should promote environmental sustainability by supporting electrification, renewable energy integration, and energy efficiency.
- **Community Benefits:** Where possible, the program should enhance community well-being through grid resilience and support for sustainable development initiatives.

Evaluating the program against these criteria, within the constraints of regulatory obligations, will ensure that Hydro Ottawa effectively supports the growing community it serves while adhering to its mandated responsibilities.

4.6.3. Preferred Alternative

Alternative two is the preferred approach for Hydro Ottawa's System Expansion program with the following rational:

- **Regulatory Compliance:** By prioritizing the connection of new customers and investing in necessary capacity upgrades, Alternative 2 ensures adherence to the DSC and other regulatory obligations. This proactive approach avoids potential legal challenges and maintains Hydro Ottawa's compliance with its licensing conditions.
- **Economic Development:** Facilitating the connection of new residential, commercial, and industrial customers is essential for supporting economic growth and development within the City of Ottawa and Municipality of Casselman. Alternative two enables new housing, businesses, and industries to access the electricity grid, fostering economic activity, job creation, and overall prosperity.

Environmental Sustainability: Alternative two directly supports environmental sustainability by enabling the electrification of transportation, heating, and other sectors. Increased grid capacity allows for the integration of renewable energy sources and facilitates the transition towards a cleaner energy mix. This contributes to reduced GHG emissions and improved air quality.

- **Community Benefits:** Investing in grid capacity enhancements improves the resilience of the electricity distribution system, minimizing the risk of outages and ensuring a reliable power supply for the community. This enhances community well-being and supports sustainable development initiatives by providing the necessary electrical infrastructure for growth and a cleaner energy future.

In contrast, the "Do Nothing" alternative fails to meet these criteria. It would result in regulatory non-compliance, hinder economic development, and limit the community's ability to transition towards a more sustainable energy future.

Therefore, Alternative two is the preferred option as it best fulfills Hydro Ottawa's mandate to provide safe and reliable electricity services while supporting the economic, environmental, and social well-being of the community.

4.7. PROGRAM EXECUTION AND RISK MITIGATIONS

4.7.1. Implementation Plan

Hydro Ottawa's System Expansion program implementation plan encompasses the management of new and modified customer connection requests, ensuring compliance with regulatory requirements, supporting the city's growth, and maintaining system reliability. Additionally each connection request is reviewed and processed in accordance with the DSC and OEB regulations, ensuring fairness and compliance to timelines and requirements. The implementation plan includes:

- **Customer Relationship Management:** Leveraging the CRM system, streamlining processes, prioritizing requests, and maintaining transparent communication with customers.
- **Project Planning and Design:** Conducting thorough capacity assessments, developing detailed engineering plans, optimizing resource allocation, and managing project risks.
- **Construction and Implementation:** Overseeing construction activities, ensuring safety and quality, and coordinating with stakeholders.

- **Customer Connection and Support:** Completing connections, providing ongoing support, and monitoring customer satisfaction.

4.7.2. Risks To Completion and Risk Mitigation Strategies

Hydro Ottawa encounters several risks in managing its System Expansion Program, particularly as new developments and evolving customer demands place increasing pressure on the electricity distribution grid. Furthermore, the program's reliance on third-party projects introduces additional potential risks. Table 12 provides a summary of these key risks and the corresponding mitigation strategies that Hydro Ottawa will employ as needed.

1 **Table 12 - Key Risks of System Expansion Program and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	These scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Technology	Integrating new technologies into existing infrastructure may present challenges related to compatibility, reliability, or cyber security vulnerabilities; this poses a risk to program delivery schedule, cost, and scope.	Conduct thorough technical assessments and pilot testing of new technologies before full-scale deployment to identify and address potential issues. Partner with technology providers and industry experts to ensure seamless integration and mitigate technological risks. Implement robust cyber security measures, including encryption, regular security audits, and continuous monitoring, to protect critical infrastructure and customer data.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

4.8. RENEWABLE ENERGY GENERATION

Under the system expansion program if new station upgrades are deemed necessary to build adequate capacity required to connect new customer demand, Hydro Ottawa ensures that new station transformers shall have reverse power flow capability to enable DERs, with additional functionality enabled by modern microprocessor relays.

5. GENERATION CONNECTIONS

5.1. PROGRAM SUMMARY

Investment Category: System Access
Capital Program Costs:
2021-2025: $0.2M
2026-2030: $0.1M
Budget Program: Generation Connections
Main Driver: Customer Service Request
Secondary Driver: Mandated Service Obligations
Outcomes: Customer Focus

Investments in the Generation Connections program are required to facilitate the integration of generation sources, including renewable DERs and energy storage systems, into the distribution grid. These investments ensure compliance with the Electricity Act[21], OEB regulations[22], and DSC[23] guidelines, which collectively establish the framework and obligations of LDC's to facilitate and manage generation connections while maintaining system reliability and safety. The program encompasses various aspects, such as upgrading infrastructure, improving grid access, and streamlining connection processes to efficiently incorporate diverse energy sources.

Hydro Ottawa's expenditure plans for the Generation Connections program are strategically aligned with the evolving energy landscape for sustainable energy solutions and strengthen the City's transition to a low-carbon future.

Hydro Ottawa plans a net investment of less than $1M through the System Access Capital Investments in the 2026-2030 period compared to a net historical spending of $0.2M in the 2021-2025 period. The increase is driven by anticipated relative accelerated adoption of DERs in 2026-2030 versus 2021-2025 in support of the increasing trend of DER connections, please refer to Section 9 of Schedule 2-5-4 - Asset Management Process, as well as incentive programs such

[21] Electricity Act, 1998, Section 19(1)
[22] OEB Regulations - Chapter 5 - Connection Procedures
[23] Distribution System Code (DSC) - Section 6.1 - Connection of Generation Facilities

as the Save On Energy Home Renovation Savings Program[24] and the Save On Energy Retrofit Program[25] and known projects as committed and/or planned by Hydro Ottawa customers (there is one anticipated large DER connection, above 500 kW, per year between 2026-2030).

There are four types of generation connections within the Generation Connection program:

- Emergency backup generators - used when the local grid electricity supply is temporarily unavailable.
- Net-metering - allows customers to offset their electricity consumption by generating their own renewable energy, with any surplus being fed back into the grid.
- Load displacement generation - for customers who produce electricity solely for self-consumption purposes at all times (no electricity will be exported back to the utility grid)
- Stand-alone generation - for customers with intention of passing all generated electricity into the utility grid with no self-consumption.

Generation categories are defined in accordance with Section 1.2 of the DSC as follows:

- Micro-embedded generation facility: Facilities with a name-plate rated capacity of 10kW or less
- Small embedded generation facility: Facilities with a name-plate rated capacity of 500kW or less in the case of a facility connected to a less than 15kV line or 1 MW or less in the case of a facility connected to a 15kV or greater line
- Medium embedded generation facility: Facilities with a name-plate rated capacity above 500kW but less than 10 MW in the case of a facility connected to a less than 15kV line, or above 1 MW but less than 10 MW in the case of a facility connected to a 15kV or greater line
- Large embedded generation facility: Facilities with a name-plate rated capacity of more than 10 MW

[24] Save On Energy, "Home Renovation Savings Program, "https://www.saveonenergy.ca/For-Your-Home/Home-Renovation-Savings
[25] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

Within Hydro Ottawa's service territory, there is a diverse array of both renewable and non-renewable DERs, including energy-generating and storage facilities. These connections continue to be established under various programs, such as IESO-administered initiatives as well as through Net Metering and Load Displacement programs.

5.2. PERFORMANCE OUTCOMES

The objective of Generation Connections outlined in Table 13 is to ensure the timely, cost-effective, reliable, and safe integration of both renewable and non-renewable DERs into the distribution system for new and existing customers

Table 13 - KPI Metrics Impacted by Generation Connections

OEB Performance Outcomes	Outcome Description
Customer Focus	Contributes to Hydro Ottawa's customer focus objectives by fulfilling generation connection requests and meet mandated service obligations guided by relevant provisions of the DSC, Electricity Act, 1988 (Electricity Act), OEB Act, 1998 (OEB Act), and Hydro Ottawa's COS. Refer to Attachment 1-3-3(C) - Electricity Utility Scorecard Benchmarking Analysis for Mandated Service Obligations in the Utility Scorecard

5.3. PROGRAM DRIVERS AND NEED

5.3.1. Drivers

Primary Driver: Third Party Requirements

The main driver for Generation Connections to the distribution grid is customer driven connection of embedded generation projects. Each request includes specific requirements, including technical specifications for integration, connection impact assessments, and compliance with regulatory standards. Customers initiate these requests to ensure that their installations meet system requirements and are aligned with project timelines and development schedules.

Secondary Driver: Mandated Service Obligations

Hydro Ottawa has a service obligation pursuant to the DSC and governed by the Distributed Energy Resources Connection Procedure (DERCP) to connect generation connections in Hydro Ottawa's service territory

5.3.2. Current Issues

The following factors can limit the distributions systems ability to accommodate generation connections:

- Station Loading – Some station transformers have limited or no capability for reverse power flow. At these stations, the total connected generation cannot exceed either:
  - 60% of the top transformer rating plus the minimum station loading
  - The minimum station loading when the station transformers do not have reverse flow capability. This limit has been adopted from Hydro One's evaluation tool for generation connection assessment.
- Feeder Thermal Rating – Exceeding the feeder ampacity rating will result in overheating the conductors and connected equipment thereby reducing their effective life. For DERs, the available thermal capacity is the full feeder ampacity rating with less contingency loading.
- Short Circuit Rating – Connection of DERs will increase the available current that flows through the system during faults. The total available current during faults cannot exceed the equipment ratings.
- Power Quality – The following power quality concerns arise when connecting distributed generation:
  - harmonics caused by inverter based generation
  - phase imbalance caused by single-phase generators
  - voltage instability caused by generators connected at various points along a feeder, or by induction generators requiring reactive power
  - flicker caused by generators intermittently turning on and off which can affect the voltage on the circuit thus impacting the quality of supply to Hydro Ottawa customers
- Anti-Islanding – DERs may introduce safety and power quality issues in the event of continued un-sanctioned generation after the loss of distribution supply. The installation of transfer trip

functionality and alternate anti-islanding methods may be used to mitigate the potential for the un-sanctioned islanding of a generator. Currently, transfer trip is only required for generation connections equal to or larger than 500kW. The DERs connected to both feeders and station must be managed to prevent adverse impact to existing Hydro Ottawa load and customers.

5.4. PROGRAM BENEFITS

5.4.1. System Operation Efficiency and Cost Effectiveness

Integrating DERs into the distribution grid enhances system operational efficiency by decentralizing power generation, reducing transmission losses, and alleviating strain on central grid infrastructure. This decentralization also drives contributions to cost-effectiveness by minimizing the need for extensive infrastructure upgrades and improving load management. Additionally, DERs offer valuable services such as peak shaving and demand response, further optimizing operational costs and enhancing grid stability.

5.4.2. Customer

For the customer, DER integration can lead to lower energy costs through mechanisms like peak shaving and energy savings, while also offering them the opportunity to generate their own energy and potentially earn bill offsets or credits through programs like Net-Metering.

DERs have the capacity to enhance grid management by supplying/providing localized power that can continue during outages, enhancing/thus improving overall grid resilience. By reducing grid overloads and transmission losses, they lower the risk of equipment failures. DERs also incorporate advanced control features and enable the formation of microgrids, further strengthening grid stability and fault tolerance. They help reduce grid overloads and transmission losses, minimizing the risk of equipment failures. Advanced control features in DERs and the ability to form microgrids further strengthen grid stability and fault tolerance.

5.4.3. Cyber Security and Privacy

DERs can enhance cyber security by decentralizing energy generation, which reduces the risk of a single- point of failures and limiting in the grid and limits the impact of potential cyberattacks. Privacy benefits of DERS include more granular control over energy data, which can be managed and protected at the local level, minimizing exposure to broader data breaches.

5.4.4. Coordination and Interoperability

The distribution grid benefits from improved coordination and interoperability through real-time data exchange and communication between different energy sources. This enhances dynamic resource management and ensures that diverse energy systems operate seamlessly together, resulting in a more flexible and resilient grid.

5.4.5. Economic Development

DERs stimulate economic development by attracting investments in clean energy and creating jobs in the renewable sector. They help reduce energy costs for businesses and households, fostering local economic growth and stability. Additionally, DERs drive innovation and infrastructure enhancement, contributing to long-term economic resilience. Boosting economic development, DERs attract investment in clean energy and create jobs in the renewable sector. They also reduce energy costs for businesses and households, fostering local economic growth and stability. Additionally, DERs drive innovation and enhance infrastructure, contributing to long-term economic resilience.

5.4.6. Environment

Integrating DERs supports environmental sustainability by reducing reliance on fossil fuels and lowering GHG emissions. Utilizing clean energy sources such as solar and wind helps build a greener, more sustainable energy system.

5.5. PROGRAM COSTS

The annual spend for the Generation Connection Program is expected to have limited net cost over the 2026-2030 period, compared to the 2021-2025 period which also reflects this trend.

Hydro Ottawa evaluates these programs based on net spending, reflecting the balance between project costs and customer contributions. Forecasts for these contributions are derived from historical data and committed customer projects. Customer contributions for the Generation Connection Program are expected to match the gross cost of the project.

Table 14 below shows the historical and future spending in the Generation Connection program.

Table 14 - Historical, Bridge and Test Year Generation Connection Expenditures ($'000 000s)[26]

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Generation Connections - Gross	$ 0.2	$ 0.1	-	$ 0.1	$ 0.1	$ 0.7	$ 0.8	$ 0.8	$ 0.9	$ 1.0
Contributed Capital	$ (0.1)	$ (0.1)	-	$ (0.1)	$ (0.1)	$ (0.7)	$ (0.7)	$ (0.8)	$ (0.9)	$ (1.0)
ANNUAL NET TOTAL	**$ 0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
5-YEAR NET TOTAL	**$ 0.2**					**-**				

The increase is driven by anticipated acceleration in adoption of DERs in 2026-2030 versus 2021-2025, this is supported by the increasing trend of DER connections, please refer to Section 9 of Schedule 2-5-4 - Asset Management Process, due to incentive programs such as the Save On Energy Home Renovation Savings Program[27] and the Save On Energy Retrofit Program[28] and known projects as committed and/or planned by Hydro Ottawa customers (there is one anticipated large DER connection, above 500 kW, per year between 2026-2030).

[26] Totals may not sum due to rounding.
[27] Save On Energy, "Home Renovation Savings Program, "https://www.saveonenergy.ca/For-Your-Home/Home-Renovation-Savings
[28] Save On Energy,"Retrofit Program," https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

5.5.1. Cost Factors

- Infrastructure upgrades or system expansion required to support new generation systems
- Material and equipment costs
- Skilled labour availability
- Regulatory changes

5.6. ALTERNATIVES EVALUATION

5.6.1. Alternatives Considered

Alternative 1: Do Nothing (Refuse Generation Connections)

Refuse customer driven generation connections. This is not an option as by doing this Hydro Ottawa would be violating the DSC as well the COS. Hydro Ottawa must adhere to regulatory requirements that mandate the connection of generation under specific conditions. This compliance necessitates financial investment in infrastructure.

Alternative 2: Enable Generation Connections (Recommended)

Propose investments required to enable generation connections. Hydro Ottawa must invest in the proposed budget to support generation connections. This expenditure is critical for accommodating customer demand and the City of Ottawa's projected growth and addressing its evolving energy needs. Hydro Ottawa is required under the DSC to facilitate these connections, as long as customers fulfill the stipulated conditions, making this investment necessary.

5.6.2. Evaluation Criteria

The alternatives for Generation Connections were evaluated based on the following criteria:

- **Regulatory Compliance:** The program must consistently meet all legislative and regulatory requirements. This criterion assesses how well each alternative adheres to all applicable laws, regulations, and industry standards, including the DSC and Hydro Ottawa COS.
- **Environmental Sustainability:** The program should promote environmental sustainability by supporting renewable energy integration. This criterion examines the program's impact on

environmental sustainability, specifically its support for integrating customer-driven generation, which often involves renewable energy sources. This aligns with Hydro Ottawa's responsibility to contribute to a cleaner energy future.

- **Community Benefits:** The program should enhance community well-being by supporting customer energy choices and energy resilience and independence. This criterion assesses the program's contribution to community well-being, facilitating customer choice by connecting generation sources, allowing them to actively participate in the energy landscape and make decisions that align with their needs and preferences.

5.6.3. Preferred Alternative

Alternative 1: refusing generation connections, fails to meet the Regulatory Compliance criterion. By not facilitating generation connections, Hydro Ottawa would be in violation of the DSC and its COS. It also fails to contribute to Environmental Sustainability or Community Benefits, as it hinders the integration of renewable energy and customer energy choices.

Alternative 2: enabling generation connections, fully satisfies the Regulatory Compliance criterion by ensuring Hydro Ottawa fulfills its legal obligations under the DSC and COS. It supports Environmental Sustainability by facilitating the integration of renewable energy sources, aligning with the company’s commitment to a cleaner energy future. Furthermore, it contributes significantly to Community Benefits by empowering customers with energy independence, enhancing energy resilience, and supporting customer choice in the evolving energy landscape.

Based on the evaluation criteria, Alternative 2: Enable Generation Connections is the preferred alternative. It balances the need to meet regulatory requirements with the opportunity to promote environmental sustainability and enhance community well-being. This approach allows Hydro Ottawa to effectively support generation connections while contributing to a sustainable and resilient energy future for the City of Ottawa.

5.7. PROGRAM EXECUTION AND RISK MITIGATIONS

5.7.1. Implementation Plan

Hydro Ottawa utilizes a CRM system to manage and process connection requests. Generation connection requests are implemented in the order in which they are received. All requests are completed in accordance with mandated timelines.

5.7.2. Risks To Completion and Risk Mitigation Strategies

For Hydro Ottawa's Generation Connection Program, several risks to completion could arise. The potential risks and corresponding mitigation strategies are outlined in Table 15 below:

Table 15 - Key Risks of Generation Connection Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Regulatory and Compliance Risks	Failure to meet existing laws and regulations or changes to those laws and regulations pose a risk to program delivery schedule.	Hydro Ottawa maintains consistent communication with regulatory bodies to stay informed about any changes in regulations. Establishing a robust compliance framework and conducting regular audits ensures adherence to all requirements, minimizing the risk of delays and ensuring smooth project progression.
Infrastructure Capacity Issues	Limited infrastructure capacity such as short circuit constrained feeders or thermal constrained feeders may impede the ability to accommodate new generation connections, posing a risk to program delivery schedule.	Hydro Ottawa conducts thorough assessments of existing infrastructure and prioritizes necessary upgrades or expansions based on capacity needs. Investing in infrastructure improvements and strategic planning helps support the increased load from new connections and ensure efficient integration.

Category	Risk	Mitigation
Technical Challenges	Technical difficulties in integrating new generation systems with existing infrastructure poses a risk to the program delivery schedule.	Hydro Ottawa engages in detailed technical planning and performs rigorous testing before full-scale implementation. Collaborating with technology providers helps identify and resolve potential issues early, ensuring that the integration process is smooth and efficient.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Customer Engagement and Delays	Delays in customer submissions, approvals, or installations can pose a risk to the program delivery schedule.	Hydro Ottawa streamlines the application and approval processes to reduce delays. Providing clear guidelines and support to customers facilitates timely and accurate submissions, thereby minimizing potential disruptions in the project schedule.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Project Management Risks	Poor project management practices can result in missed deadlines and incomplete installations.	Hydro Ottawa implements robust project management practices, including detailed planning, regular progress reviews, and clear accountability structures. Utilizing project management tools to track progress and manage risks helps ensure that projects are completed on time and to specification.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

5.7.3. Timing Factors

Hydro Ottawa is mandated by the DERCP to maintain timelines required in generation connection projects in each stage of the project from connection impact assessments to energization. Hydro Ottawa uses a CRM system to track timelines for each step and monitor performance to avoid non-compliance.

Any delays due to scope change, cost overruns are clearly communicated to the customer to manage customer expectations on project delivery.

5.8. RENEWABLE ENERGY GENERATION

Investments in the Generation Connections program are required to facilitate the integration of generation sources, including renewable DERs and energy storage systems, into the distribution grid.

6. METERING

6.1. PROGRAM SUMMARY

Investment Category: System Access

Capital Program Costs:

2021-2025: $1.7M

2026-2030: $1.7M

Budget Program: Suite Metering

Main Driver: Customer Service Request

Secondary Driver: Mandated Service Obligation

Outcomes: System Accessibility, Customer Engagement, External Governance

The Suite Metering program supports investments in suite metering technology to ensure accurate and compliant measurement of electricity for Hydro Ottawa. Suite Metering initiatives, addresses both new customer connections and planned upgrades for existing customers. Suite Meters are used to individually meter electricity consumption in multi-unit residential buildings, enhancing precision and regulatory compliance.

The scope of the Suite Metering program includes installing smart meters in new or existing residential or commercial buildings, with clear definition of responsibilities for both Hydro Ottawa and the building owner. Hydro Ottawa supplies and installs the metering equipment, ensuring it meets Measurement Canada, building and electrical code standards, while the owner provides access and accurate occupant data.

6.2. PERFORMANCE OBJECTIVES AND TARGETS

The following outcomes are expected to be achieved through the Suite Metering Program, as outlined in Table 16 below.

Table 16 - Suite Metering Program Performance Outcomes

OEB Performance Outcomes	Target
Customer Focus	● Enhance customer engagement with expanded energy management tools by providing access to detailed energy use data. These tools will provide customers personalized insights into energy consumption, opportunities for enhanced energy efficiency and cost savings, greater control over their energy use, ultimately leading to improved customer satisfaction
Operational Effectiveness	● Improve grid planning and grid management by gaining insights from behind the meter customer energy data and consumption patterns at a granular level ● Enhance data-driven decision-making by leveraging meter data using analytics and tools to enhance visibility of behind the meter DERs and their impacts, identify trends, and inform opportunities for Non-Wires Solutions (NWSs) and other demand-side management programs for flexibility and reliability
Public Policy Responsiveness	● Contributes to Hydro Ottawa's grid modernization strategy and the OEBs expectation that utilities incorporate consideration of NWSs into their distribution system planning process by: ○ Utilizing load disaggregation and energy analytics tools for bottom-up behind the meter visibility to DERs and other electricity appliances. Improving visibility will enhance data-driven decision making, inform grid planning, and help uncover opportunities for load reduction and shifting using NWSs

6.3. PROGRAM DRIVERS AND NEEDS

6.3.1. Drivers

Primary Driver: Customer Service Request

The main driver for Hydro Ottawa in the Suite Metering program is to improve billing transparency, accuracy, and provide a single point of contact for customers, addressing potential issues with third-party providers.

Secondary Driver: Mandated Service Obligations

Secondary drivers include enhanced service reliability, consistent regulatory compliance with OEB standards, fair and transparent pricing by eliminating third-party fees, and more efficient maintenance and upgrades. Together, these factors contribute to a better customer experience and greater confidence in the metering and billing processes.

6.3.2. Current Issues

Suite metering presents Hydro Ottawa with several challenges, each requiring specific strategies and investments to overcome.

- **Complex and Costly Installation:** The installation process, whether fitting new buildings or retrofitting older ones, is complex and costly due to varying building layouts and infrastructure constraints. This variability leads to unique engineering requirements and potentially extensive on-site modifications. To address this, Hydro Ottawa uses strategic planning and coordination to optimize timelines and reduce expenses. Investments will support thorough site assessments and customized plans for efficient deployment.
- **Ensuring Reliable Communication with Numerous Meters:** Maintaining consistent and reliable communication with a large number of meters in a suite metering system poses a significant challenge, as building materials and signal interference can disrupt data transmission. This disruption can lead to inaccurate readings and operational inefficiencies, hindering the benefits of real-time monitoring and accurate billing. To address this, Hydro Ottawa will invest in robust communication infrastructure and advanced network technologies. This ensures consistent data transmission and real-time monitoring for accurate metering.

6.4. PROGRAM BENEFITS

6.4.1. System Operation Efficiency and Cost Effectiveness

Suite metering allows for more accurate tracking of individual consumption patterns. This data can be used to implement demand-side management programs in the future, encouraging consumers to shift their usage away from peak hours, thus reducing strain on the grid and the need for infrastructure upgrades.

6.4.2. Customer

By accurately measuring individual consumption in each unit, tenants can ensure fair billing according to their usage.

6.4.3. Environment

Suite metering drives environmental benefits by encouraging energy conservation. It allows for better grid management, lessening the need for infrastructure. By supporting green building practices, suite metering contributes to a more sustainable built environment. Ultimately, it empowers tenants to actively participate in a more environmentally responsible energy system.

6.5. PROGRAM COSTS

The annual spend for the Suite Metering Program is expected to average $0.3M over the 2026-2030 period which is consistent with the $0.3M average annual spend during the 2021-2025 timeframe. Hydro Ottawa expects the investment needs in this program to remain the same at $1.7M in both the 2026-2030 and 2021-2025 periods. Suite metering has remained relatively stable over the 2021-2025 period and this trend is expected to continue.

Table 17 presents the historical and projected future expenditures for the Suite Metering Program between 2021 and 2030.

Table 17 - Historical, Bridge and Test Year Metering Expenditures ($'000 000s)[29]

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Suite Metering	$ 0.6	$ 0.4	$ 0.2	$ 0.3	$ 0.3	$ 0.3	$ 0.3	$ 0.3	$ 0.4	$ 0.4
5-YEAR TOTAL					**$ 1.7**					**$ 1.7**

Cost projections for the Suite Metering Program were formulated by extrapolating from the 2021-2023 average volume. Continued investment levels in the Suite Metering Program will continue to support customers, providing more visibility of their consumption and facilitating customer conservation efforts. Variability in installation cost, prevalence of third party energy metering, changes in material and equipment, skilled labour availability, changes to regulations, and evolving communication requirements may cause deviations from this forecast. Hydro Ottawa

[29] Totals may not sum due to rounding

will continue to monitor suite metering expenditure trends and continue to support customers, providing more insight into their electrical consumption.

6.5.1. Cost Factors

- Variability of installation cost
- Prevalence of third party energy metering
- Changes in material and equipment, as well as, cost changes
- Skilled labour availability
- Changes to regulations

6.6. ALTERNATIVE EVALUATION

6.6.1. Alternatives Considered

Alternative 1: Bulk Metering: Managing a single meter for the entire building simplifies operations, reduces complexity, and avoids significant infrastructure upgrades. However, tenants lack direct control over their energy use and billing, leading to unfair cost distribution, higher energy consumption, and dissatisfaction with energy transparency.

Alternative 2: Third-Party Metering: Third-party providers handle the metering infrastructure, reducing upfront capital costs for Hydro Ottawa. This arrangement allows Hydro Ottawa to avoid dealing directly with tenants for billing or service issues. However, it loses control over the customer experience, which can lead to lower service standards, delayed issue resolution and inconsistent billing. This situation may result in customer complaints and potential reputational damage to Hydro Ottawa.

Alternative 3: Suite Metering (Hydro Ottawa Managed) - Preferred Alternative: Hydro Ottawa directly manages the suite metering program. This approach allows for increased customer base, enhances energy efficiency and conservation, and improves customer experience and satisfaction. Suite metering enables Hydro Ottawa to expand its customer base by serving individual tenants in a multi-residential unit building instead of only the building owner as a single customer. It encourages responsible energy consumption by providing individual tenants with direct control over their electricity usage and billing, aligning with Hydro Ottawa's energy conservation goals and regulatory mandates. Suite metering also allows for more accurate and personalized billing, leading to higher customer satisfaction. Tenants can monitor their usage and bills directly with Hydro Ottawa.

6.6.2. Evaluation Criteria

The alternatives considered for suite metering were evaluated based on the following key criteria to determine the most beneficial approach for Hydro Ottawa and its customers:

- **Customer Empowerment and Energy Awareness:** The extent to which the alternative provides tenants with direct control over their energy usage and billing, fostering energy awareness and promoting conservation.
- **Operational Efficiency and Complexity:** The impact of the alternative on Hydro Ottawa's operational processes, including billing, customer service, and infrastructure management.
- **Customer Experience and Satisfaction:** The potential of the alternative to enhance customer satisfaction through accurate billing, personalized service, and transparent energy management.
- **Regulatory Alignment and Strategic Goals:** The degree to which the alternative supports Hydro Ottawa's regulatory obligations, energy conservation goals, and strategic objectives, including expanding its customer base.
- **Cost-Effectiveness and Risk Mitigation:** The financial implications of the alternative, including upfront costs, ongoing maintenance, and potential risks associated with customer dissatisfaction or operational inefficiencies.

6.6.3. Preferred Alternative

Based on the evaluation criteria, **Alternative 3**: managing suite metering directly by Hydro Ottawa is the preferred alternative.

Alternative 1: While bulk metering offers operational simplicity, it fails to empower tenants or promote energy conservation, leading to potential customer dissatisfaction.

Alternative 2: Third-party metering, while reducing upfront costs, compromises customer experience and control, posing reputational risks.

Alternative 3: Hydro Ottawa's direct management of suite metering aligns with its strategic goals by expanding its customer base and enhancing energy efficiency. It empowers tenants with direct control over their energy consumption, leading to increased energy awareness and conservation. This approach also ensures a high level of customer satisfaction through accurate and personalized billing, while maintaining control over the customer experience. By directly managing the suite metering program, Hydro Ottawa can effectively balance operational efficiency, customer satisfaction, and regulatory compliance.

6.7. PROGRAM EXECUTION AND RISK MITIGATIONS

6.7.1. Implementation Plan

Hydro Ottawa utilizes a CRM system to manage and process suite metering requests. Suite metering requests are implemented in the order in which they are received. All requests are completed in accordance with mandated timelines.

6.7.2. Risks To Completion and Risk Mitigation Strategies

Resource availability and suite metering panel supply pose the biggest risk to project completion. To meet demand, Hydro Ottawa engaged three suite metering service providers. Clear communication with building owners ensures timely panel delivery and project completion.

6.7.3. Timing Factors

Hydro Ottawa must provide an offer to connect for suite metering requests within 60 calendar days after receiving a complete application. The timeline for an offer to connect is specified in the OEB's DSC, Section 6.2.7. The offer outlines the connection terms, costs, and requirements for connection unit suites.

SYSTEM RENEWAL INVESTMENTS

1. SUMMARY

Hydro Ottawa's System Renewal Capital Investments for 2026-2030 total $431.8M, focusing on five key programs designed to replace deteriorating infrastructure, enhance grid resilience, and ensure the continued delivery of safe and reliable electricity service to the community.

System Renewal Capital Programs:

Section 2. Stations and Buildings Infrastructure Renewal ($107.7M):
Hydro Ottawa's Station and Buildings Infrastructure Renewal Program invests in upgrading and replacing deteriorating assets for stations and station buildings to maintain system reliability and safety. These assets include transformers, switchgear, batteries, protection and control systems, and other minor assets such as reclosers, insulators, arresters, online monitoring equipment and station building roofs. Investment prioritization of condition based assets utilizes Predictive Analytics, the risk assessment model which considers reliability, safety, financial, environment and compliance factors. Non-condition based assets, including RTUs, station minor assets, buildings/facilities and transfer trip installations are prioritized based on age.

Section 3. OH Distribution Asset Renewal ($67.8M):
This program focuses on renewing overhead distribution infrastructure, including poles, transformers, switches and reclosers, with the objective of mitigating long-term risk based on the results from Predictive Analytics.

Recent weather events have highlighted the vulnerability and increased failure rate of overhead equipment. Consequently, the program now includes incremental investment attributed to strategic undergrounding, line relocation, or hardening of critical overhead sections due to added complexity.

Section 4. UG Distribution Asset Renewal ($103M):

This program replaces deteriorating underground distribution assets, including cables, transformers, and switchgear, civil infrastructure and vault equipment, with the objective of mitigating short-term risk based on the results from Predictive Analytics. Investments in this area are essential for maintaining the reliability and resilience of the underground network.

Section 5. Metering Renewal ($86.4M):

This program involves upgrading and replacing functionally obsolete metering infrastructure to support advanced metering functionality and improve system monitoring capabilities. This investment ensures regulatory compliance, improves customer billing, and enables advanced grid management capabilities for improved reliability and customer engagement.

Section 6. Corrective Renewal ($66.9M):

This program addresses the replacement of assets that have degraded to a point of functional failure and pose an imminent failure risk, or have been damaged by third parties. While prioritizing proactive renewal, Hydro Ottawa also recognizes the need for reactive measures to maintain system integrity and address unexpected failures.

These investments address key challenges such as deteriorating infrastructure, the need to adapt to evolving technology (e.g. smart meters), and climate change impacts (including extreme weather events). Hydro Ottawa is committed to providing safe, reliable, and sustainable electricity service to the residents and businesses of Ottawa, and these investments are crucial to fulfilling that commitment.

These investments will deliver tangible benefits to Hydro Ottawa's customers:

- **Enhanced Reliability:** Modernizing and strengthening the grid will reduce the frequency and duration of outages.
- **Enabling a Cleaner Energy Future:** Facilitating the integration of renewable energy sources supports a more sustainable energy future for Ottawa.
- **Improved Accuracy & Transparency:** Advanced metering infrastructure will enhance the accuracy and transparency of electricity measurement and provide customers with greater insights into their energy consumption.

Hydro Ottawa acknowledges the challenges inherent in implementing these investment programs, including the need to replace deteriorating equipment to prevent outages, strengthening the grid to withstand extreme weather and ensure reliable power, and investing in smart meter infrastructure. This document details how these investments will address these challenges to deliver safe, reliable, and sustainable electricity service to the residents and businesses of Ottawa.

2. STATIONS AND BUILDINGS INFRASTRUCTURE RENEWAL

2.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $31.4M

2026-2030: $107.7M

Budget Programs: Station Transformer Renewal, Station Switchgear Renewal, Station Battery Renewal, Station P&C Renewal, Station Minor Assets Renewal, Station Major Rebuild, EOL Voltage Conversion.

Main Driver: Failure Risk

Secondary Driver: Reliability, Safety, Environmental, Capacity Constraints

Outcomes: Operational Effectiveness, Customer Focus

Hydro Ottawa's Station and Buildings Infrastructure Renewal Program invests in renewing station assets and station buildings. This program replaces end-of-life station assets in a deteriorated condition, ensuring long-term performance and prioritizing projects based on asset condition and risk, as determined through the distribution asset model in Copperleaf PA (described in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process).

An investment of $107.7M is proposed to this program for this Application. The primary contributor is investments in five voltage conversion projects necessitated by the need to replace end-of-life station transformers. These projects account for over half of the program's expenditure. The majority of the remaining investment is attributed to four station switchgear renewal projects, based on the needs identified through Copperleaf Predictive Analytics (PA). This funding will maintain overall system reliability by optimizing asset replacement strategies and improving the operational asset performance of existing station infrastructure.

The Stations and Buildings Infrastructure Renewal Program encompasses the following Budget Programs for the 2026-2030 period:

Stations Switchgear Renewal: This budget program covers the cost of replacing end-of-life breakers in deteriorated condition at four stations: Rideau Heights DS, Parkwood Hills DS, Hinchey TH, and Russell TB. The program also includes funding to replace relays and RTUs at these stations that have become obsolete or have operational issues.

Station Battery Renewal: This budget program includes the replacement of an average of two battery banks per year over the course of the 2026-2030 rate period. There are 11 stations planned for battery replacement: Augusta UD, Beechwood UB, Bronson SB, Bantree AL, Woodroffe DS, Bayswater UJ, Florence UF, Holland SH, Urbandale AE, Centrepointe DS and Moulton MS stations.

Station Protection & Control (P&C) Renewal: This budget program encompasses the replacement of several critical components within the protection and control system, such as relays and Remote Terminal Units (RTUs). This includes replacing the end-of-life electromechanical relays at both the Carling TM and King Edward TK stations. Additionally, the program targets the replacement of obsolete RTUs at Centrepointe DS, Jockvale DS, and Queensway-Carleton Hospital (QCH) DS. Finally, the program will address the replacement of end-of-life transfer trip installations for the Lemieux Island Filtration Plant and the Britannia Filtration Plant.

Station and Building Minor Asset Renewal: This budget program focuses on replacing non-major station assets, including station outdoor reclosers, lightning arresters/insulators, online dissolved gas analysis (DGA) monitors, and station buildings and operational facilities. The funds will be utilized to replace and upgrade station equipment and buildings, and for specific capital projects at the Dibblee and Maple Grove operational sites. These investments are crucial for maintaining the reliability and efficiency of the electricity distribution system, and for preventing costly equipment failures and service disruptions.

EOL Voltage Conversion: This budget program focuses on decommissioning 4kV stations that have reached end-of-life (EOL). The prioritization of voltage conversion projects is based on station transformer risk assessments conducted within Copperleaf PA. As detailed in Section 9.1.4.6 of Schedule 2-5-4 - Asset Management Process, the 4kV system cannot accommodate anticipated future demands. Consequently, there are plans to decommission 4kV assets. The program's scope encompasses voltage conversion for five stations: Fisher AK, Dagmar AC, Henderson UN, Church AA and Vaughan UG.

2.2. PERFORMANCE OUTCOMES

Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. Investments in stations and buildings infrastructure renewal programs support Hydro Ottawa's performance on the outcomes shown in Table 1.

Table 1 - Station Asset Renewal Program Performance Outcomes

OEB Performance Outcome	Description
Operational Effectiveness	Hydro Ottawa's system reliability objectives are supported by: ● Replacing assets at a pace that allows Hydro Ottawa to achieve 55% of station assets that have reached their end-of-life by 2030. ● Replacing assets at a pace that allows Hydro Ottawa to minimize the percentage of station assets in poor and very poor condition by 2030.
	● Contributes to Hydro Ottawa's Grid Modernization Plan by replacing 145 electromechanical relays with digital relays, thereby improving station-level observability
Customer Focus	Contributes to Customer Satisfaction by maintaining system reliability

2.3. PROGRAM DRIVERS AND NEED

2.3.1. Main and Secondary Drivers

The Station Asset Renewal program's primary and secondary drivers are as follows:

Primary Driver – Failure Risk: The primary driver for station renewal investments is the increasing failure risk due to the number of assets in a deteriorated condition or surpassing their typical useful life (TUL). The proposed investments are supported by the Copperleaf PA distribution asset model which considers asset condition as a part of the risk assessment value framework. Further detail on the distribution asset model is provided in Section 5.1.4.2 of Schedule 2-5-4 - Asset Management Process.

Secondary Drivers – Reliability, Safety, Environmental and Capacity Constraints: Station assets directly affect system reliability, as any failure can lead to power outages for large numbers of connected customers. An increase in station asset failures will negatively impact reliability indices such as System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI), which measure the frequency and duration of customer interruptions.

These assets also pose significant safety risks to Hydro Ottawa personnel, contractors, and the public due to the potential for asset failure. Major oil-filled equipment like station transformers can create environmental hazards through oil leaks. Similarly, the failure of Sulfur Hexafluoride (SF_6) switchgear presents environmental risks, as SF_6 is a potent greenhouse gas.

Additionally, increased system capacity needs and the growing demand for electrification make the capacity limitations of 4kV stations a key factor driving station renewal investments, particularly for voltage conversion projects.

2.3.2. Current Issues

The primary focus of the station renewal program is to mitigate the risks associated with station assets in degraded condition. The age and condition demographics of the major station assets considered within scope of the station asset renewal program are provided in Figures 3 to 14, with the overall summary highlighted in Figure 1 and Figure 2.

Figure 1 - Overall Age Demographics Profile of Station Assets

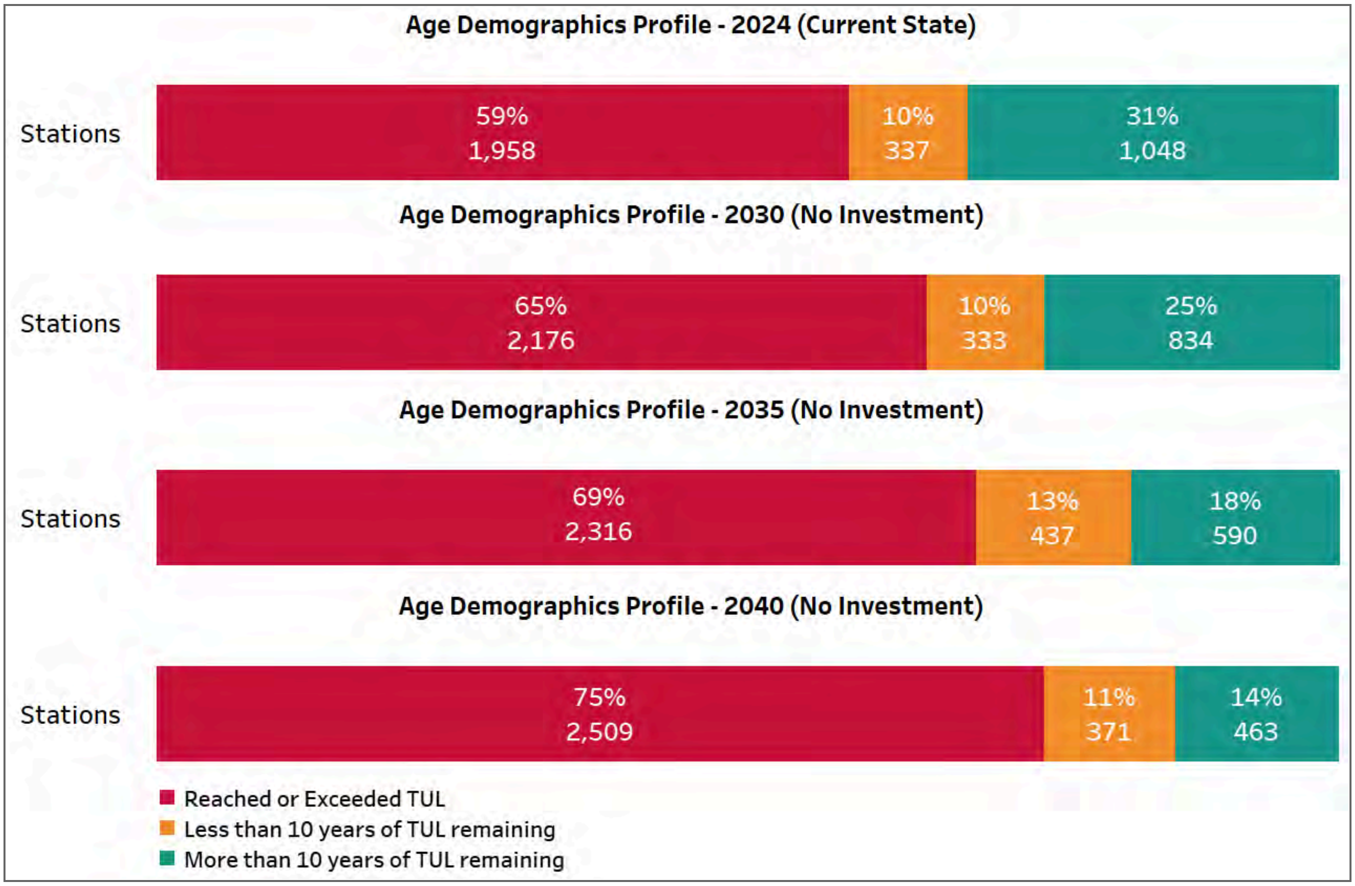
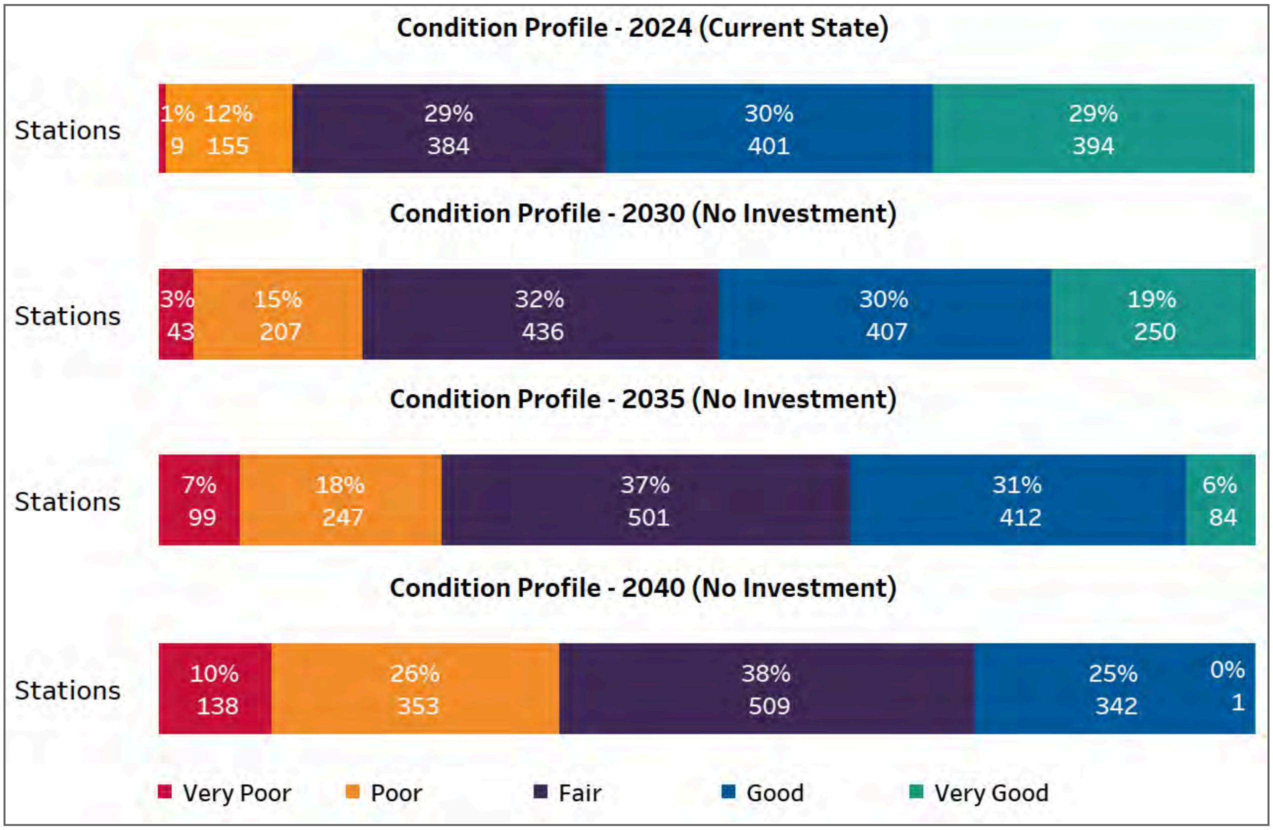


Figure 2[1] - Overall Condition Profile of Station Assets



For context, TUL refers to the expected duration an asset can reliably operate before it requires replacement or refurbishment. Condition ranges also provide a way to assess the state of an asset and determine the urgency of any necessary interventions. To this end, Hydro Ottawa uses a health index, which is a score from 0% to 100%, to evaluate the condition of an asset from Very Poor to Very Good. More details on Hydro Ottawa's condition assessment framework is presented in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process.

Through Copperleaf PA, Hydro Ottawa established the unique degradation pattern of each individual asset in the system into 2040. Figure 1 shows that, without intervention, Copperleaf PA

[1] Excludes station relays

forecasts Hydro Ottawa's end-of-life station assets to increase by about 5% every five years. Likewise, without intervention, the percentage of assets in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years.

The following sub-sections summarize some of the challenges faced by Hydro Ottawa specific to its existing station assets.

2.3.3. Station Transformers

Figures 3 and 4 demonstrate that Hydro Ottawa's station transformers are reaching end of life at a rapid pace, with some degree of deterioration. Specifically, Copperleaf PA forecasts that without intervention the percentage of station transformers that have reached their end of life will increase to more than half (51%) in 2030 and continue to grow at a rate of approximately 2.5% every five years, thereafter. Likewise, without intervention, the percentage of station transformers in degraded condition (poor or very poor) will continue to grow at a rate of approximately 7% every 5 years. The risk of failure for station transformers, a major asset class, can significantly disrupt the distribution system. As lead times for new transformers exceed two years and unit replacement costs have significantly increased, the urgency of addressing the risk of failure is amplified. The risk is further compounded by the increased load associated with electrification, as existing transformers are strained to support these additional loads, resulting in accelerated deterioration.

Figure 3 - Age Demographics Profile of Station Transformer

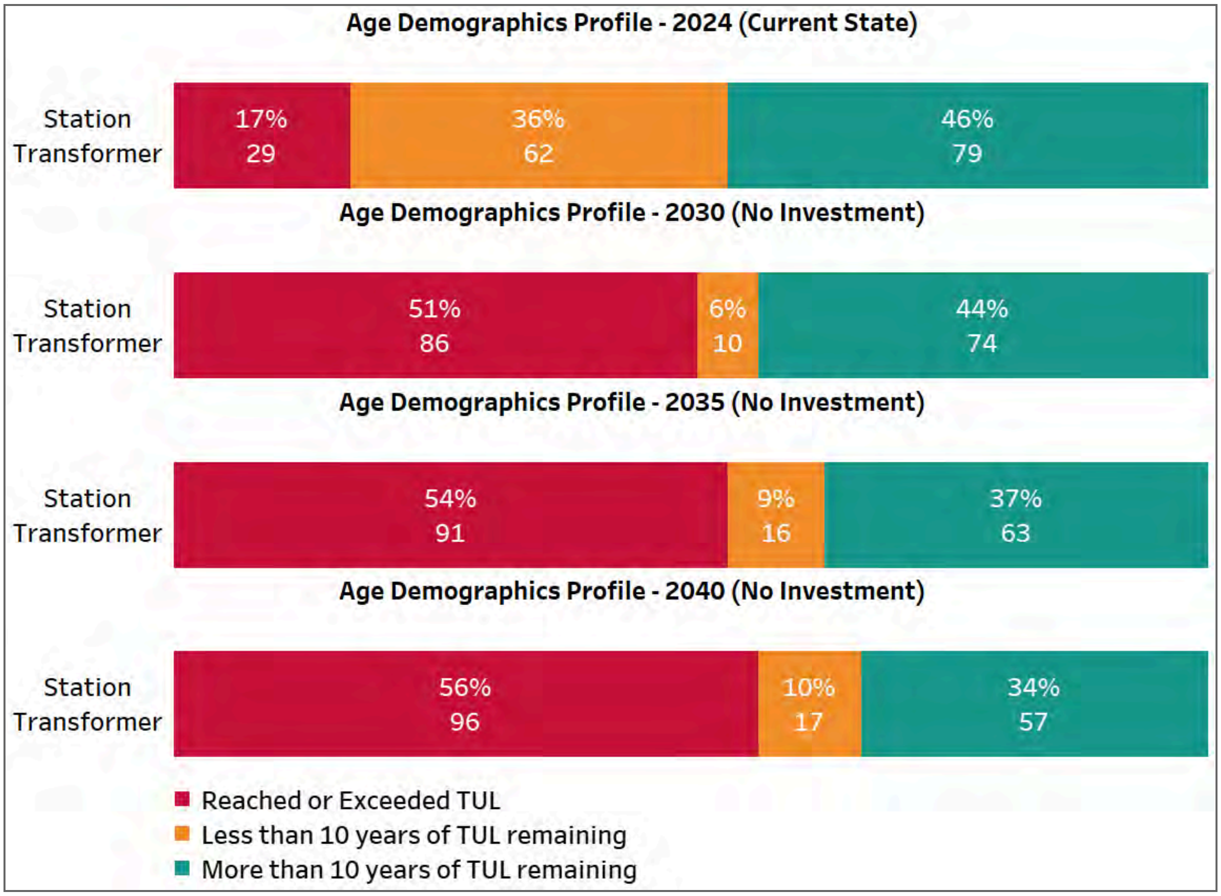
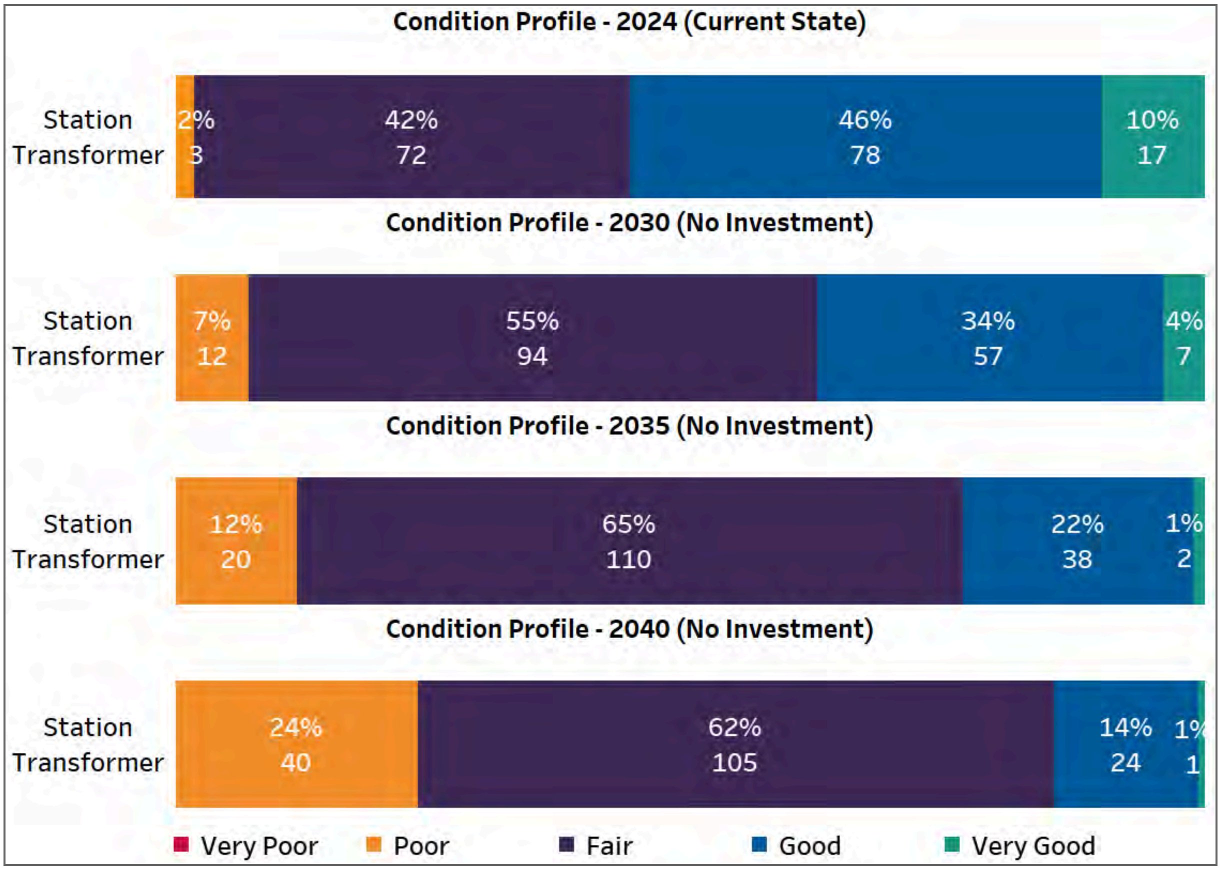


Figure 4 - Condition Profile of Station Transformers



4kV Station Assets: Of Hydro Ottawa's 92 stations, 35 are 4kV stations. These 4kV stations contain 95 station transformers, of which approximately 17% have exceeded their anticipated TUL. By 2030, 7% of these transformers are forecast to be in deteriorated condition. Consequently, Copperleaf PA recommended intervention for station transformers at five stations: Henderson UN, Church AA, Vaughan UG, Carling SM, and Nepean AB.

The 5 aforementioned stations are located in areas of Hydro Ottawa's service territory that are seeing growth due to intensification, transit oriented development and electrification. Hydro

Ottawa's lower voltage systems (4kV/8kV) have limitations compared to the 13kV and 28kV systems as listed below:

- Compared to 28kV/13kV, the 4kV/8kV systems are less efficient for long-distance power distribution, leading to greater losses and voltage drop issues.
- The maximum capacity that a 4kV/8kV feeder can carry is low compared to higher voltage systems significantly limiting the ability to accommodate the large load requests. The maximum capacity of a 4kV feeder is 2.3MVA, 8kV feeder is 3.6MVA compared to 9.7 MVA on 13kV and 16.4 MVA on 28kV.
- Some 4kV and 8kV stations are heavily loaded, hindering new customer connections.

With the anticipated customer demand growth, the 4kV system will be unable to support the forecasted capacity in the future, therefore investments in voltage conversion are essential when replacing the 4kV transformers.

In addition to the station transformers, Hydro Ottawa also reviewed the age/condition of the related station switchgear at the identified stations. Figure 5 and Figure 6 represent the condition and age profiles of these major assets within the aforementioned five 4kV stations. Without intervention, the percentage of 4kV station assets in a degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years. Approximately 86% of the 4kV station assets within these stations have reached the TUL, with all assets forecasted to reach their TUL by 2030.

Figure 5 - Condition Profile of 4kV Assets at Henderson UN, Church AA, Vaughan UG, Carling SM, and Nepean AB

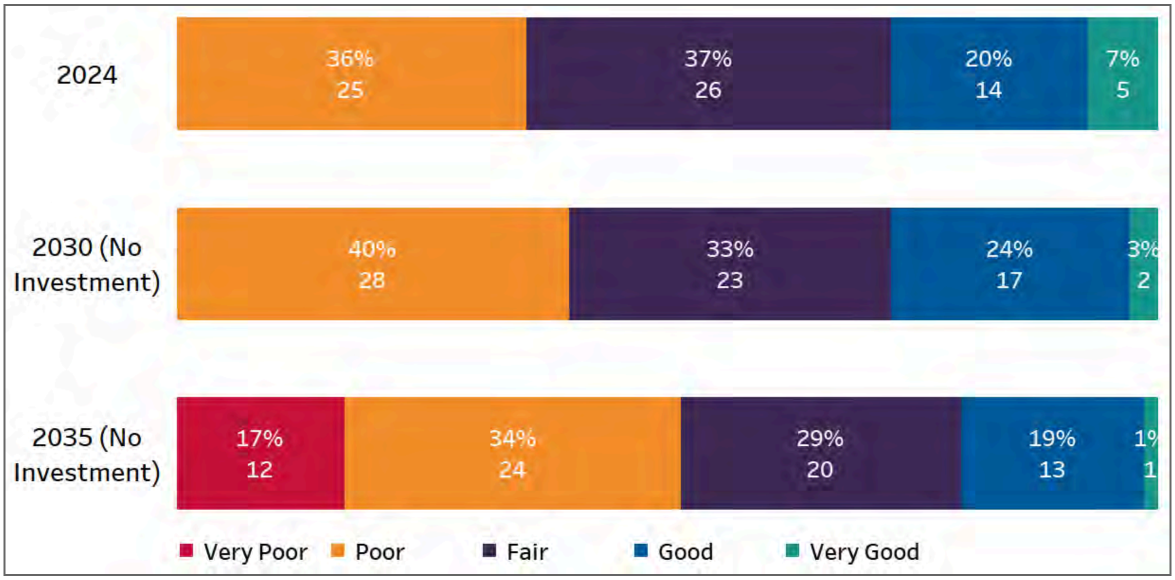
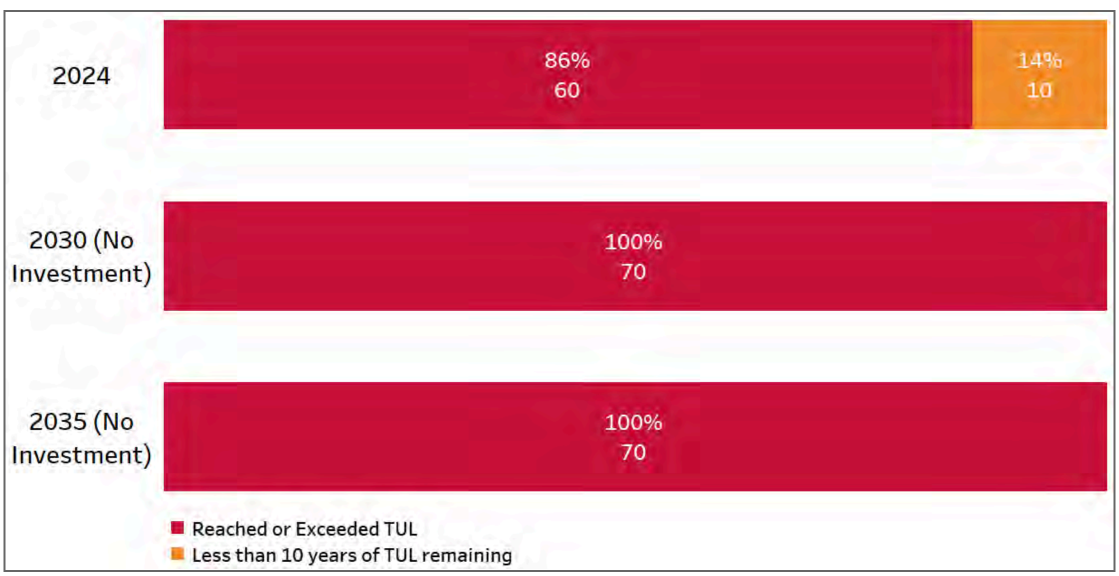


Figure 6 - Age Demographic Profile of Henderson UN, Church AA, Vaughan UG, Carling SM, and Nepean AB



Upon reviewing the 2035 projections of the assets at the aforementioned five stations, Hydro Ottawa has proposed a phased approach to the decommissioning of the 4kV transformers and related station equipment at 3 of the 5 stations (Henderson UN, Church AA, Vaughan UG) through voltage conversions to 13kV. To mitigate the increased risk associated with the two remaining stations (Carling SM, and Nepean AB), Hydro Ottawa will increase monitoring and testing at and will ensure capital spares are available. The high cost and resource intensity of 4kV voltage conversions led Hydro Ottawa to the decision to defer 2 of the 5 stations, leading to an approach that balances long term risk with short term financial and resourcing limitations. In addition to the phased approach of decommissioning station equipment at the aforementioned 3 stations, Hydro Ottawa will prioritize the completion of the EOL voltage conversion initiatives at Fisher AK and Dagmar AC substations. The costs and resources for the planned voltage conversion at these stations is also accounted for, as Hydro Ottawa has a solid plan for execution in 2026-2030, based on the analysis performed to support the re-scoping/deferral strategy.

2.3.4. Station Switchgear

Figure 7 demonstrates that more than half (51%) of Hydro Ottawa's station switchgear have currently reached or exceeded their TUL, with some degree of deterioration. Likewise, without intervention, the percentage of station switchgear in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years.

Figure 7 - Age Demographics Profile of Station Switchgear

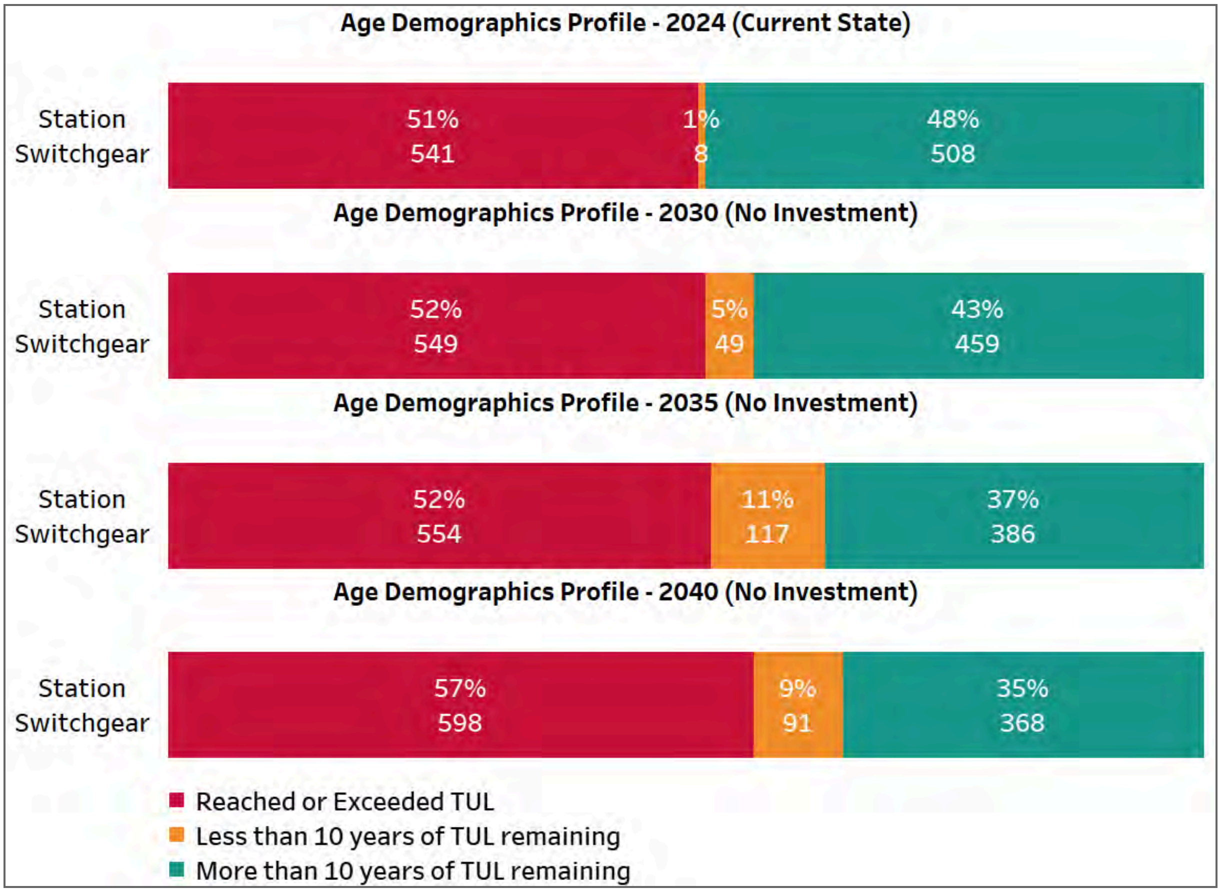
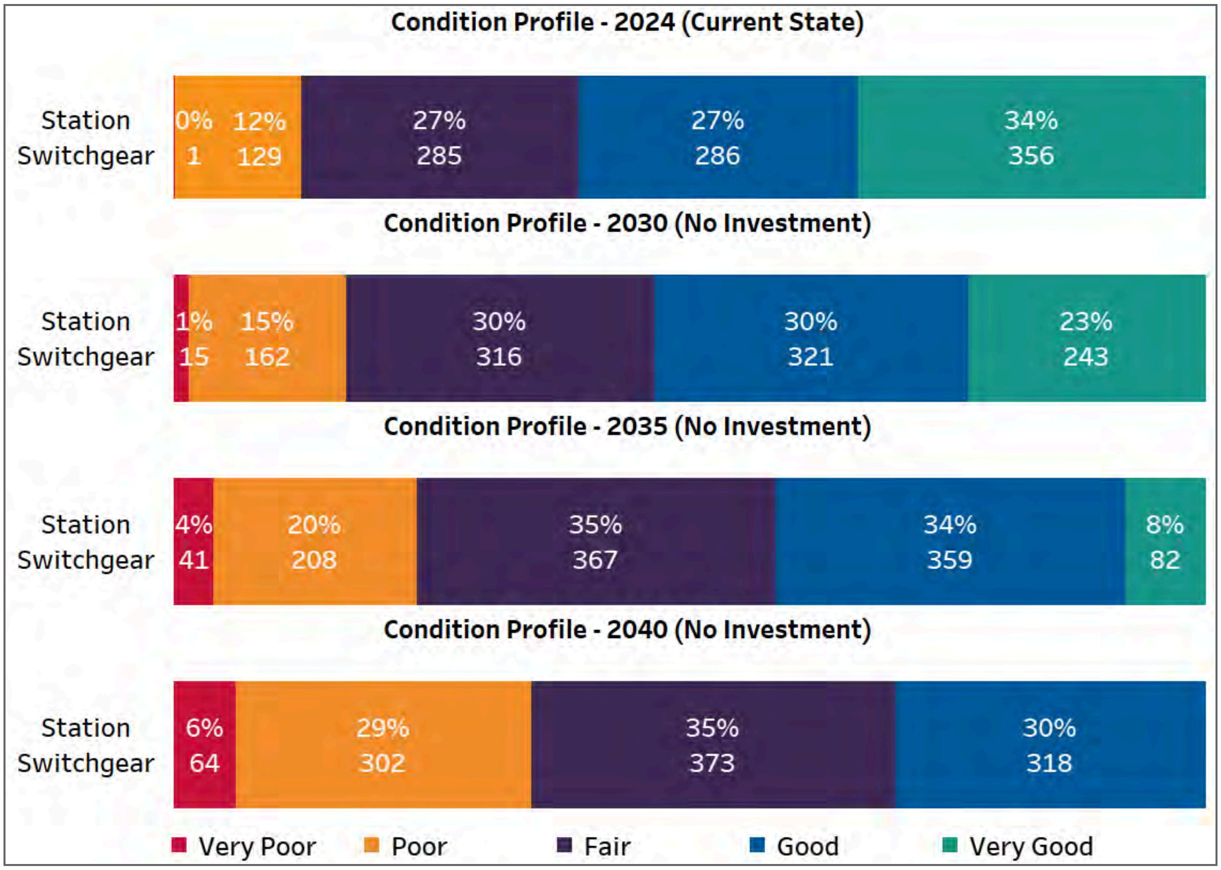


Figure 8 - Condition Profile of Station Switchgear



Furthermore, Hydro Ottawa has experienced metal clad switchgear failures, specifically with the air and SF_6 types, impacting system reliability and resulting in customer interruptions, as shown in Figure 9 and Figure 10. A specific type of air type breaker (FPE DST-2) had reclosed on a fault and failed on two occasions. During both failure events, an arc on one of the phases was not successfully extinguished by the arc chute, leading to the melting of the fixed arcing contact.

Figure 9 - FPE DST-2 Breaker Failure Event

Figure 10 - SF_6 Switchgear Failure Event

Hydro Ottawa has also seen SF_6 switchgear failures with multiple potential failure modes identified, such as overtravel and material damage due to contaminated SF_6. The strain hardening of the copper material due to minor deformation, led to sudden or progressive fracture. Overtravel of the moving contact “hammering” on the fixed arcing contact, or misalignment of the moving contact causing bending of the fixed arcing contact on closing operations had been the underlying contributing failure mechanisms. These failures were addressed under the Emergency Renewal budget program, as outlined in Section 6 - Corrective Renewal.

In light of the aforementioned equipment failures and a comprehensive assessment of the current condition of existing switchgear population, Hydro Ottawa has prioritized the replacement of end-of-life SF_6 and air-type switchgear at 4 critical stations, for the 2026-2030 rate period.

2.3.5. Station Batteries

A substantial proportion of the station battery fleet, approximately 53%, will reach the end of their typical useful life by 2030 (refer to Figure 11). Likewise, without intervention, the percentage of station batteries in degraded condition (poor or very poor) will continue to grow at a rapid rate, reaching 100% by 2040. Batteries play a critical role as a backup power supply for stations and need to be proactively managed to ensure the operation of protection and control devices. As such, Hydro Ottawa is recommending the replacement of 12 battery banks during the 2026-2030 period.

Figure 11 - Age Demographics Profile of Station Batteries

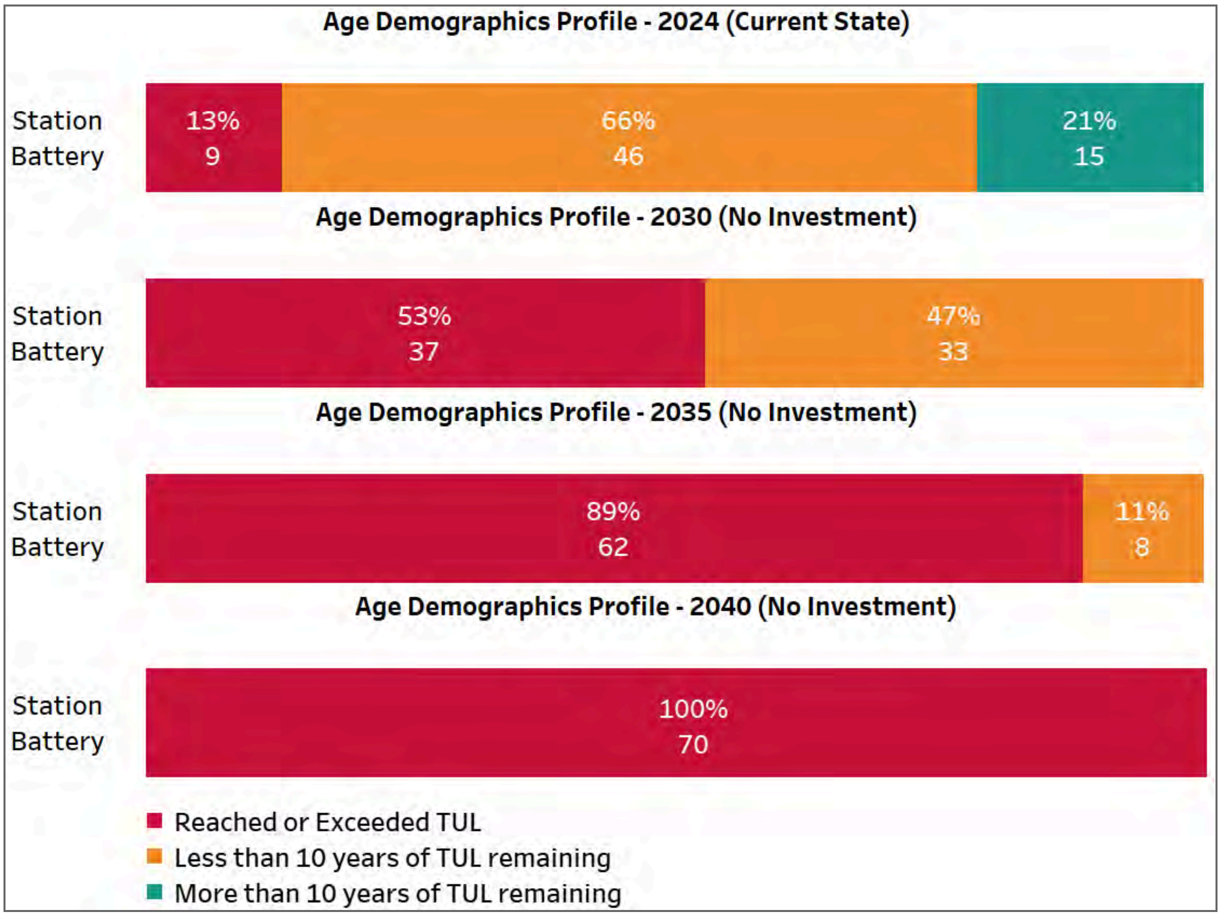
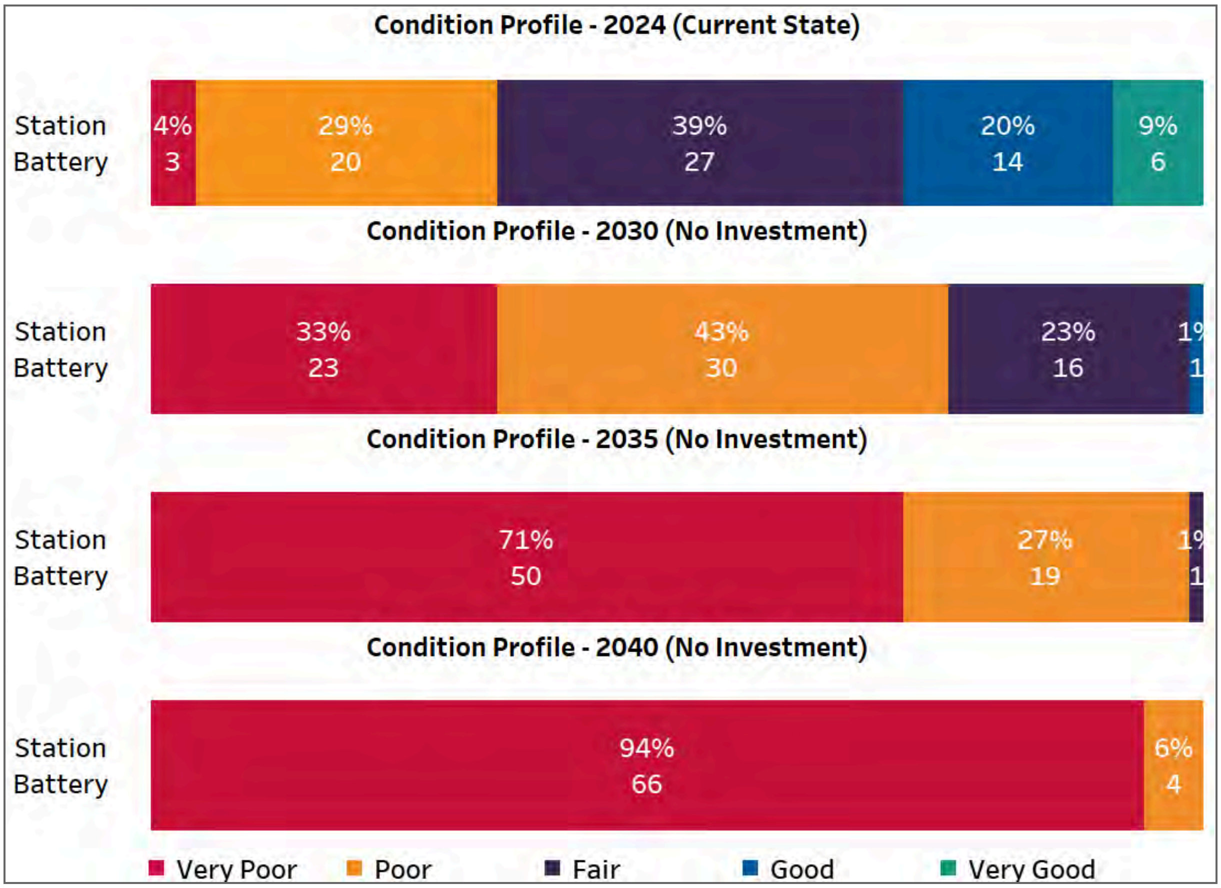


Figure 12 - Condition Profile of Station Batteries

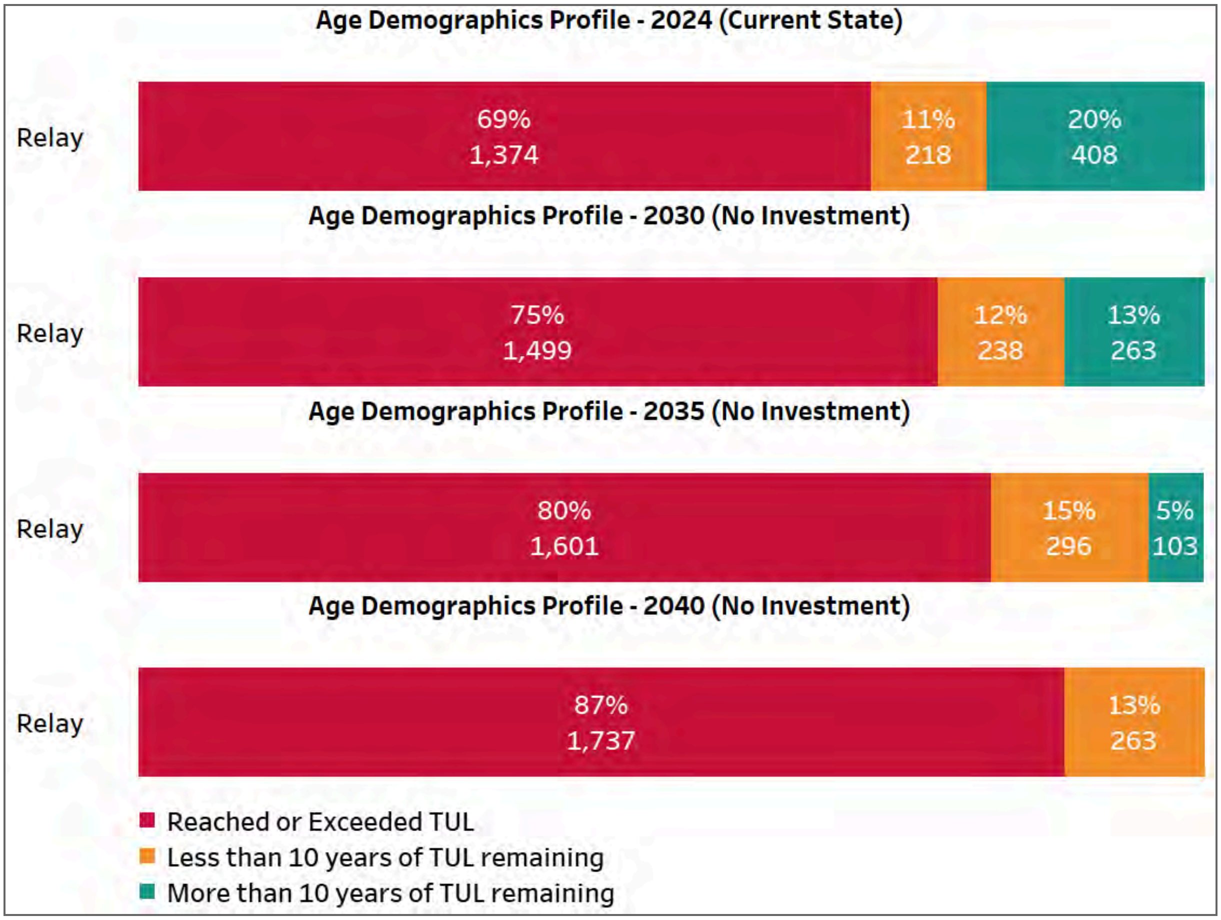


2.3.6. Station P&C

Relays

Approximately 69% of Hydro Ottawa's 2,000 service relays (across all types) have reached the end of their TUL (refer to Figure 13). There is a need to upgrade the obsolete, conventional, electromechanical relays with microprocessor-based ones, to ensure control and protection operation as intended, and eliminate any safety risks around unanticipated failures or miscoordination, alongside minimizing interruption to customers. The planned conversion of the 4kV stations will provide an opportunity to systematically address the obsolescence and failure risk of the electromechanical relays.

Figure 13 - Existing and Forecasted Age Demographics of Station P&C Equipment



Remote Terminal Units (RTUs)

Hydro Ottawa has approximately 340 RTU installations in its substations. The SCOUT, SAGE and RTAC installations represent approximately 30% of the population. Hydro Ottawa has observed the failure of some obsolete SCOUT RTUs which has resulted in them no longer reporting to Supervisory Control and Data Acquisition (SCADA), despite attempts to maintain them. These operational issues affect the substation's ability to communicate with System Office. Hydro Ottawa is proposing investments towards replacing the obsolete SCOUT RTUs at select stations such as Centrepointe DS, Jockvale DS and QCH DS.

Transfer Trip Installations

Hydro Ottawa manages transfer trip installations associated with generation connections. Following consultations with customers regarding their projected operational needs and long-term plans, Hydro Ottawa ensures the ongoing compliance of transfer trip installations with present operational requirements, while also considering anticipated future demands. To this end, Hydro Ottawa has identified two major locations requiring the replacement of transfer trips during the 2026-2030 period: Lemieux Island filtration plant and Britannia filtration plant. The installations at these filtration plants rely on aging telephone line infrastructure for communication, which are susceptible to failure. Strategically targeting the renewal of these P&C assets and their associated communication infrastructure will enable Hydro Ottawa to verify transfer trip functionality and ensure compliance with current standards, to effectively mitigate the risk of disruptions.

2.3.7. Stations and Buildings Minor Assets

Station Minor Assets

Station minor assets, including insulators, lightning arresters, and outdoor reclosers, are crucial for substation operations and reliability. A recent outage at Bells Corner DS substation caused by an insulator-fuse connection failure (Figure 14), necessitated the emergency isolation of a station transformer, highlighting the importance of these assets. Additionally, Hydro Ottawa has experienced operational issues with Kelman online DGA monitors. Managing these units is essential for continuous monitoring of gassing levels, which provides early indication of failures in station transformers, ensuring their safe and reliable operation.

Figure 14 - Station Outdoor Insulator Damage at Bells Corner DS Substation

Hydro Ottawa proactively monitors these assets through annual visual inspections and infrared scans which identifies potential problems, enabling preventative maintenance or replacements to minimize outages and service interruptions. Proactive replacements, determined through these inspections, are implemented to prevent such disruptions. Through these inspections, Hydro Ottawa has identified the need to replace outdoor reclosers, lightning arresters, insulators, and 30% of Kelman online DGA monitors on station transformers, over the 2026-2030 period.

Station Buildings

Hydro Ottawa's service area includes over 70 Hydro Ottawa owned distribution stations, with buildings ranging in age from 2 to 102 years, five of which are designated heritage sites. The City of Ottawa has recognized these five century-old substations (see Table 2) for their architectural significance. Figures 15 and 16 showcase two examples: the Bronson SB and Holland SH stations, respectively. Maintaining these heritage buildings, which house essential equipment, requires significantly greater investments of time, resources and financial expenditure.

Table 2 - List of Hydro Ottawa Heritage Stations

Name	Building Category	In Service Year
Bronson US	Substation	1922
Holland US	Substation	1924
Carling Avenue TS	Substation	1928
King Edward TS	Substation	1931
Riverdale TS	Substation	1933

Figure 15 - Bronson SB Substation

Figure 16 - Holland SH Substation

A primary capital expenditure on station buildings is related to roof replacement. Since the structural integrity of station buildings is critical, Hydro Ottawa utilized a third party to inspect the roof conditions of stations. These inspections have been used to define the capital expenditures for station building infrastructure.

Some examples of deteriorating substation building roof conditions are shown in Figure 17 to Figure 19.

Figure 17 - Substation Roof Bubbling

Figure 18 - Substation Roof Water Pooling

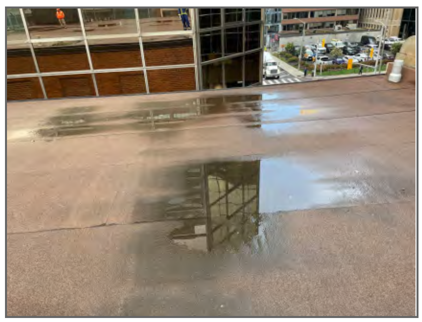
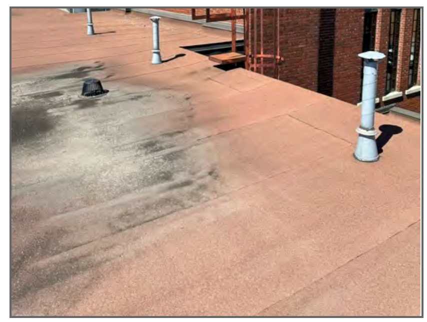


Figure 19 - Substation Roof Damage Caused by Water Pooling



Operations Facilities

In addition to the substations, Hydro Ottawa has two operational facilities: the Dibblee site (98,586 sq ft) and the Maple Grove site (18,300 sq ft). The major planned capital projects for these facilities consist of standard replacements and upgrades typical for maintaining buildings.

2.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the station renewal program are summarized in the section below.

2.4.1. Safety

The replacement of station assets mitigates the risk of catastrophic failure events. Upgraded protection and control systems help rapidly isolate station assets (specifically the station transformer) under fault conditions. Switchgear replacements reduce the risk to employee safety by implementing current standards for arc-resistant switchgear.

2.4.2. System Operation Efficiency and Cost Effectiveness

The renewal of station assets and supporting infrastructure allows for operational advancements, primarily ensuring robust communication between substations and the System Office, with the ability to remotely monitor and control devices through SCADA. Improvements through upgraded protection, monitoring and control systems result in increased system operational efficiencies.

EOL voltage conversion through 4kV station decommissioning increases the availability of distribution feeders and backups, as the dedicated 13kV feeders used to supply 4kV stations can now be re-allocated for other purposes. Investing in voltage conversion when the corresponding station assets reach EOL allows Hydro Ottawa to meet both asset needs as well as growing capacity demands, realizing cost effectiveness in the process. The EOL voltage conversion initiative allows Hydro Ottawa to optimize capital allocation by addressing the risk of station equipment failure and eliminates the need for separate future investments to address capacity issues, ensuring efficient use of resources and improved system performance.

2.4.3. Customer

The stations and buildings infrastructure renewal program focuses on replacing deteriorating and failing station assets to decrease the risk of equipment failures and reduce the risk of outages for customers. The program also includes a significant initiative to convert the older 4kV system thereby increasing the system's capacity to support customers' growing demand for electricity.

2.4.4. Cyber Security and Privacy

The cyber security of digital systems is greatly improved by installation of modern equipment, which addresses the vulnerability of the previous generation of microprocessor equipment around remote access and communication protocols being used.

2.4.5. Coordination and Interoperability

For station transformer renewal projects that involve transmission connection requirements, Hydro Ottawa coordinates with Hydro One Networks Inc. to ensure successful completion of the transmission connection. This coordination is critical for maintaining system reliability and operational efficiency during the replacement process.

The use of modern P&C equipment allows seamless integration of distributed generation resources into the grid, ensuring that new energy sources can be safely and efficiently incorporated into the existing infrastructure.

2.4.6. Economic Development

Hydro Ottawa's Station and Buildings Infrastructure Renewal Program is a key driver of regional economic development. By strategically replacing deteriorating station assets, the program ensures sustained system reliability, a critical factor for attracting and retaining businesses, particularly commercial and industrial customers vital to job creation and economic stability within the service territory. The work under this program directly minimizes costly downtime, safeguarding productivity and investor confidence. Furthermore, the program's focus on maintaining and enhancing capacity ensures that Hydro Ottawa can accommodate the growing energy demands of expanding businesses and new developments, enabling future economic growth within its operational area. Prioritizing projects based on asset condition and risk secures the uninterrupted operation of critical infrastructure, which are fundamental to the community's well-being. Ultimately, this program strengthens the economic landscape within Hydro Ottawa's service area by demonstrating a commitment to a modern, reliable power grid, fostering a favorable environment for investment and sustainable economic development.

2.4.7. Environment

Hydro Ottawa minimizes the risk of environmental contamination by replacing a select population of at-risk station transformers that have reached or exceed their TUL and installing advanced oil containment systems beneath each transformer. These containment units are designed to capture any potential oil leaks, thereby reducing the risk of oil entering the surrounding environment.

The replacement of end-of-life station switchgear mitigates the risk of SF_6 leaks in the event of a switchgear failure.

2.5. PROGRAM COSTS

Table 3 shows the historical and future spending by Budget Programs, as a part of the Station and Building Infrastructure Renewal program. In the 2026-2030 period Hydro Ottawa expects the investment needs in this program to reach $107.7M, compared to $31.4M in the 2021-2025 period. There are considerations around equipment and resource availability as well as project prioritization and scheduling which results in some variability in the projected annual spend between 2026 and 2030.

Table 3 - Historical, Bridge and Test Year Expenditure per Station Renewal Budget Program ($000 000s)[2]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Station Transformer Renewal	$ 1.2	$ 0.6	$ 0.7	$ 0.6	$ 0.1	$ 0.2	$ 0.8	-	-	-
Station Switchgear Renewal	$ 3.5	$ 2.2	$ 1.4	$ 0.4	-	$ 6.0	$ 7.0	$ 0.6	$ 0.6	$ 9.3
Station Battery Renewal	$ 0.0	$ 0.0	$ 0.0	$ 0.1	$ 0.1	$ 0.2	$ 0.1	$ 0.1	$ 0.1	$ 0.2
Station P&C Renewal	$ 1.0	$ 1.1	$ 0.1	$ 0.2	-	$ 2.4	$ 2.3	$ 2.1	$ 1.0	$ 1.0
Station and Building Minor Assets Renewal	$ 0.4	$ 0.7	$ 1.1	$ 0.6	$ 0.4	$ 2.0	$ 1.9	$ 1.9	$ 1.9	$ 1.7
Station Major Rebuild	$ 2.6	$ 6.4	$ 1.6	$ 0.5	$ 0.1	-	-	-	-	-
EOL Voltage Conversion	$ 0.4	$ 1.0	$ 0.5	$ 1.8	-	$ 14.7	$ 11.2	$ 12.2	$ 14.3	$ 11.9
ANNUAL TOTAL	**$ 9.1**	**$ 12.0**	**$ 5.4**	**$ 4.2**	**$ 0.7**	**$ 25.4**	**$ 23.3**	**$ 16.9**	**$ 17.9**	**$ 24.0**
5-YEAR TOTAL					**$ 31.4**					**$ 107.7**

[2] Totals may not sum due to rounding

Table 4 - Detailed Unit Replacement and Removal (through EOL voltage conversion) Overview per Station Asset Class[3]

Station Asset Class	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Station Transformers (Replacement)	-	2	3	-	-	-	1	-	-	-
Station Transformers (Removed through EOL Voltage Conversion)	-	-	-	-	-	3	-	3	2	2
Station Switchgear (Replacement)	10	18	8	2	-	7	8	2	14	14
Station Switchgear (Removed through EOL Voltage Conversion)	-	-	-	-	-	13	4	7	8	6
Station Batteries (Replacement)	-	2	2	2	3	3	2	2	2	2
Station Batteries (Removed through EOL Voltage Conversion)	-	-	-	-	-	1	-	-	1	1
Station Relays (Replacement)	-	28	-	7	4	35	55	55	-	-
Station Relays (Removed through EOL Voltage Conversion)	-	-	-	-	-	39	-	-	38	30
Station RTUs (Replacement)	-	-	-	-	2	1	1	1	-	-
Station RTUs (Removed through EOL Voltage Conversion)	-	-	-	-	-	1	-	-	1	1

[3] During the 2021-2025 period Hydro Ottawa has begun voltage conversion plans for Fisher AK and Dagmar AC on the distribution side and no station assets have been decommissioned yet.

2.5.1. Station Transformer Renewal

The Station Transformers Renewal program's spending is forecasted to decrease from $3.3M in 2021-2025 to $1M in 2026-2030, to only complete the Longfields T2 renewal project. Ten station transformers proposed for decommissioning/removal will be addressed through the EOL Voltage Conversion program, which is introducing 13kV feeders to these 4kV regions, to increase capacity. Decommissioning 4kV transformers will also include decommissioning their connected switchgear and protection & control apparatus.

2.5.2. Station Switchgear Renewal

The Station Switchgear Renewal program's budget is forecasted to increase from $7.4M in 2021-2025 to $23.4M in 2026-2030. During 2021-2025, 36 breakers at Overbrook TO were replaced under the Station Switchgear Renewal program; with the remaining two breakers replaced at Bronson SB substation. The 2026-2030 plan includes the replacement of 45 station breakers at four different stations, all under the Station Switchgear Renewal program. The increase in average cost per breaker can be attributed to the need for mobilization at four different stations, increased material costs with inflation observed since 2023 and budget allocation to also replace/upgrade any related obsolete P&C systems. In 2023, Hydro Ottawa observed an increase in the material cost for a switchgear lineup by about $1.3M as compared to the 2022 estimate, which has been included in the costing consideration for the 2026-2030 station switchgear renewal program, resulting in at least a $220k/breaker unit cost increase. Increased equipment costs are not the only driver of switchgear renewal project expenses. Costs are also impacted by unique aspects like building modifications or additions, complex distribution and medium voltage ties, and station-specific custom engineering, the effort of which is proportional to project complexity

2.5.3. Station Battery Renewal

The Station Battery Renewal program's spending is forecast to increase from $0.3M in 2021-2025 to $0.8M in 2026-2030. Based on an observed trend of increased expenditures for emergency and critical battery replacements towards the end of the 2021-2025 rate application period (in addition to the condition/risk projections), 11 battery bank replacements are recommended for the 2026-2030 period.

2.5.4. Station P&C Renewal

The Station P&C Renewal program's spending is forecasted to increase from $2.5M in 2021-2025 to $8.9M in 2026-2030. Traditionally, P&C equipment replacements were incorporated into broader station infrastructure initiatives, such as the Station Switchgear Replacement Program and the EOL Voltage Conversion Program. However, an enhancement to the traditional approach through dedicated P&C renewal projects is deemed necessary to address the growing need to target obsolescence, particularly within RTU equipment. This enhancement is in response to the evolving needs to maintain critical infrastructure and cyber security requirements. The increasing prevalence of obsolescence specifically impacting RTU equipment, independent of other station components, necessitates a focused and strategic response. This dedicated approach will ensure the timely replacement and modernization of these critical assets.

Targeted projects under this program will enable timely and focused mitigation, directly addressing the vulnerability of these critical P&C assets. In particular, the obsolescence of SCOUT RTUs at select stations, which currently are not within the scope of existing renewal programs, necessitate immediate action. These RTUs are critical for station-to-control center communication, and their obsolescence poses a significant operational risk.

Furthermore, high-priority transfer trip installations at the Lemieux Island and Britannia filtration plants, commissioned in 2004, require an intervention due to the failure risk around aging, after consultation with the customer.

Beyond addressing immediate obsolescence, projects under this budgeted program allow for the timely integration of modern P&C technologies, thereby enhancing grid resilience and operational efficiency. This focused approach also optimizes planning and execution, ensuring timely resolution of critical obsolescence issues. The augmented budget allocation reflects the imperative to modernize aging P&C infrastructure, driven by specific obsolescence risks and the need to maintain a robust and reliable electrical grid. This transition ensures targeted, efficient, and timely P&C system upgrades, ultimately safeguarding the integrity of the electrical network.

2.5.5. Station & Building Minor Assets Renewal

The Station & Building Minor Assets Renewal program is subdivided into the following distinct classifications:

- Station Minor Assets
- Station Buildings
- Operations Facilities

The Station & Building Minor Assets Renewal program's spending is expected to increase from $3.2M in 2021-2025 to $9.3M in 2026-2030. Of this increase, the majority ($5.3M) is allocated to Operations Facilities. In the previous 2021-2025 application, this parent program and the associated expenditures for the Maple Grove and Diblee facilities were grouped with general plant expenditures. However, because there are no administrative functions at these facilities, they are now grouped with distribution facilities. This includes spending for facility assets reaching their end of life, and upgrades to the electrical service to support increased load for electrification and sustainability.

Station Minor Assets

The Station Minor assets program funds necessary investments in targeted renewal and upgrades across multiple stations, encompassing critical minor asset components that are essential for preserving the safety and reliability of the electrical distribution system. These strategic investments mitigate the risk of future failures and ensure optimal system performance. Key initiatives include:

- Prioritized replacement of outdoor reclosers at stations with known failures and persistent operational deficiencies, such as Janet King DS.

- Targeted replacement of lightning arresters, insulators, and online DGA monitoring equipment with operational issues.

Station Buildings

The Station Buildings program proposes investments in station building infrastructure, such as:

- **Roof Replacements:** Maintaining building integrity and protecting electrical equipment.
- **Exterior and Yard Upgrades:** Improving station safety, security, and appearance, including storage yards and access.
- **Lighting and Mechanical Renewal:** Upgrading lighting for better visibility and efficiency and replacing/refurbishing essential mechanical components.

These investments are vital to maintaining the reliable and efficient operation of the electricity distribution system. By addressing these essential maintenance and renewal needs, the budget aims to prevent costly equipment failures, safety hazards, and service disruptions, ultimately ensuring that the electricity distribution system continues to meet the needs of customers.

Operations Facilities

Some planned renewal investments around Hydro Ottawa's operations facilities are:

Dibblee Site Renewal Investments

- 2026: Parking lot expansion to accommodate additional employees as outlined in Attachment 4-1-3(C) - Workforce Growth, enclosed office space in warehouse, HVAC system upgrades, and garage door replacement.
- 2028: Installation of automated barriers to regulate vehicle entry (day arms) to enhance site security.
- 2030: Electrical service upgrade to support electrification and sustainability.

Maple Grove Site Renewal Investments

- 2026: Office fit-up and parking expansion to accommodate new employees as outlined in Attachment 4-1-3(C) - Workforce Growth.
- 2027: Main gate and emergency generator replacement (due to end of useful life).
- 2028: Office area roof top unit replacement (due to end of useful life).
- 2029: Electrical service upgrades to support electrification and sustainability.

2.5.6. Station Major Rebuild

The Station Major Rebuild program's spending is expected to decrease from $11.2M in 2021-2025 to $0 in 2026-2030. Through 2021-2025, stations with transformers and switchgears that needed replacement were typically recommended for full station upgrades. However, for the 2026-2030 rate period, all stations requiring major asset replacements are in the 4 kV system, being converted to 13 kV under the EOL Voltage Conversion program.

2.5.7. EOL Voltage Conversion

The EOL Voltage Conversion program's spending is forecasted to increase from $3.6M in 2021-2025 to $64.2M in 2026-2030. Five stations in the 4kV system that require transformer and switchgear replacements will be converted to 13kV under this program. This program also facilitates the retirement of deteriorating poles and underground cables on the distribution side. To decommission the 4kV station assets, 4kV feeders will be converted to 13kV through pole and cable replacements in these regions, alongside the removal of end-of-life station equipment.

As detailed in Section 2.3.2 - Current Issues, Hydro Ottawa plans to prioritize the completion of EOL voltage conversion initiatives at Fisher AK and Dagmar AC substations with a remaining forecasted spend of ~$20M. In addition, the plan includes conversion of the entire distribution system of Henderson UN (~$20.2M) and 50% conversion of Vaughan UG (~$15M) and Church AA (~$9M) adding up to the total forecast of $64.2M under this budget program. The cost estimates for Henderson UN, Vaughan UG and Church AA are based on the quantity of assets in the 4kV distribution system requiring conversion (including poles, transformers, cables, etc) multiplied by the estimated unit costs. For Fisher AK and Dagmar AC, the estimates are based on remaining project scopes scheduled for completion between 2026 and 2030.

2.5.8. Cost Factors

Cost factors that affect station renewal projects are listed below:

- Material prices and lead times of major station equipment (specifically transformers and breakers)
- Delays in the project schedule
- Compatibility with existing equipment

2.6. ALTERNATIVES EVALUATION

2.6.1. Alternatives Considered

In order to address the drivers and achieve the performance objectives of the program, Hydro Ottawa conducted an analysis using Copperleaf PA to evaluate and optimize its station asset renewal strategy with the goal to reduce asset failure risks, improve operational performance, and balance renewal costs with long-term asset sustainability. To develop the station asset renewal strategy, three investment alternatives were considered, as outlined in Table 5, with varying levels of replacement rates and alignment to the Outcomes described in Table 1. The alternatives were developed with the objective of balancing long term-cost impacts with equipment lead-time, resourcing limitations and risk mitigation associated with assets in degraded condition.

1 **Table 5 - Summary of Program Investments of Alternatives Considered**

Program Investments	Alternative 1: Cost Containment	Alternative 2: Short Term Risk Mitigation (Preferred)	Alternative 3: Long Term Risk Mitigation
Station Transformers (replacement)	1 (0.2/year)	1 (0.2/year)	1 (0.2/year)
Station Transformers (removed during EOL Voltage Conversion)	5 (1/year)	10 (2/year)	13 (2.6/year)
Station Breakers (replacement)	10 (2/year)	45 (9/year)	90 (18/year)
Station Breakers (removed during EOL Voltage Conversion)	26 (5.2/year)	38 (7.6/year)	59 (11.8/year)
Relays (replacement)	58 (12/year)	145 (29/year)	300 (60/year)
Relays (removed during EOL Voltage Conversion)	77 (15.4/year)	107 (21.4/year)	173 (34.6/year)
Station Batteries (replacement)	5 (1/year)	10 (2/year)	20 (4/year)
Station Batteries (removed during EOL Voltage Conversion)	2 (0.4/year)	3 (0.6/year)	5 (1/year)
RTUs (replacement)	3 (0.6/year)	3 (0.6/year)	8 (1.6/year)
RTUs (removed during EOL Voltage Conversion)	2 (0.4/year)	3 (0.6/year)	5 (1/year)
Transfer Trip	0	2 (0.4/year)	2 (0.4/year)
Minor Station Assets	None	Medium	Highest
Minor Building Assets	None	Medium	Highest
System Observability Investments	Minor	Medium	Highest
TOTAL PROGRAM COST	**$55M**	**$108M**	**$220M**

2

Alternative 1 - Cost Containment (~$55M): This alternative will provide:

- Cost impacts are minimized during the 2026-2030 period, however replacement rates will not allow Hydro Ottawa to balance long term affordability or effectively manage risk associated with assets in degraded condition:
  - A net 5% increase in the station transformers in degraded condition compared to 2024 levels (refer to Figure 21) and a net 31% increase in station transformers that have reached their typical useful life by 2030 (refer to Figure 20), creating a back-log of station transformers to be replaced in the long term.
  - A net 4% increase in the station switchgears in degraded condition compared to 2024 levels (refer to Figure 23) and a minor 2% decrease in station switchgears that have reached their typical useful life by 2030 (refer to Figure 22), creating a back-log of station switchgears to be replaced in the long term.
  - A net 33% increase in the station batteries in degraded condition compared to 2024 levels (refer to Figure 25) and a net 33% increase in station batteries that have reached their typical useful life by 2030 (refer to Figure 24), creating a back-log of station batteries to be replaced in the long term.
  - A minor 1% decrease in the station relays that have reached their typical useful life by 2030 (refer to Figure 26).
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Minimum ability to increase system observability through the station P&C renewal program
- Very limited risk reduction associated with EOL 4kV assets and limited ability to support growth in 4kV areas

Alternative 2 - Short Term Risk Mitigation (~$108M - Preferred Alternative): This alternative will provide:

- Cost impacts are more significant and replacement rates will allow Hydro Ottawa to mitigate only short term risk associated with assets in degraded condition.
  - A net 4% increase in the station transformers in degraded condition compared to 2024

levels (refer to Figure 21) and a 28% net increase in station transformers that have reached their typical useful life by 2030 (refer to Figure 20), moderately reducing the back-log of station transformers to be replaced in the long term.
    - A net 2% increase in the station switchgears in degraded condition compared to 2024 levels (refer to Figure 23) and a 5% decrease in station switchgears that have reached their typical useful life by 2030 (refer to Figure 22), moderately reducing the back-log of station switchgears to be replaced in the long term.
    - A net 24% increase in the station batteries in degraded condition compared to 2024 levels (refer to Figure 25) and a net 24% increase in station batteries that have reached their typical useful life by 2030 (refer to Figure 24), moderately reducing the back-log of station batteries to be replaced in the long term.
    - A 6% decrease in the station relays that have reached their typical useful life by 2030 (refer to Figure 26), moderately reducing the back-log of station relays to be replaced in the long term.
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Moderate ability to increase system observability through the station P&C renewal program
- Moderate risk reduction associated with EOL 4kV assets and moderate ability to support growth in 4kV areas

Alternative 3 - Long Term Risk Mitigation (~$220M): This alternative will provide:
- Cost impacts are highest however replacement rates will allow Hydro Ottawa to most effectively balance long term affordability and minimize risk associated with assets in degraded condition
    - A net 3% increase in the station transformers in degraded condition compared to 2024 levels (refer to Figure 21) and a net 26% increase in station transformers that have reached their typical useful life by 2030 (refer to Figure 20), reducing the back-log of station transformers to be replaced in the long term.
    - A net 1% decrease in the station switchgears in degraded condition compared to 2024 levels (refer to Figure 23) and a net 12% decrease in station switchgears that have

reached their typical useful life by 2030 (refer to Figure 22), largely reducing the back-log of station switchgears to be replaced in the long term.
   - A net 8% increase in the station batteries in degraded condition compared to 2024 levels (refer to Figure 25) and a net 10% increase in station batteries that have reached their typical useful life by 2030 (refer to Figure 24), reducing the back-log of station batteries to be replaced in the long term.
   - A 17% decrease in the station relays that have reached their typical useful life by 2030 (refer to Figure 26), largely reducing the back-log of station relays to be replaced in the long term.
- Inability to manage resourcing levels and to procure long-lead items at the rate required
- High ability to increase system observability through the station P&C renewal program
- High risk reduction associated with EOL 4kV assets and moderate ability to support growth in 4kV areas

Figures 20 to 26 show the proportion of station assets that will reach a deteriorated condition by 2030, based on current state and a consideration of the different intervention strategies around managing the station asset population.

Figure 20 - Number of Station Transformers Projected to Reach Typical Useful Life by 2030

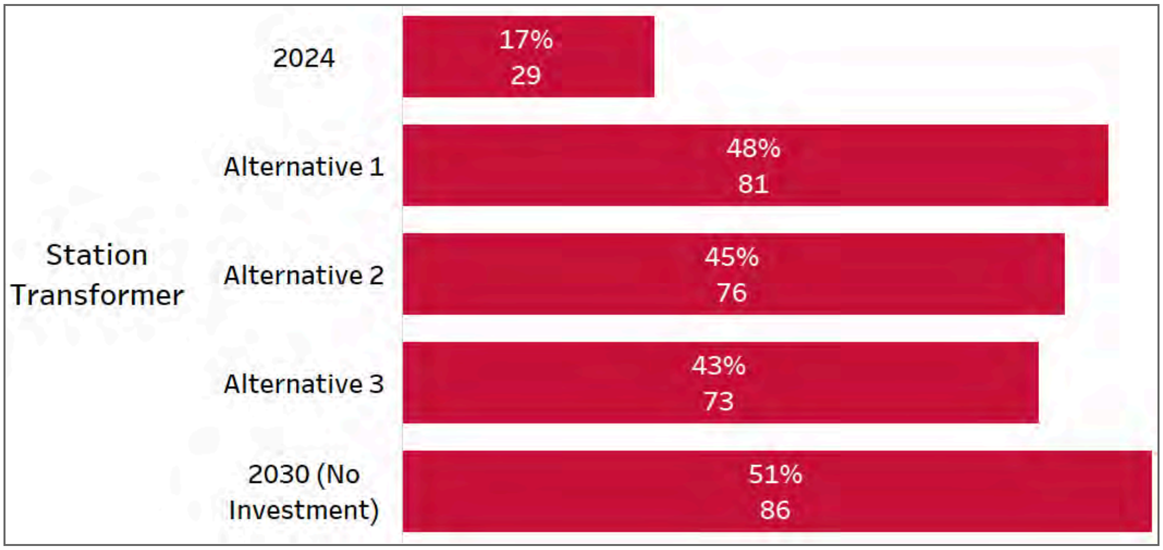


Figure 21 - Number of Station Transformers Projected to Reach a Deteriorated Condition by 2030

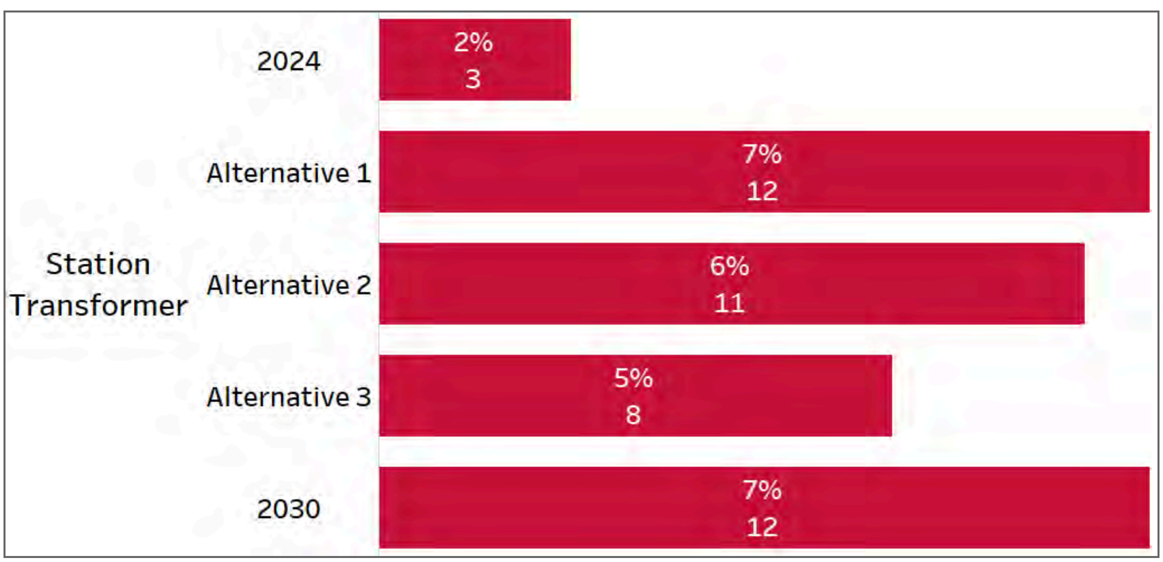


Figure 22 - Number of Station Switchgears Projected to Reach Typical Useful Life by 2030

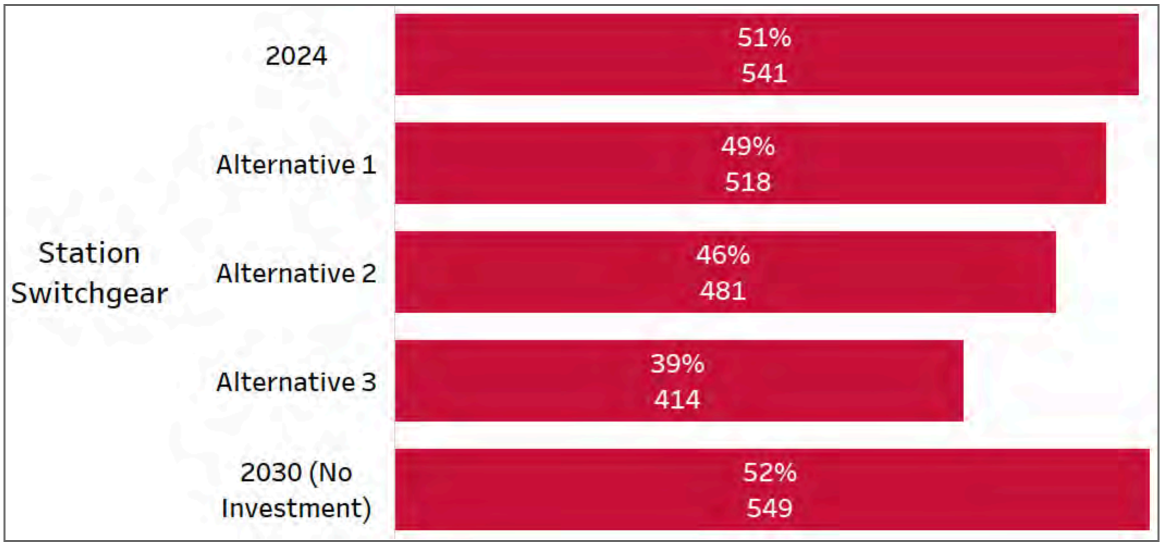


Figure 23 - Number of Station Switchgears Projected to Reach a Deteriorated Condition by 2030

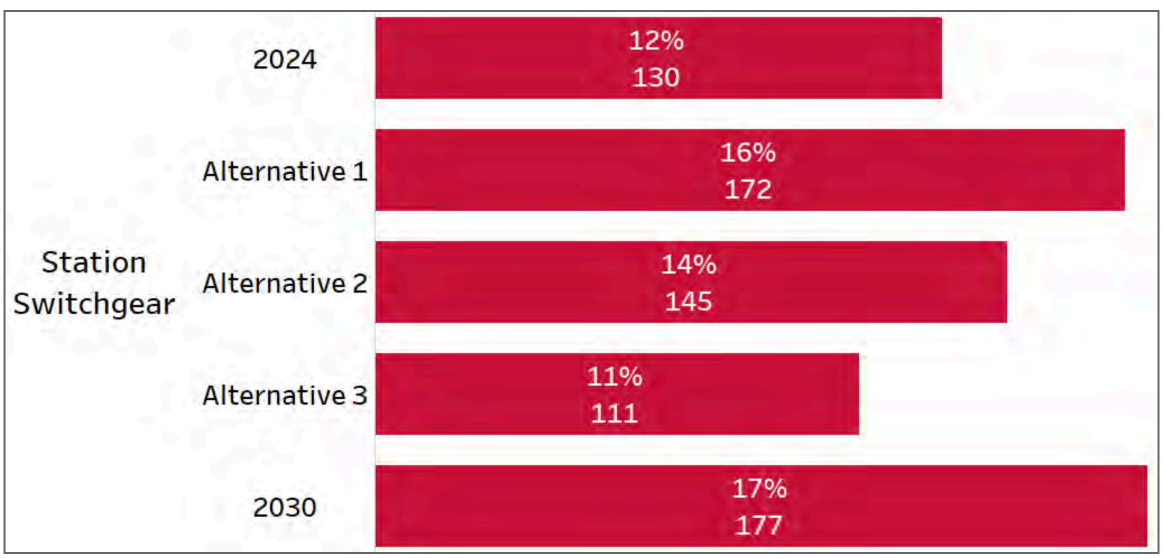


Figure 24 - Number of Station Batteries Projected to Reach Typical Useful Life by 2030

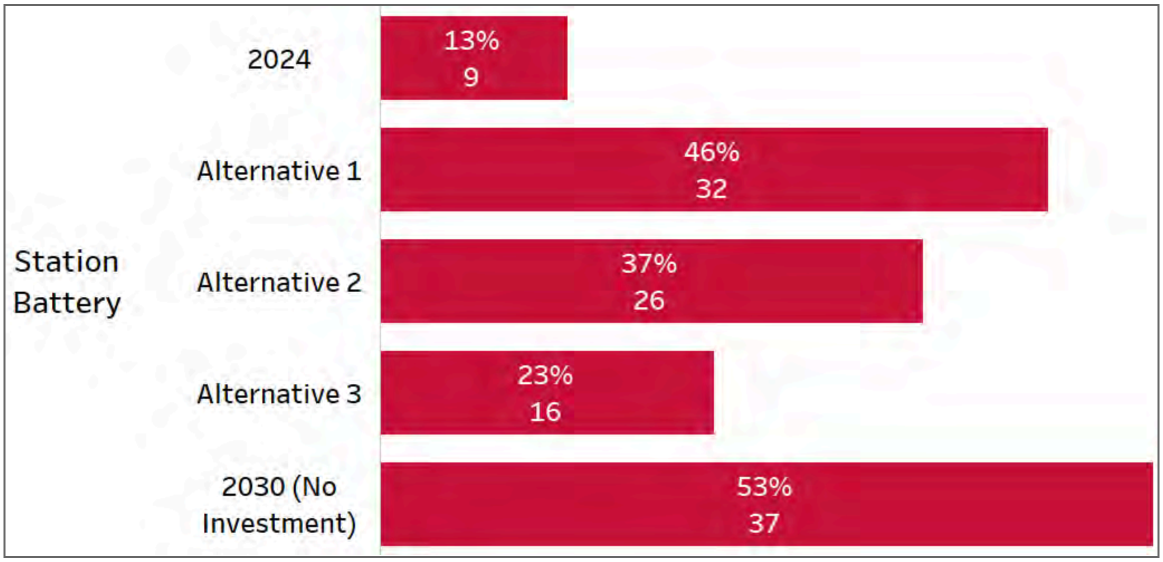


Figure 25 - Number of Station Batteries Projected to Reach a Deteriorated Condition by 2030

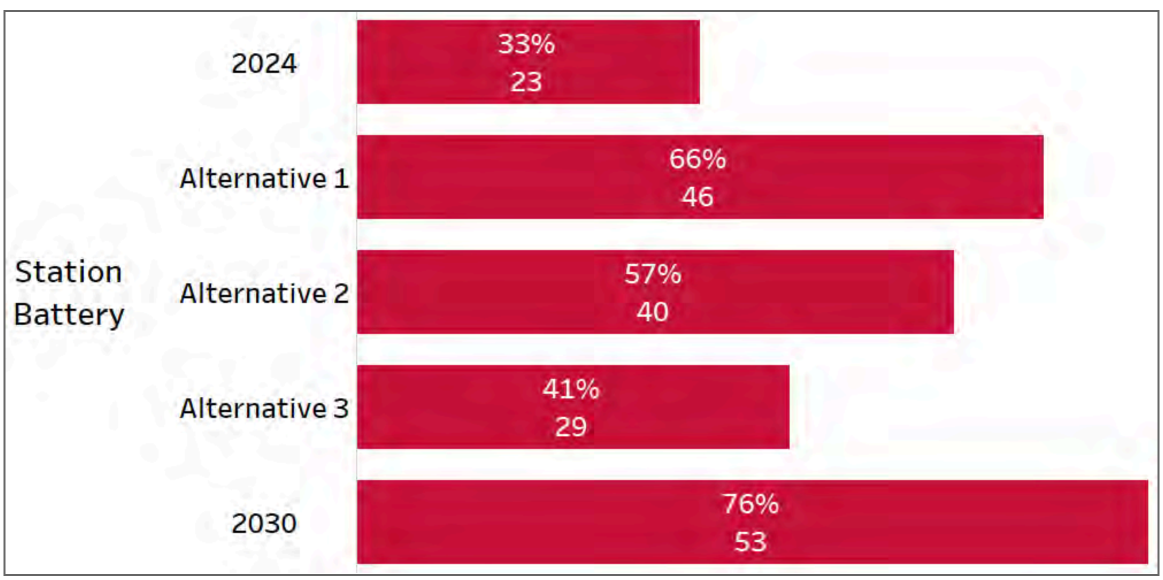
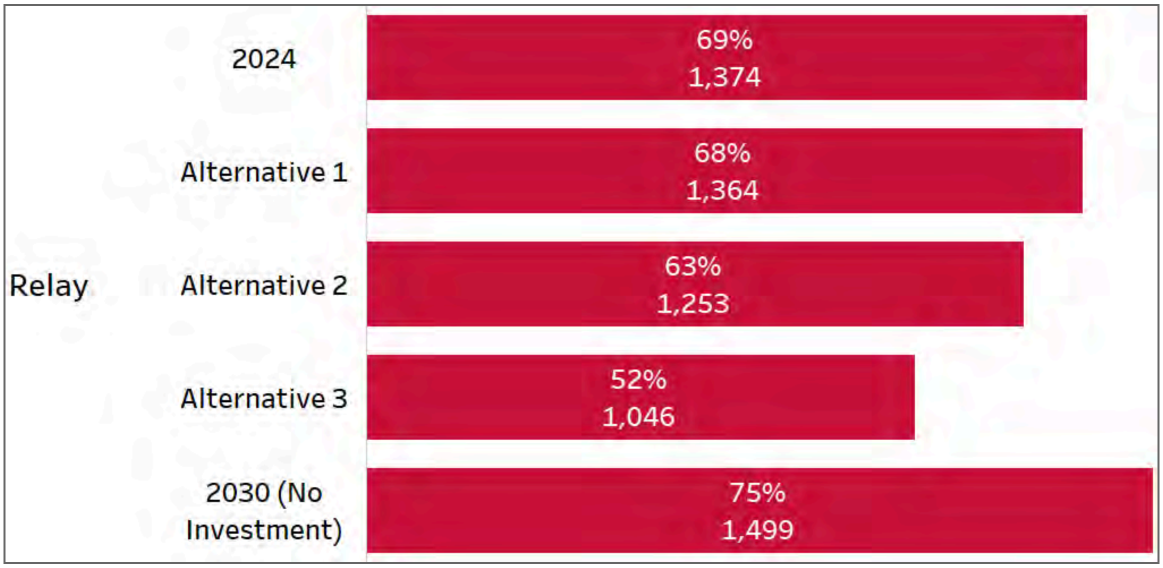


Figure 26 - Number of Station Relays Projected to Reach Typical Useful Life by 2030



2.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. The preferred alternative must mitigate any risks to Hydro Ottawa's employees and public safety.

Reliability

The increased potential of failure posed by deteriorating station assets will impact Hydro Ottawa's ability to deliver reliable power. The selected alternative shall help manage asset performance by reducing the reliability risk posed by station assets and mitigate the risk of failure.

Financial

This criterion assesses the ability to manage long-term financial needs for station assets. This helps to avoid large spikes in asset renewal spending and the associated rate impacts on customers. The selected alternative should ensure a levelized spending profile, manage long-term asset performance, and prevent significant service disruptions due to deteriorating station asset failures.

System Accessibility (Capacity)

The preferred alternative should improve system capacity and accessibility, thereby enhancing the quality and reliability of electric power delivery. This would enable Hydro Ottawa to satisfy increasing power demands resulting from intensification, electrification and large load requests, alongside improving the visibility and control of substations, specifically addressing the capacity needs on the 4kV system as outlined in Section 9.1.4.6 of Schedule 2-5-4 - Asset Management Process.

System Observability

With approximately 36% digital relays currently in Hydro Ottawa's substations, this criterion assesses the ability to enhance the monitoring or diagnosis of substation conditions within the scope of the station switchgear and P&C programs. The objective is to support Hydro Ottawa's grid modernization initiatives by increasing the number of digital relays by at least 5% relative to the existing number.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

2.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 2.6.1 - Alternatives Considered under the evaluation criteria of Section 2.6.2 - Evaluation Criteria.

The recommended approach, Alternative Two, involves replacing 45 station breakers, 145 relays, 10 station batteries, 3 obsolete RTUs, 2 obsolete transfer trip installations, a medium volume of minor station assets and complete necessary upgrades to station buildings, in addition to tackling 10 station transformers and other station assets through the EOL voltage conversion program.

The rate at which Hydro Ottawa's stations (particularly 4kV stations assets) are deteriorating exceeds the pace at which Hydro Ottawa can reasonably intervene. The 4kV EOL Voltage Conversion projects are particularly resource intensive and costly, as described in Section 3.1.2.2 of Attachment 4-1-3(C) - Workforce Growth. To this end, Alternative Two is optimized to account for supply chain and resource management considerations (both internal and external) and is also in alignment with Hydro Ottawa's workforce growth strategy for 2026-2030, to execute on the EOL voltage conversion initiatives. Alternative Two also results in a well phased out voltage conversion strategy that is manageable to the customers and results in short-term failure risk mitigation.

In light of this reality and subsequent to the decision in 2023 to defer two voltage conversion projects to the 2026-2030 period, Hydro Ottawa expanded its stations monitoring and maintenance program, to manage station asset performance. Key improvements included advanced diagnostic testing and increased maintenance activities of 4kV assets. Furthermore, unlike distribution assets, stations assets are conducive to remediation/refurbishment activities in the event of a failure. Through 2026-2030, Hydro Ottawa has provisioned for incremental reactive maintenance to support these efforts. The new and expanded programs will require incremental station electricians and technicians, distribution engineers, and project engineers. More information on the Stations Maintenance program for 2026-2030 is outlined in Section 3.4 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

Over half of station switchgear units have currently reached or exceeded their TUL with some degree of deterioration. Alternative Two also includes plans for the replacement of SF_6 and air-type switchgear with known issues at critical stations, further resulting in a 5% reduction in the number of station switchgear projected to reach TUL by 2030 and allowing for only a minor 2% increase in the number of switchgears in deteriorated condition.

Alternative Two allows for addressing the station batteries with known functional issues, having reached their TUL and in a deteriorated condition. It also allows for a moderate reduction in the back-log of station batteries reaching their TUL and in a deteriorated condition in the long run.

Approximately 69% of the station relays have currently reached or exceeded their TUL, with obsolete SCOUT RTUs causing operational issues. Alternative Two allows for a 6% reduction in the number of station relays that have reached or exceeded the TUL, alongside addressing the functional obsolescence of SCOUT RTUs at major stations. It also allows for a moderate improvement to the station level observability, based on increasing the number of digital relays.

Alternative Two also allows Hydro Ottawa to handle issues with minor station assets such as insulator failures, operational problems with online dissolved gas analysis (DGA) monitors, and deteriorating station infrastructure (buildings and roofs), through a medium level of investment.

Alternative Two provides a middle ground, allowing Hydro Ottawa to tackle critical station asset issues without an unsustainable spike in costs, and improving the related asset performance by:

- Mitigating short-term station asset failure risks
- Moderately reducing the backlog of station assets needing replacement
- Increasing station level observability through P&C renewals
- Executing EOL voltage conversion plans in a manageable, phased-out manner

2.7. PROGRAM EXECUTION AND RISK MITIGATIONS

2.7.1. Implementation Plan

The station renewal projects to be executed between 2026 and 2030 were obtained based on using Copperleaf PA for risk-based investment planning, as outlined in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process.

The station renewal projects typically span 3-5 years and Table 6 shows the projects proposed for the 2026-2030 period, as a part of the stations and buildings infrastructure renewal program.

Table 6 - Proposed Projects under the Stations and Buildings Infrastructure Renewal Program

Year	Proposed Projects
2026	• Longfields T2 Transformer Renewal • Rideau Heights DS Switchgear Renewal • Parkwood Hills DS Switchgear Renewal • Hinchey TH Switchgear Renewal • Carling TM Electromechanical Relay Renewal • King Edward TK Electromechanical Relay Renewal • Centrepointe DS RTU Renewal • Transfer Trip Renewal (Placeholder): Lemieux Island Filtration Plant/ Britannia Filtration Plant • Augusta UD, Beechwood UB and Bronson SB Battery Renewal • Station Minor Renewal (Janet King DS Recloser Replacement, Lightning Arrester Replacement, Kelman Online DGA Monitor Replacement, Buildings/operations facilities upgrade) • Fisher AK EOL Voltage Conversion • Dagmar AC EOL Voltage Conversion • Henderson UN EOL Voltage Conversion • Church AA EOL Voltage Conversion • Vaughan UG EOL Voltage Conversion
2027	• Longfields T2 Transformer Renewal • Parkwood Hills DS Switchgear Renewal • Rideau Heights DS Switchgear Renewal • Hinchey TH Switchgear Renewal • Carling TM Electromechanical Relay Renewal • King Edward TK Electromechanical Relay Renewal • Jockvale DS RTU Renewal • Transfer Trip Renewal (Placeholder): Lemieux Island Filtration Plant/ Britannia Filtration Plant • Bantree AL and Woodroffe DS Battery Renewal • Station Minor Renewal (Lightning Arrester Replacement, Kelman Online DGA Monitor Replacement, Buildings/operations facilities upgrade) • Vaughan UG EOL Voltage Conversion • Dagmar AC EOL Voltage Conversion • Henderson UN EOL Voltage Conversion • Church AA EOL Voltage Conversion
2028	• Rideau Heights DS Switchgear Renewal • Carling TM Electromechanical Relay Renewal • King Edward TK Electromechanical Relay Renewal • QCH DS RTU Renewal • Bayswater UJ and Florence UF Battery Renewal • Station Minor Renewal (Lightning Arrester Replacement, Kelman Online DGA

Year	Proposed Projects
	Monitor Replacement, Buildings/operations facilities upgrade) ● Vaughan UG EOL Voltage Conversion ● Dagmar AC EOL Voltage Conversion ● Henderson UN EOL Voltage Conversion ● Church AA EOL Voltage Conversion
2029	● Russell TB Switchgear Renewal ● Holland SH and Urbandale AE Battery Renewal ● Station Minor Renewal (Lightning Arrester Replacement, Kelman Online DGA Monitor Replacement, Buildings/operations facilities upgrade) ● Vaughan UG EOL Voltage Conversion ● Dagmar AC EOL Voltage Conversion ● Henderson UN EOL Voltage Conversion ● Church AA EOL Voltage Conversion
2030	● Russell TB Switchgear Renewal ● Centrepointe DS and Moulton MS Battery Renewal ● Station Minor Renewal (Lightning Arrester Replacement, Kelman Online DGA Monitor Replacement, Buildings/operations facilities upgrade) ● Vaughan UG EOL Voltage Conversion ● Henderson UN EOL Voltage Conversion ● Church AA EOL Voltage Conversion

Aside from the aforementioned projects to be implemented during the 2026-2030 rate app period, the renewal of the Longfields station transformer T2 is to be completed in 2027, with the order placed for the transformer in 2024.

2.7.2. Risks to Completion and Risk Management Strategies

Hydro Ottawa faces several risks in managing its Stations and Buildings Infrastructure Program, Table 7 outlines the key risks and corresponding mitigation strategies:

Table 7 - Key Risks to Stations and Buildings Infrastructure Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment transportation/installation delays) can complicate project planning, increase costs, and impact timelines. Ineffective project management could further exacerbate these issues.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

2.8. RENEWABLE ENERGY GENERATION

As the integration of distributed energy resources (DERs) like solar photovoltaic systems and battery storage increases within Hydro Ottawa's distribution network, it's crucial to address the potential for reverse power flow. Traditionally, distribution systems were designed for unidirectional power flow from substations to consumers. However, DERs can inject power back into the grid, leading to reverse power flow and potential overloading of existing infrastructure.

To mitigate this, Hydro Ottawa ensures that new station transformers have reverse power flow capability, with additional functionality enabled by modern microprocessor relays. This means the transformers are designed to handle power flow in both directions without exceeding their thermal limits. By enabling reverse power flow capability, the transformers are no longer a bottleneck for DER integration.

In addition to new station transformers with reverse power flow capability, voltage conversion projects also enable the connection of more DER's to the distribution system by increasing voltage levels and thereby increasing the distribution systems capacity to carry electricity, ultimately accommodating increased output from DERs.

3. OH DISTRIBUTION ASSET RENEWAL

3.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $43.1M

2026-2030: $67.8M

Budget Programs: Pole Renewal, OH Switch/ Recloser Renewal

Main Driver: Failure Risk

Secondary Driver: Reliability, Safety, Environmental

Outcomes: Operational Effectiveness and Customer Focus

Hydro Ottawa's overhead (OH) distribution system is supported mechanically by a system of poles and fixtures. The continued reliability, safety and resilience of the OH distribution system is dependent on the performance of these assets. To this end, Hydro Ottawa has proposed investments targeted at renewing OH distribution infrastructure over this Application period. This program replaces end-of-life OH distribution assets in a deteriorated condition, ensuring long-term performance and prioritizing projects based on asset condition and risk, as determined through the distribution asset model in Copperleaf PA (described in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process).

Hydro Ottawa's OH Distribution Asset Renewal Program proposes a strategic investment of $67.8M during this Application period. This capital allocation is dedicated to maintaining a high degree of system reliability through the optimization of asset replacement strategies, thereby enhancing the operational performance of the existing OH asset population.

The OH distribution assets renewal program addresses the needs under the following budget programs over the 2026-2030 period:

Pole Renewal: This Budget Program covers the cost of replacing 1,975 poles in degraded condition between 2026-2030 in key areas such as Playfair, Pleasant Park, Ryan Farm, Canterbury, Carlington, Glebe, Alta Vista, Convent Glen, Wood Park, Westboro, Overbrook, Fallowfield, Athlone, Riverside Park, Woodroffe, Wellington Village Presland, Scott, Richmond. The replacement of adjacent assets in poor condition including overhead switches, insulators, and overhead transformers are considered a part of the pole renewal project scoping.

Project scoping within the pole renewal program will also contemplate incremental investments that enhance the resilience of the OH system, inclusive of strategic undergrounding, line relocation, and the fortification of critical overhead sections. This expansion is attributed to the increasing frequency of recent weather events, which have revealed the heightened susceptibility and failure rate of overhead equipment. Vulnerability assessments supported by climate assessments have identified overhead assets as the most vulnerable, due to the direct impact from extreme weather. Based on the assessment and the outcomes of the Resilience Investment Business Case report detailed in Attachment 2-5-4(E) - Resilience Investment Business Case Report, it is recommended that at least one lateral line per year (approximately 30 poles) slated for replacement are amenable to undergrounding or other hardening measures. For further information, please refer to Section 3.6.3 - Preferred Alternative.

OH Switch/Recloser Renewal: This Budget Program involves replacing 340 OH switches between 2026-2030. Project scoping within the OH switch/recloser program will also contemplate incremental investments to convert existing manual switches at open points to SCADAmates in support of grid modernization efforts related to system observability. The proposed plan assumes 40 manual switches would be converted to SCADAmates.

3.2. PERFORMANCE OUTCOMES

Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. With the implementation of the OH Distribution Renewal Program, improvements are expected in the outcomes shown in Table 8 below.

Table 8 - OH Distribution Asset Renewal Program Performance Outcomes

OEB Performance Outcome	Target
Operational Effectiveness	Hydro Ottawa's system reliability objectives are supported by: ● Replacing assets at a pace that allows Hydro Ottawa to achieve 42% of OH distribution assets that have reached their end-of-life by 2040. ● Replacing assets at a pace that allows Hydro Ottawa to minimize the percentage of OH distribution assets in poor and very poor condition by 2040.
	● Contributes to Hydro Ottawa's Grid Modernization Plan by replacing 40 manual OH switches with SCADAmates, resulting in increased observability and controllability of Hydro Ottawa's distribution system.
Customer Focus	● Contributes to Customer Satisfaction by maintaining system reliability and improving system resilience through effective capital deployment during renewal projects

3.3. PROGRAM DRIVERS AND NEED

3.3.1. Main and Secondary Drivers

Primary Driver – Failure Risk: The primary driver for OH distribution renewal is the increasing failure risk due to the number of units (specifically wood poles) in a deteriorated condition or surpassing their TUL. The proposed investments are supported by the Copperleaf PA distribution asset model which considers asset condition as a part of the risk assessment value framework. Further detail on the distribution asset model is provided in Section 5.1.4.2 of Schedule 2-5-4 - Asset Management Process.

Secondary Drivers – Reliability, Safety, and Environmental: The OH distribution asset renewal mitigates the reliability and safety impacts associated with OH distribution asset failures by proactively replacing these assets before they fail, and doing so in a cost efficient, planned manner. Further, the replacement of OH transformers in this program also reduces the environmental risk of oil spills due to unanticipated failures.

3.3.2. Current Issues

The primary focus of the OH distribution asset renewal program is to mitigate the risks associated with asset failure. The age and condition demographics of major OH assets considered as a part of the OH distribution asset renewal program are shown in Figures 29 to 35, with the overall summary highlighted in Figure 27 and Figure 28.

Figure 27 - Overall Age Demographics Profile of OH Distribution Assets

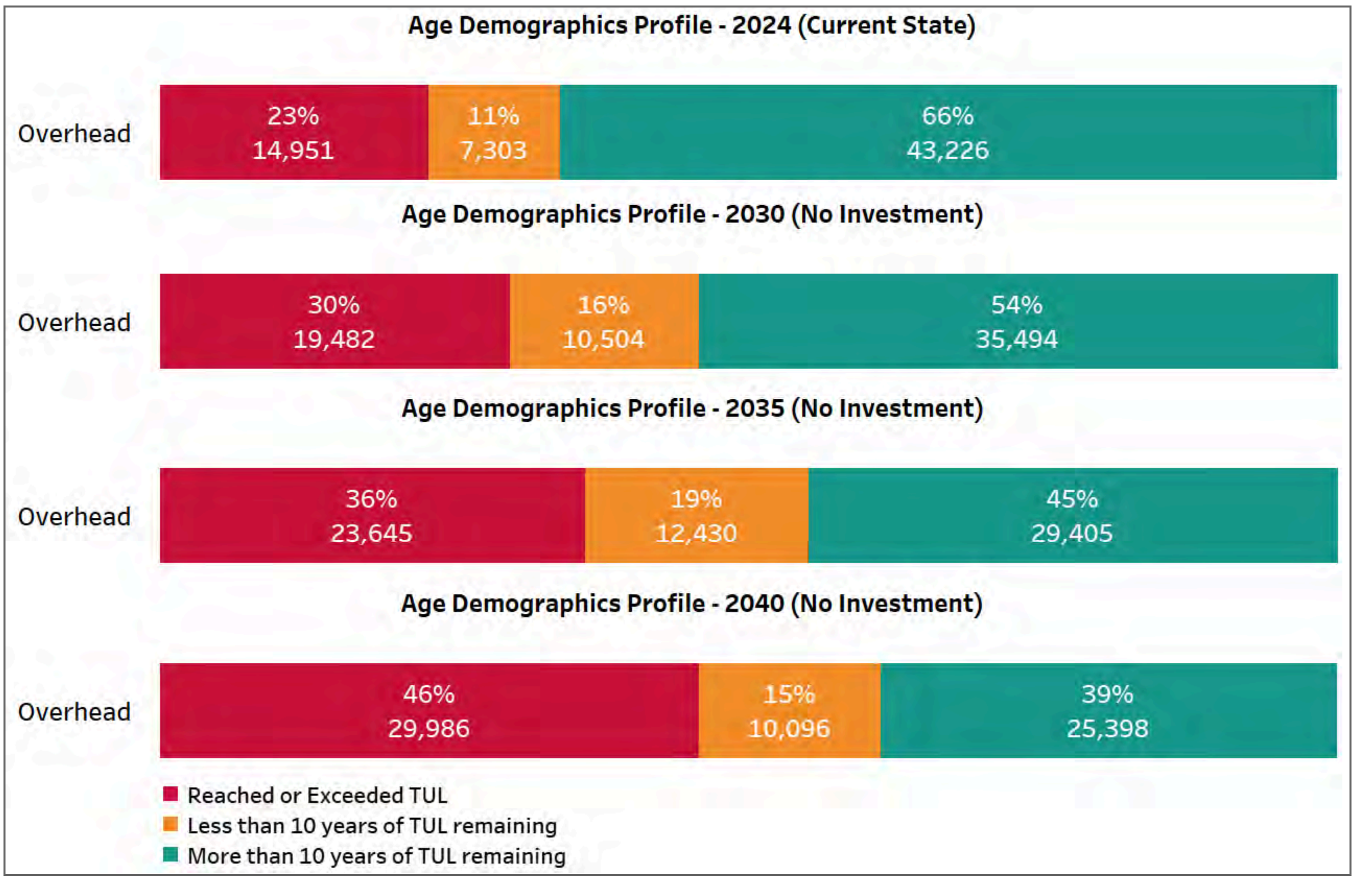
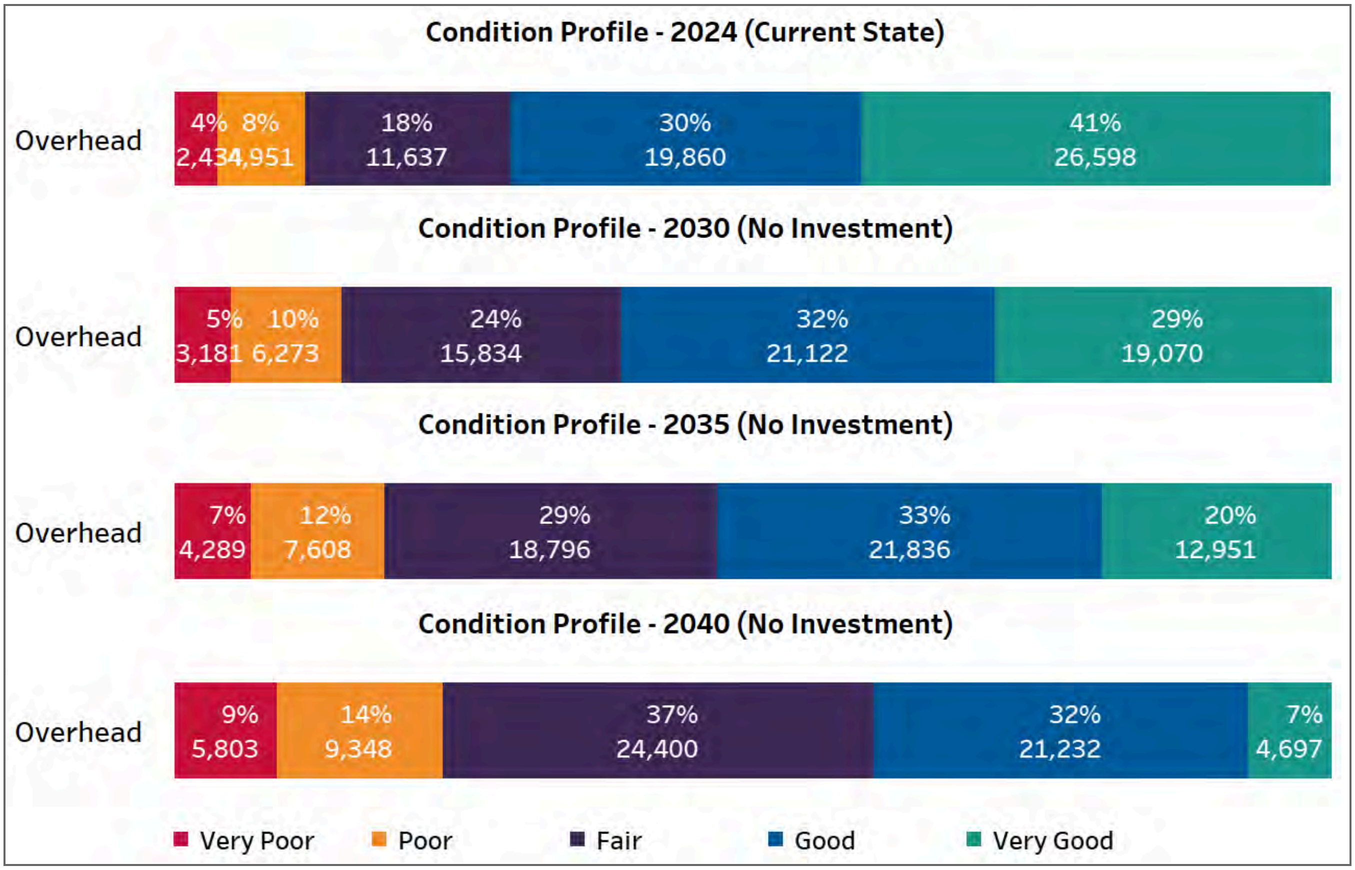


Figure 28 - Overall Condition Profile of OH Distribution Assets



TUL refers to the expected duration an asset can reliably operate before it requires replacement or refurbishment. Condition ranges provide a way to assess the actual state of an asset to determine the urgency of any necessary interventions. Hydro Ottawa uses a health index, which is a score from 0% to 100%, to evaluate the condition of an asset from Very Poor to Very Good for condition ranges. More details on Hydro Ottawa's condition assessment framework is presented in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process.

Through Copperleaf PA, Hydro Ottawa established the unique degradation pattern of each individual asset in the system to 2040. From Figure 27, it can be observed that without intervention the percentage of Hydro Ottawa's OH assets that have reached their end of life will continue to grow at a rate of approximately 8% every five years. Likewise, without intervention, the percentage of assets in degraded condition (poor or very poor) will continue to grow at a rate of approximately 4% every 5 years.

The following sub-sections summarize some of the challenges faced by Hydro Ottawa specific to its existing OH distribution asset categories.

3.3.3. Poles and OH Distribution Transformers

OH Poles

Figures 29 and 30 demonstrate that Hydro Ottawa's poles are reaching end of life and are projected to degrade at a high rate through to 2040. Specifically, Copperleaf PA forecasts that without intervention the percentage of poles that have reached their end of life will continue to grow at a rate of approximately 8% every five years. Likewise, without intervention, the percentage of poles in a degraded condition (poor or very poor) will continue to grow at a rate of approximately 3% every 5 years.

Figure 29 - Age Demographics Profile of Poles

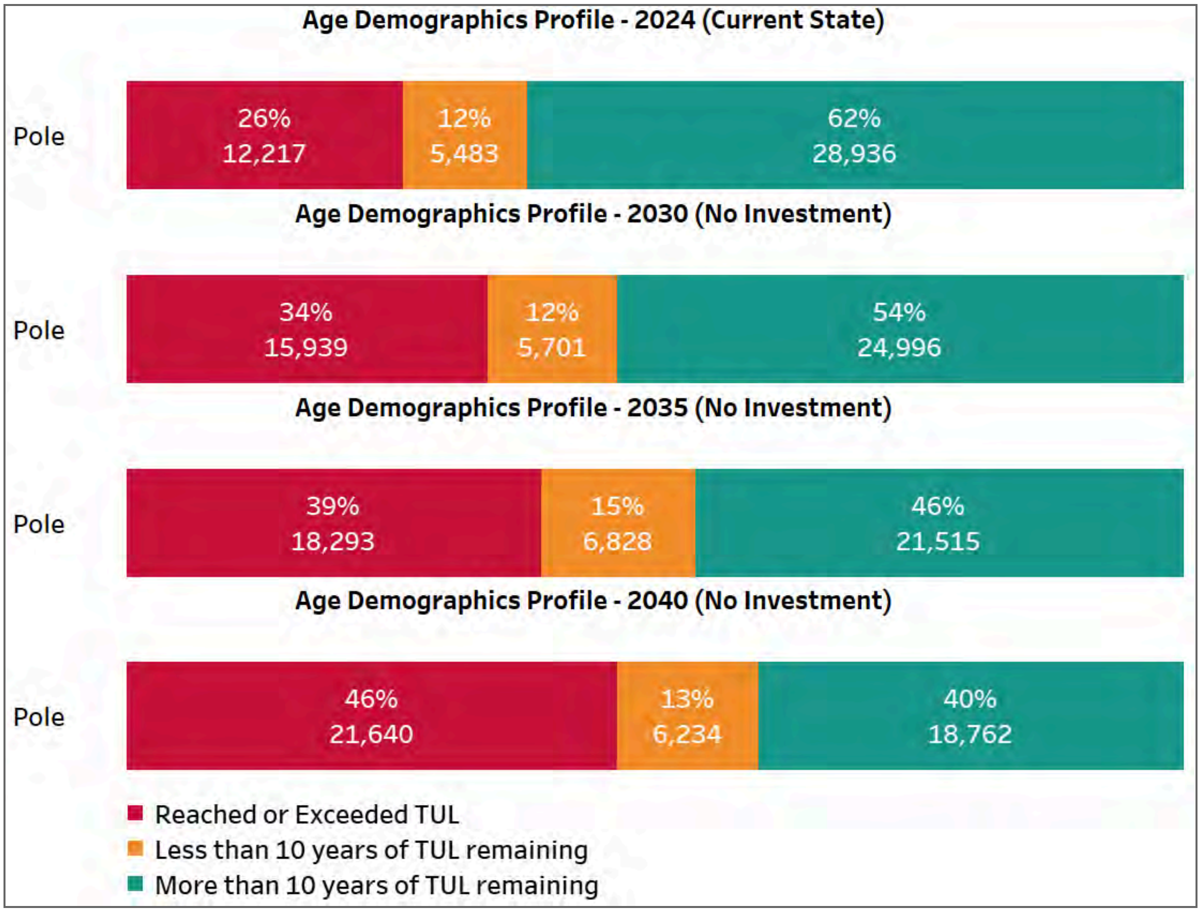
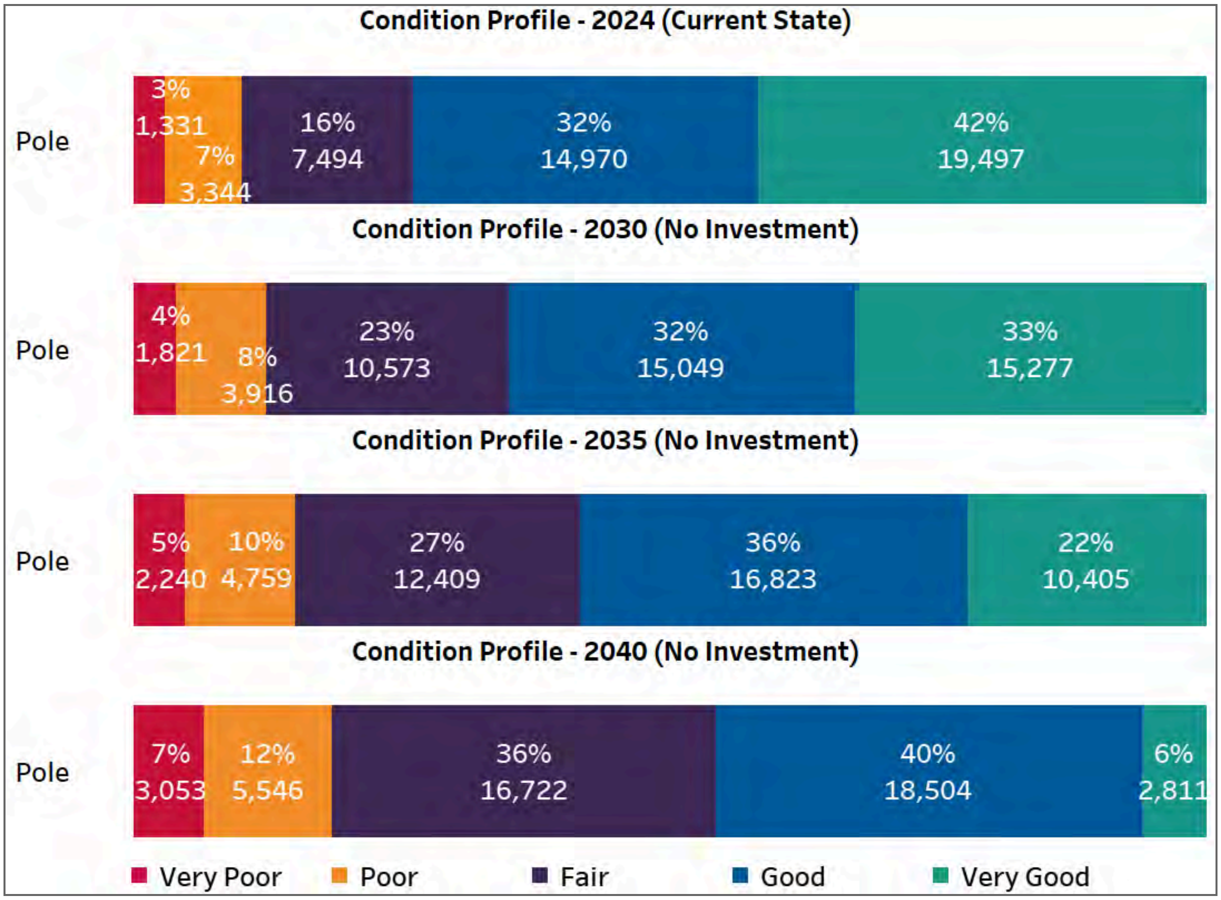
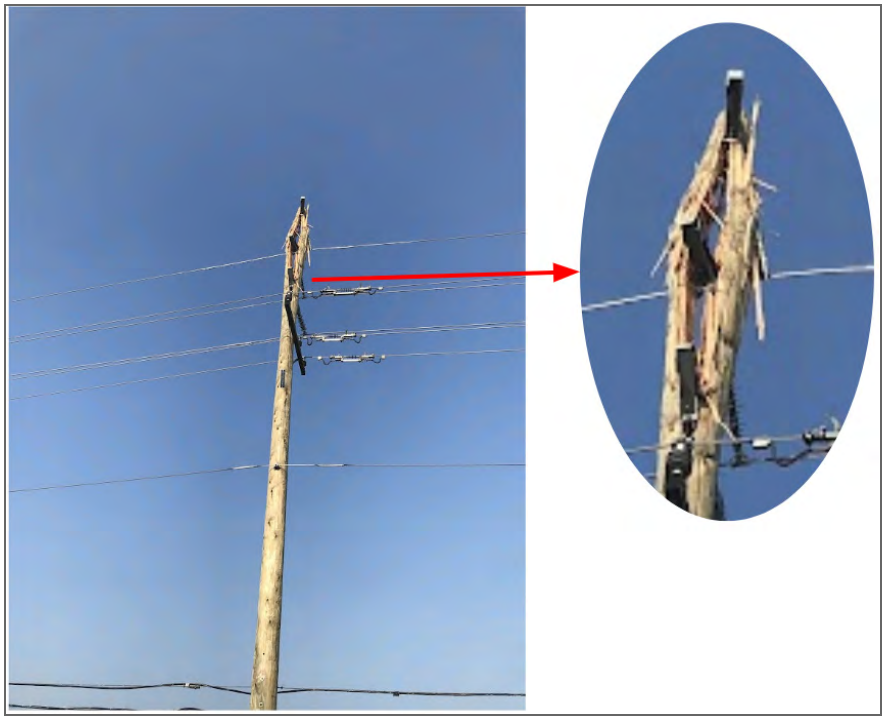


Figure 30 - Condition Profile of Poles



Poles in a degraded condition pose significant risk to Hydro Ottawa's system highlighted by the steady trend of outages due to poles and pole attachments (an average of 18 outages per year between 2019 and 2023) as detailed in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. This shows a consistent impact to reliability each year based on the unanticipated failure of in-service poles. Hydro Ottawa has also been experiencing the lingering impact of extreme weather events on its OH asset population. There are OH assets such as wood poles that haven't failed as a result of an adverse weather event, but have certain components (e.g. pole top, OH switchgear, OH conductor etc.) impacted/degrading faster than expected which may lead to power interruption to customers if not managed proactively. Figure 31 shows an example of a pole top that had been damaged following a storm event (but not failed), making it a high risk to support multiple OH circuits.

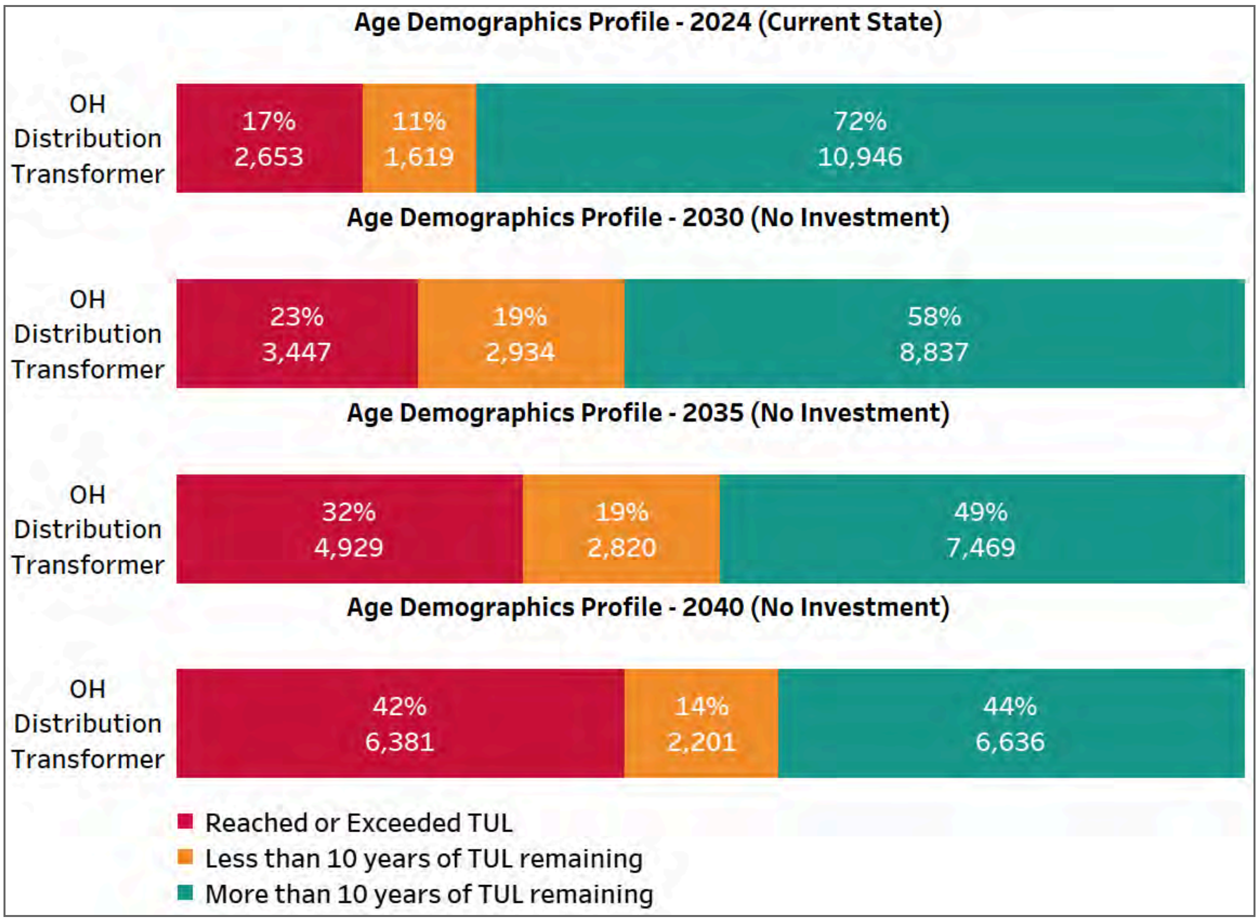
Figure 31 - Example of an Impacted Pole Top Following an Extreme Weather Event



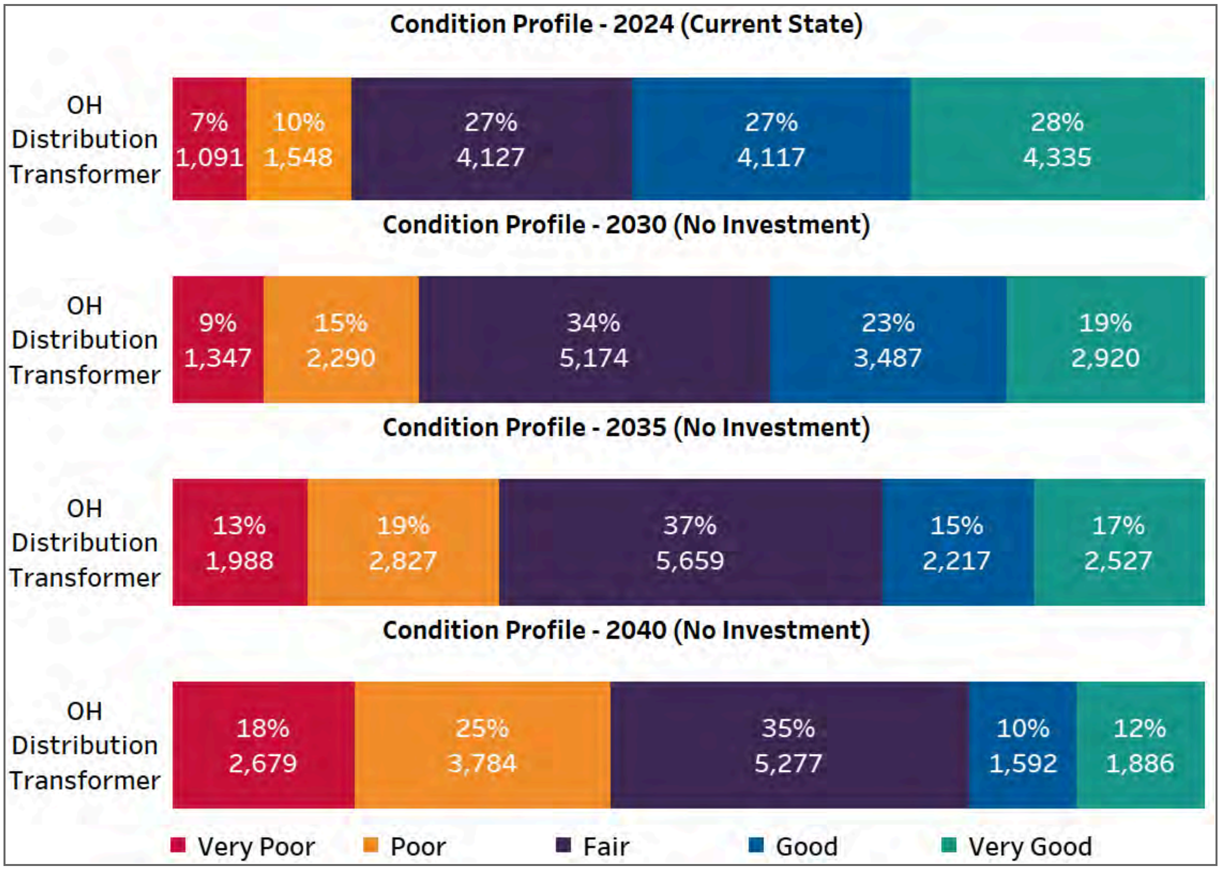
OH Transformers

Hydro Ottawa has also observed a steady trend with respect to the annual number of OH transformer failures resulting in an outage (an average of 25 outages per year between 2019 and 2023), as outlined in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Approximately 17% of the OH transformers owned by Hydro Ottawa have reached their TUL. The number of OH transformers which have surpassed their TUL will continue to increase at a rate of over 8% every 5 years without the proposed level of investment in the pole renewal program (shown in Figure 32). The data on the condition of OH transformers is improving and is primarily based on the translation of age to condition through Copperleaf PA. To enhance condition assessment data, there are suggested improvements to the OH transformer maintenance program through drone-based inspections, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

Figure 32 - Age Demographics Profile of OH Transformers



1 **Figure 33 - Condition Profile of OH Transformers**



2

3 3.3.4. OH Switches/Reclosers

4 Hydro Ottawa did not historically have a capital program in place to renew 3-phase OH switches.
5 Reviewing the age demographics of OH switches (excluding fuse cut-outs), approximately 3% of
6 OH switches will reach or exceed the TUL by 2030, without any intervention. However, there is a
7 sharp increase in the number of OH switches reaching their TUL by 2035 (at 12%), and further
8 increasing to more than half (54%) of the OH switches reaching their TUL by 2040. This shows the
9 need for intervention now, to avoid a backlog in the future.

Figure 34 - Age Demographics Profile of OH Switches

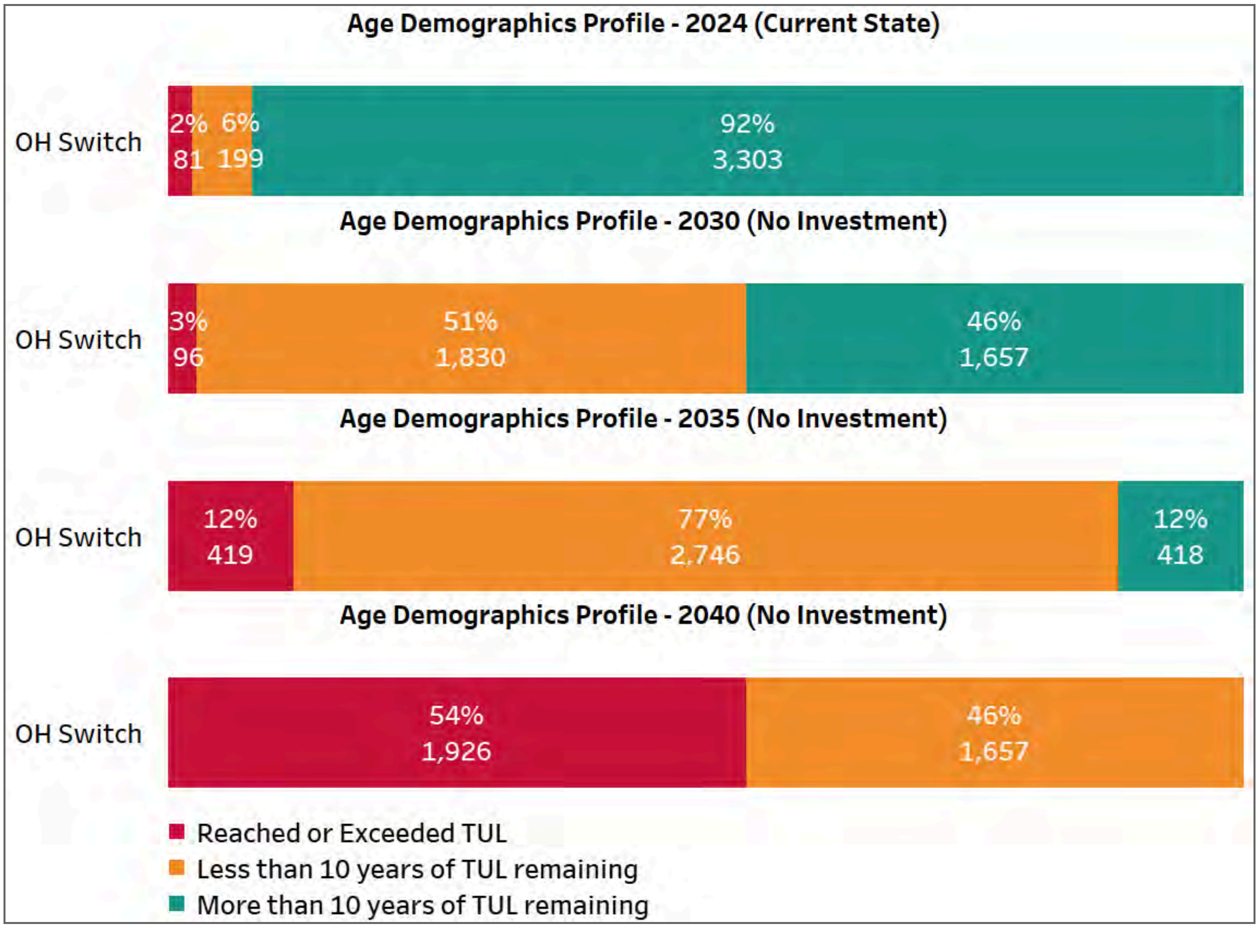
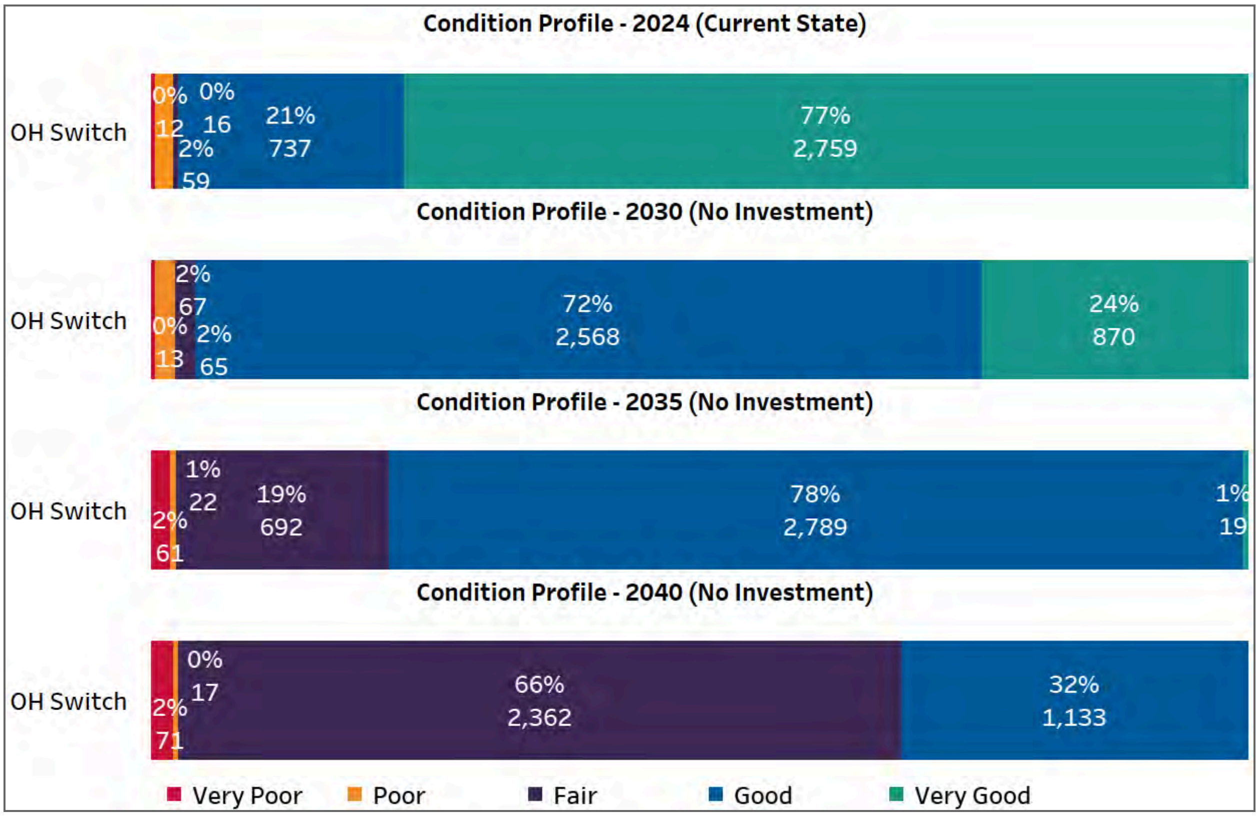
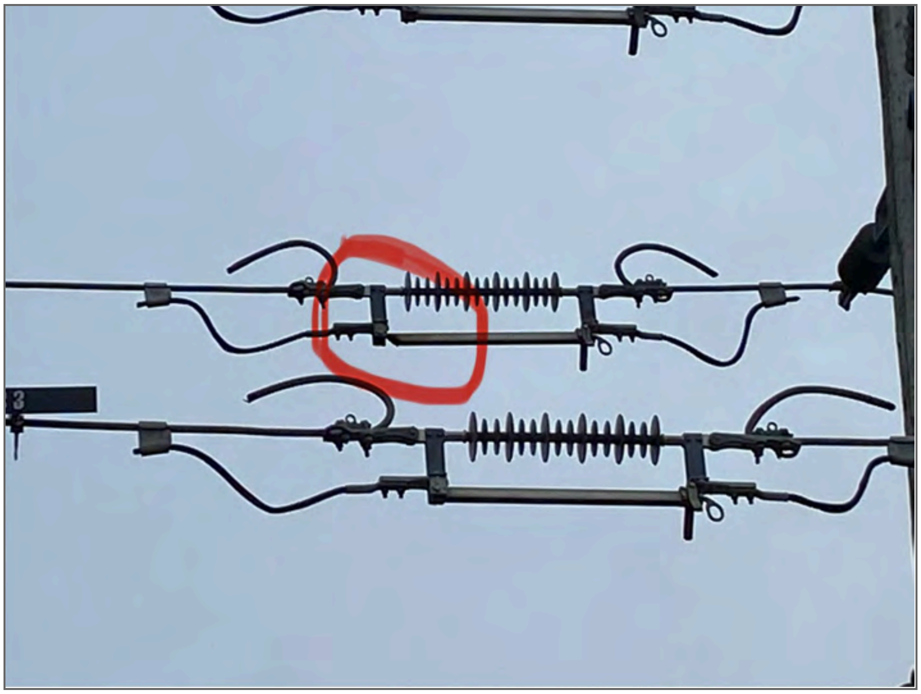


Figure 35 - Condition Profile of OH Switches



Hydro Ottawa has experienced a relatively high number of outages each year (an average of 32 outages per year between 2021 and 2025) due to OH switchgear as detailed in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Further investigation has found a lack of correlation between the condition information on OH switches and outages due to OH switch failures, further emphasizing the need for increased investment in an improved maintenance program for OH switches, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. An example of a burnt OH switch (post thermal failure) is shown in Figure 36.

Figure 36 - Burnt Switch Failure



3.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the OH distribution renewal program are summarized in the section below.

3.4.1. Safety

The replacement of deteriorated OH distribution equipment reduces the risk of in-service equipment failure and consequently, reduces the potential safety risk to employees and the public from catastrophic equipment failures.

3.4.2. Customer

The OH distribution asset renewal program focuses on replacing deteriorating and failing OH distribution assets with the aim to maintain the number of outages due to equipment failures below levels experienced between 2021 to 2025. The program also considers incremental investment to improve resilience through strategic undergrounding or other hardening measures, which is an important outcome for customers.

3.4.3. System Operation Efficiency and Cost Effectiveness

Upgrading manual OH switches to SCADAmates will improve system observability and allow for efficient system operations and control, and reducing truck rolls to operate manual switches. Additionally, the replacement of related pole-mounted hardware (such as OH transformers) as a part of the pole renewal program drives cost savings and efficiencies through the synergy gained by Hydro Ottawa replacing these deteriorated assets in conjunction with pole replacements.

3.4.4. Economic Development

Robust and reliable electric distribution infrastructure is essential for Ottawa's economic stability and growth. Hydro Ottawa's OH distribution asset renewal program contributes to consistent and dependable power which businesses need to thrive, supporting job retention and creation, furthermore the ability to provide stable power will continue to attract commercial investment in Ottawa.

3.4.5. Environment

Hydro Ottawa will be replacing a select population of at-risk OH oil-filled distribution equipment that have reached or exceeded the TUL and are in a deteriorated condition, minimizing the risk of environmental contamination.

3.5. PROGRAM COSTS

Table 9 shows a budget program breakdown of the historical and future investments in the OH distribution asset renewal program. In the 2026-2030 period Hydro Ottawa forecasts expenditures in this program of $67.8M, compared to $43.1M in the 2021-2025 period. There are considerations around equipment/resource availability as well as project prioritization/scheduling which results in some variability in the projected spending between 2026 and 2030.

Table 9 - Historical, Bridge and Test Year Expenditures per OH Distribution Asset Renewal Budget Program ($'000 000s)[4]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Pole Renewal	$ 9.1	$ 8.2	$ 8.8	$ 7.3	$ 8.8	$ 11.3	$ 11.3	$ 11.8	$ 12.3	$ 12.5
OH Switch / Recloser Renewal[5]	$ 0.2	$ 0.6	-	$ 0.1	-	$ 1.6	$ 1.7	$ 1.7	$ 1.8	$ 1.8
ANNUAL TOTAL	**$ 9.3**	**$ 8.8**	**$ 8.8**	**$ 7.4**	**$ 8.8**	**$ 12.9**	**$ 12.9**	**$ 13.5**	**$ 14.1**	**$ 14.3**
5-YEAR TOTAL					**$ 43.1**					**$ 67.8**

Table 10 shows the detailed historical and future units (either replaced or forecasted) by the underlying OH distribution asset class, as a part of OH distribution asset renewal program. The count for OH transformers shows the forecasted units to be replaced under the pole renewal program between 2026 and 2030. The OH switch/recloser renewal program between 2021-2025 aimed at replacing porcelain insulated cut-outs, in-line switches and re-fusing of adjacent taps on select feeders. The focus of the 2026-2030 OH switch renewal program is around replacing aged 3-phase OH switches.

Table 10 - Detailed Unit Replacements per OH Distribution Asset Class

Asset Class	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Poles	370	419	283	330	330	395	395	395	395	395
OH Transformers	85	54	46	62	62	80	80	80	80	80
OH Switches / Reclosers	-	43	-	13	-	68	68	68	68	68

[4] Totals may not sum due to rounding
[5] 2021-2025 units include loadbreak/non loadbreak switches, inline switches and disconnects whereas the units proposed for the 2026-2030 rate app only consider loadbreak/ non loadbreak switches planned for replacement.

3.5.1. Pole Renewal

The Pole Renewal program's spending is forecasted to increase by $16.9M from $42.3M in 2021-2025 to $59.2M in 2026-2030, of which $9M is due to support incremental investments in resilience related activities, such as strategic undergrounding. The remaining nearly $8M increase is related to the increased volume of poles being proposed for replacement. Hydro Ottawa made significant productivity improvements to the pole renewal program over the 2021-2025 period, as outlined in Schedule 1-3-4 - Facilitating Continuous Improvement and Innovation. As a result, Hydro Ottawa has maintained the baseline cost per pole for the 2026-2030 period, accounting for continued inflation. The 2026-2030 pole renewal program allows Hydro Ottawa to replace 395 poles per year, which is in line with the targeted rate of 400 poles per year that was approved for the 2021-2025 rate period. Further details related to Hydro Ottawa's decision to defer pole replacements through the 2021-2025 period are provided in Section 4.1 of Schedule 2-5-5 - Capital Expenditure Plan.

The renewal of OH transformers do not have a distinct program budget as the cost for replacement is contemplated within the pole renewal budget.

3.5.2. OH Switch/Recloser Renewal

The OH switch/recloser renewal program spending is forecasted to increase by $7.7M from $0.9M in 2021-2025 to $8.6M in 2026-2030. Between 2021-2025, the only planned replacements and expenditures for overhead switches and reclosers were for replacing porcelain insulated cut-outs, in-line switches and re-fusing of adjacent taps on select feeders. Any other overhead switch replacements during this period were done as part of pole renewals or other programs, as there was no specific plan to renew OH switches and reclosers.

The historical strategy of replacing 3-phase OH switches under the pole renewal program is no longer reasonable primarily due to a misalignment in asset lifespans: the typical useful life (TUL) of switches is 25 years, while poles have a significantly longer TUL of 53 years, resulting in a large number of switches reaching their end-of-life well before the poles (see Figure 34). This issue is compounded by the high reliability impact Hydro Ottawa has experienced due to OH switch failures, averaging 32 outages per year between 2021 and 2025. This has also resulted in a Corrective Renewal spending of $2.5M (on an emergency and critical basis) for OH switches between 2021 and 2023, thereby having a considerable financial impact. As a result, Hydro Ottawa has set a budget for the proactive replacement of 3-phase OH switches under the OH Switch/Recloser renewal program. This program allows Hydro Ottawa to replace 340 manual switches and also contemplates upgrading 40 manual switches to remote controllable switches, refer to Section 3.6.3 - Preferred Alternative for OH switch replacement rationale.

3.5.3. Cost Factors

Cost factors that affect OH distribution asset renewal are listed below:

- Location and number of circuits being supported
- Type and quantity of distribution assets installed on a pole
- Nature of renewal: like-for-like or like-for-better (e.g. wood pole with a wood pole or a wood pole replaced with a composite pole)

3.6. ALTERNATIVES EVALUATION

3.6.1. Alternatives Considered

In order to address the drivers and achieve the performance objectives of the program, Hydro Ottawa conducted an analysis using Copperleaf PA to optimize the number of units renewed as part of OH distribution asset renewal projects, with the goal of minimizing the number of asset failures and managing long term operational performance. As a result of the low relative replacement cost compared to the value of mitigated risk and Copperleaf PA's focus on individual asset performance, the PA analysis recommended that Hydro Ottawa replace all assets in degraded condition over the 5-year period. To achieve this objective, Hydro Ottawa would need to invest $199M in the OH renewal program, far exceeding the $43M investment levels of the 2021-2025 period. This level of investment would result in customer rate and resourcing impacts that do not align with the overall objectives of this Distribution System Plan.

In this regard, three investment alternatives were considered, as outlined in Table 11, with varying levels of replacement rates and alignment to the outcomes detailed in Table 8 with the objective of balancing long term-cost impacts with the risks associated with assets in a degraded condition.

Table 11 - Summary of Program Investments of Alternatives Considered

Program Investments	Alternative 1: Cost Containment	Alternative 2: Short Term Risk Mitigation	Alternative 3: Long Term Risk Mitigation (Preferred)
Poles	1100 (220/year)	1475 (295/year)	1975 (395/year)
OH Transformers	225 (45/year)	300 (60/year)	400 (80/year)
3-Phase OH Switches/Reclosers	110 (22/year)	220 (44/year)	340 (68/year)
Incremental Resilience Investments	No	No	Yes ($1.6M/year)
System Observability Investments	Minor (2/year)	Medium (4/year)	Highest (8/year)
TOTAL PROGRAM COST	**$35M**	**$50M**	**$68M**

Alternative 1: Cost Containment (~$35M): This alternative will provide:

- Cost impacts are minimized during the 2026-2030 period, however replacement rates will not allow Hydro Ottawa to balance long term affordability or effectively manage risk associated with assets in degraded condition:
  - No reduction in the percent of poles in degraded condition compared to 2024 levels (refer to Figure 38) and a net 6% increase in poles that have reached their typical useful life by 2030 (refer to Figure 37), creating a back-log of poles to be replaced in the long term.

    - A 4% net increase in the number of OH transformers that have reached their typical useful life (refer to Figure 39).
    - Replacement of all 3-phase OH Switches that have reached their typical useful life (refer to Figure 41).
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Minimum ability to increase system observability through the OH asset renewal program
- Inability to enhance system resilience through the OH asset renewal program

Alternative 2: Short Term Risk Mitigation (~$50M): This alternative will provide:

- Cost impacts are more significant and replacement rates will allow Hydro Ottawa to mitigate only short term risk associated with assets in degraded condition:
    - A minor 1% reduction in the percent of poles in degraded condition compared to 2024 levels (refer to Figure 38) and a 5% net increase in poles that have reached their typical useful life by 2030 (refer to Figure 37), creating a back-log of poles in deteriorated condition to be replaced in the long term.
    - A 4% net increase in the number of OH transformers that have reached their typical useful life (refer to Figure 39).
    - Replacement of all 3-phase OH Switches that have reached their typical useful life (refer to Figures 41).
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Minimum ability to increase system observability through the OH asset renewal program
- Inability to enhance system resilience through the OH asset renewal program

Alternative 3 - Long Term Risk Mitigation (~$68M - Preferred Alternative): This alternative will provide:

- Cost impacts are highest however replacement rates will allow Hydro Ottawa to most effectively balance long term affordability and risk associated with assets in degraded condition:
    - A more significant 2% reduction in the percent of poles in degraded condition compared

to 2024 levels (refer to Figure 38) and a 4% net increase in poles that have reached their typical useful life by 2030 (refer to Figure 37), reducing the back-log of poles to be replaced in the long term.
  - A 3% net increase in the number of OH transformers that have reached their typical useful life (refer to Figure 39).
  - Replacement of all 3-phase OH Switches that have reached their typical useful life (refer to Figures 41).
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Ability to maximize system observability through efficient deployment of capital, replacing an estimated 40 switches with remote controllable switches during renewal efforts
- Ability to increase system resilience by including a plan to underground approximately 30 poles per year

Figures 37 to 42 show the proportion of OH distribution assets that will reach the TUL and deteriorating condition by 2030, based on current state and a consideration of the different intervention strategies around managing the OH distribution asset population.

Figure 37 - Number of Poles Projected to Reach Typical Useful Life by 2030

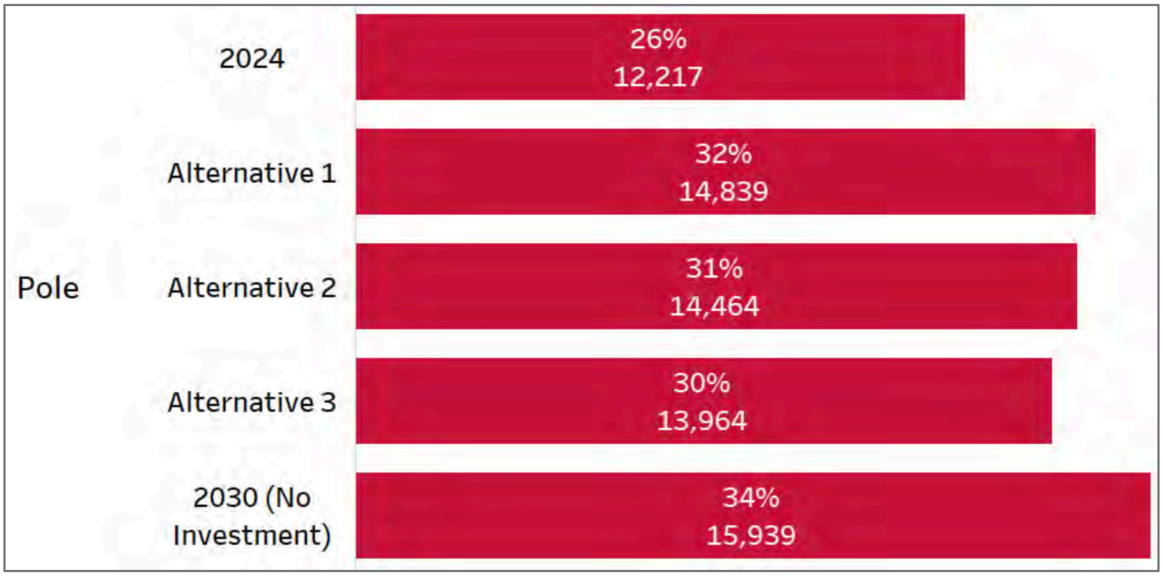


Figure 38 - Number of Poles Projected to Reach a Deteriorated Condition by 2030

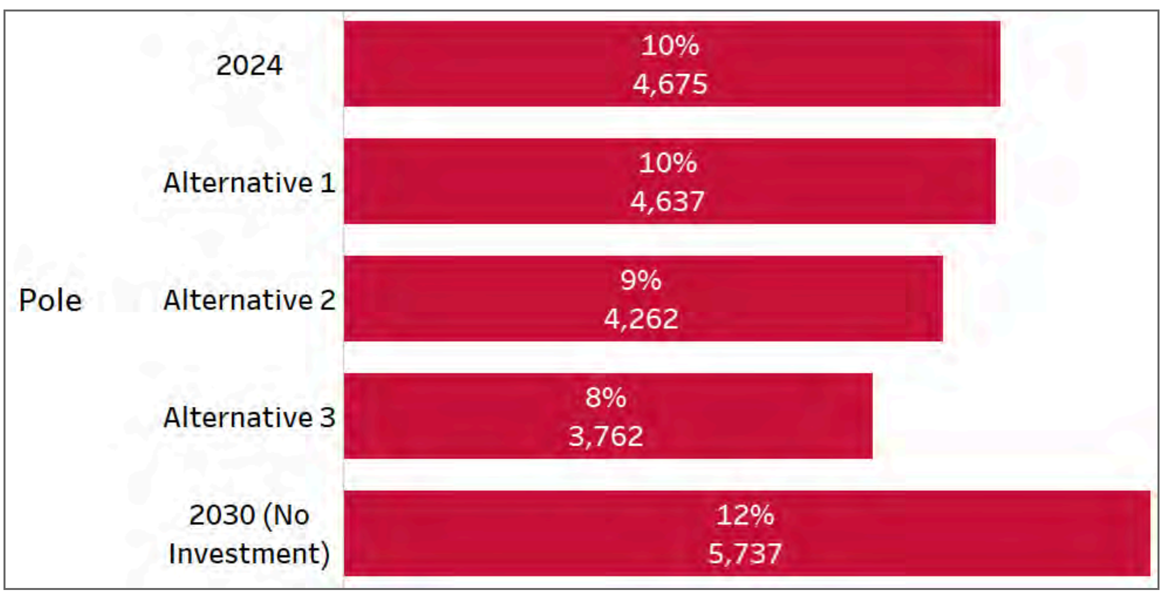


Figure 39 - Number of OH Transformers Projected to Reach Typical Useful Life by 2030

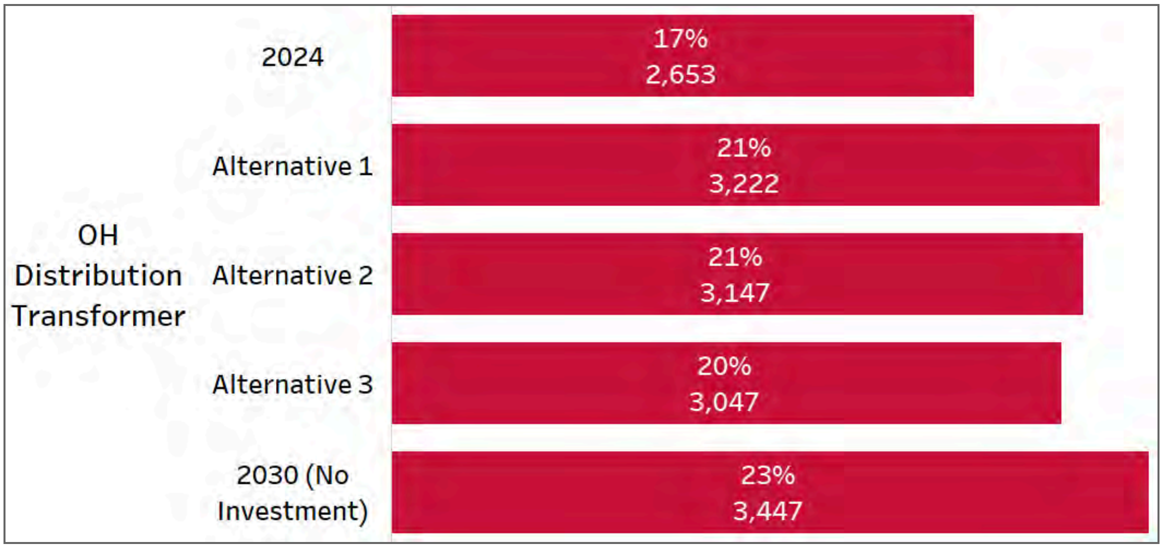


Figure 40 - Number of OH Transformers Projected to Reach a Deteriorated Condition by 2030

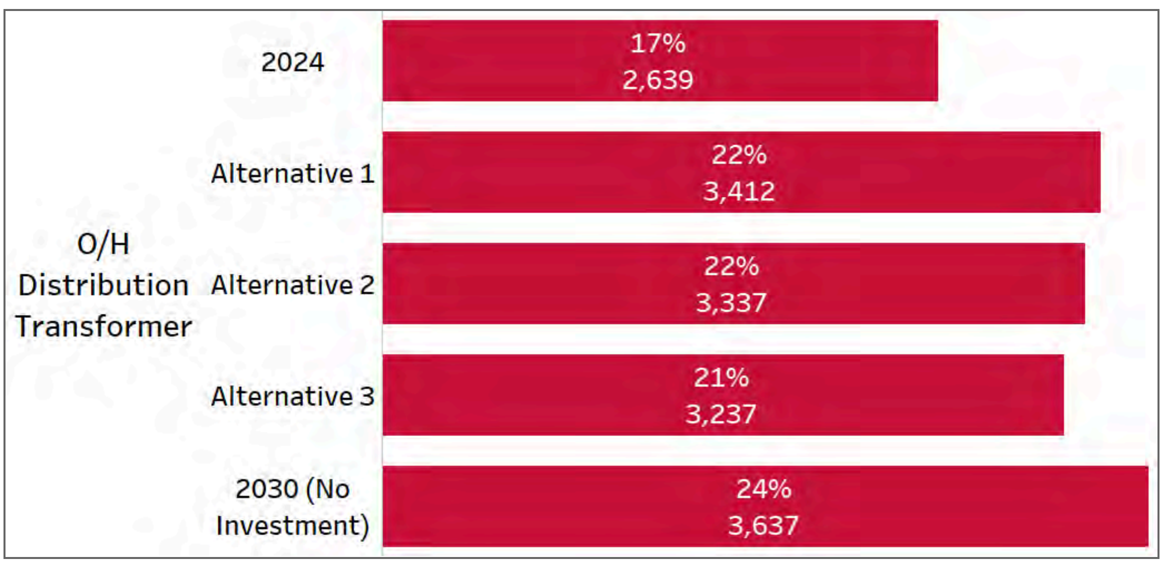


Figure 41 - Number of Overhead Switch/Recloser Projected to Reach Typical Useful Life by 2030

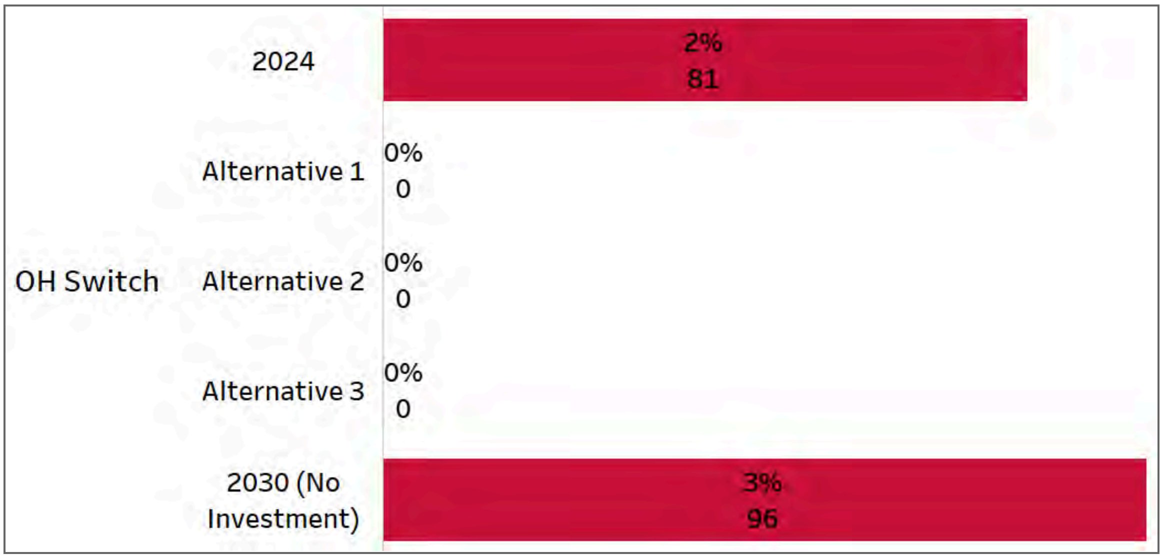
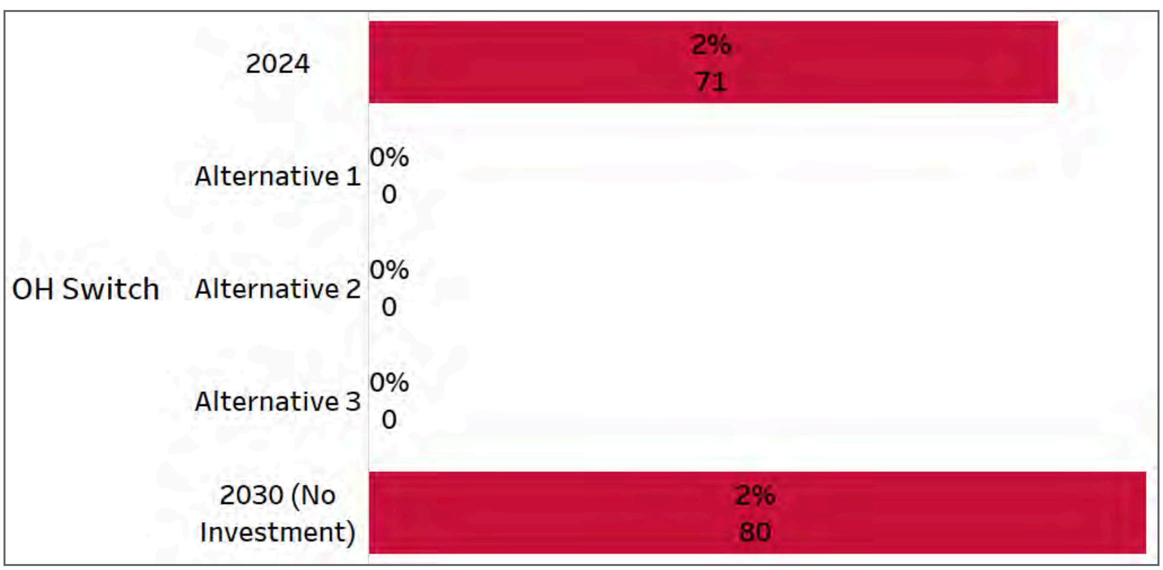


Figure 42 - Number of OH Switches Projected to Reach a Deteriorated Condition by 2030



3.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. The increased risk of failure posed by deteriorating poles can impact Hydro Ottawa's ability to protect workers and public safety. This criterion assesses the ability to maintain or improve the safety of Hydro Ottawa's employees and the public.

Reliability

The increased potential of failure posed by deteriorating OH distribution assets will impact Hydro Ottawa's ability to deliver reliable power. This criterion assesses the ability to maintain or improve the reliability performance of deteriorating OH distribution assets.

Financial

This criterion assesses the ability to manage long-term financial needs for OH distribution assets. This helps to avoid large spikes in asset renewal spending and the associated rate impacts on customers. The selected alternative should ensure a levelized spending profile, manage long-term asset performance, and prevent significant service disruptions due to deteriorating OH distribution asset failures.

System Observability

This criterion assesses the ability to increase the overall system observability and control (through the introduction of SCADAmates), in line with Hydro Ottawa's grid modernization initiatives/efforts.

Resilience

Weather resilience is a crucial factor in planning renewal investments for OH distribution assets because extreme weather events can significantly impact these assets, leading to failures and customer interruptions. This criterion assesses the ability to enhance the resilience of OH infrastructure in response to the increasing impact of extreme weather events such as ice storms, Derechos, and tornadoes.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

3.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 3.6.1 - Alternative Considered under the evaluation criteria of Section 3.6.2 - Evaluation Criteria.

The recommended approach, Alternative Three, involves replacing 1,975 poles, 400 OH transformers, and 340 OH switches/reclosers (including replacement of an estimated 40 manual switches with SCADAmates). This alternative also includes a strategic approach to improve overhead line resilience by evaluating resilience measures, such as strategic undergrounding, line reinforcements, feeder reconfigurations, and line relocations.

As demonstrated in Figure 30, Hydro Ottawa projects a 3% increase in poles in degraded condition every 5 years between 2026 and 2040. The proposed replacement rate allows Hydro Ottawa to keep pace with long term risk associated with poles in degraded condition, however with 3,700 additional poles reaching their TUL by 2030, the percentage of Hydro Ottawa's poles that have reached their TUL will continue to grow. To mitigate against the risk associated with an aging population, Hydro Ottawa has proposed changes to the inspection cycle from 10 years to 5 years for selected poles which have reached or exceeded their TUL (as described in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs). The replacement rate of 1,975 poles under Alternative Three strategically balances the imperative to address immediate risks posed by degraded poles with the proactive management of increased failure probability associated with assets exceeding their TUL.

While only a small percentage of OH switches currently exceed their TUL, a significant increase is anticipated in the coming years. Specifically, there is a sharp increase in the number of OH switches reaching their TUL by 2035 (at 12%, 419 switches), further resulting in more than half (54%) of the OH switches reaching their TUL by 2040. Hydro Ottawa's understanding of OH switch/transformer condition is evolving and drone-based inspections are recommended through 2026-2030, to capture more accurate data, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. However, Hydro Ottawa has experienced a high number of outages due to OH switchgear failures, reinforcing the need for planned replacements, in addition to the aging consideration. To this end, Alternative three allows Hydro Ottawa to mitigate the growing risk associated with asset failures and maintain the age demographics of OH switches to avoid a substantial backlog in the future.

Although resilience-related investments during pole renewal increase initial costs, they offer a cost-effective way to enhance system resilience against increasingly frequent and severe weather events, aligning with the expanded program supported by Alternative Three.

Alternative Three also positions Hydro Ottawa to efficiently deploy capital in support of Grid Modernization. Switches that will be targeted for observability will be upgraded to remote operable switches while undergoing planned renewal. Remote operable switches contribute to increased system observability and control to better manage outage responses and reduce the related customer interruption impact.

Ultimately, the selected OH distribution asset investment program translates to manageable long term costs and asset condition levels as well as efficient deployment of capital, leading to increased customer satisfaction and a sustainable grid.

3.7. PROGRAM EXECUTION AND RISK MITIGATIONS

3.7.1. Implementation Plan

Planned OH distribution replacements are prioritized based on the related equipment's condition and level of risk posed to Hydro Ottawa. Using the recommended rate of planned renewal, OH asset renewal investments will begin in 2026 addressing OH equipment whose condition poses the highest level of risk. The renewal of deteriorated OH infrastructure to withstand climatic forces from storm events is key to resilience over the long term for the system. As such, Hydro Ottawa will enhance the impact of the OH distribution renewal program over the 2026-2030 period by evaluating alternative design standards (anti-cascade) capable of withstanding increased loading, and creating risk based application guides to further mitigate potential damage in high risk installations.

3.7.2. Risks to Completion and Mitigation Strategies

Hydro Ottawa faces several risks in managing its OH distribution asset renewal program, Table 12 outlines the key risks and corresponding mitigation strategies.

Table 12 - Key Risks of OH Distribution Asset Renewal Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.

Category	Risk	Mitigation
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

4. UG DISTRIBUTION ASSETS RENEWAL

4.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $63.3M

2026-2030: $103M

Budget Programs: UG Switchgear Renewal, Cable Renewal, Civil Renewal, Vault Renewal

Main Driver: Failure Risk

Secondary Driver: Reliability, Safety, Environmental

Outcomes: Operational Effectiveness and Customer Focus

Hydro Ottawa's underground (UG) distribution system is supported by a network of UG cables, transformers and switchgear (with the related UG civil infrastructure), ensuring power delivery to the end customer. The continued reliability and safety of the UG distribution system is dependent on the performance of these assets. Hydro Ottawa has proposed investments targeted at renewing UG distribution infrastructure over this Application period. This program replaces end-of-life UG distribution assets in a deteriorated condition, ensuring long-term performance and prioritizing projects based on asset condition and risk, as determined through the distribution asset model in Copperleaf PA (described in Section 5.1.4 of Schedule 2-5-4 - Asset Management Process).

Hydro Ottawa proposes to invest $103M to renew UG distribution assets over this Application period. This capital allocation is dedicated to maintaining a high degree of system reliability through the optimization of asset replacement strategies, thereby enhancing the operational performance of the existing UG asset population. Also, a major focus in defining these measures is the positive impact on customers. This program aims to mitigate the risk of UG distribution equipment failures and improve reliability, reducing customer interruptions due to failures.

This UG Distribution Renewal Program addresses the UG system needs under the following budget programs over the 2026-2030 period:

UG Cable Renewal: This budget program involves the replacement of approximately 61.4 km of UG cables in the Beaverbrook and Bilberry regions of Ottawa. The program also includes the replacement of adjacent end-of-life assets including pad-mounted transformers and pad-mounted switchgear.

UG Switchgear Renewal: This budget program involves the replacement of 30 UG switchgear, specifically, existing air-insulated underground switchgear and select gas type switchgear in a deteriorated condition. This program may also require the replacement of adjacent assets in poor condition, including UG cables.

Civil Renewal: This budget program involves performing a variety of civil renewal activities including replacing worn cable chamber lids, collar replacements, roof replacements, and complete cable chamber replacements. This program may also include the renewal of additional cable chambers in conjunction with City of Ottawa road projects and Hydro Ottawa's UG cable renewal, UG switchgear renewal and EOL voltage conversion programs. Hydro Ottawa plans to replace 30 cable chambers between 2026-2030.

Vault Renewal: This budget program involves the replacement of Hydro Ottawa owned vault transformers deemed to pose an increased risk to safety or system reliability. In addition to this, customer-owned vault switchgear will also be combined/considered for replacement (especially those units that pose a major reliability risk and are in a degraded condition), with Hydro Ottawa taking ownership of the identified customer equipment for further intervention and management. Hydro Ottawa shall strategize combining vault transformer and switchgear replacements for efficiencies, after a close evaluation of the corresponding risk/condition posed by the corresponding units. Hydro Ottawa plans to replace 90 single phase vault transformers and 30 vault switchgear units (contingent on Hydro Ottawa taking ownership of the assets), through 2026-2030.

4.2. PERFORMANCE OUTCOMES

Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. With the implementation of the UG distribution asset renewal program, improvements are expected in the outcomes shown in Table 13 below.

Table 13 - UG Distribution Asset Renewal Program Performance Outcomes

OEB Performance Outcome	Target
Operational Effectiveness	Hydro Ottawa's system reliability objectives are supported by: ● Replacing assets at a pace that allows Hydro Ottawa to achieve 36% of UG distribution assets that have reached their end-of-life by 2030. ● Replacing assets at a pace that allows Hydro Ottawa to minimize the percentage of UG distribution assets in poor and very poor condition by 2030.
	● Contributes to Hydro Ottawa's Grid Modernization Plan by replacing 10 UG switchgear with remote operability, resulting in increased observability and controllability of Hydro Ottawa's distribution system
Customer Focus	● Contributes to Customer Satisfaction by maintaining system reliability

4.3. PROGRAM DRIVERS AND NEED

4.3.1. Main and Secondary Drivers

Primary Driver – Failure Risk: The primary driver for UG distribution assets renewal is the increasing failure risk due to the number of units in a deteriorated condition or surpassing their TUL. The proposed investments are supported by the Copperleaf PA distribution asset model which considers asset condition as a part of the risk assessment value framework. Further detail on the distribution asset model is provided in Section 5.1.4.2 of Schedule 2-5-4 - Asset Management Process.

Secondary Drivers – Reliability, Safety and Environmental: The UG distribution asset renewal program is important to minimize the impact failed UG distribution assets have on reliability, and by extension SAIFI and SAIDI (by replacing them before they fail), and to mitigate the associated safety impact to the public around catastrophic failure, while undertaking the renewal in a cost efficient planned manner. UG distribution assets pose a huge safety risk mainly to Hydro Ottawa's personnel and the public/contractors, due to the potential for asset failure. The failure of UG and vault transformers poses a huge environmental risk, due to the related oil leak. The failure of UG and vault SF_6 gas switchgear will also result in SF_6 gas leaks, which has a huge environmental impact, since SF_6 is considered to be a greenhouse gas.

4.3.2. Current Issues

The primary focus of the UG distribution asset renewal program is to mitigate the risks associated with asset failure. The age and condition demographics of the major UG distribution assets considered as a part of the UG distribution asset renewal program are provided in Figures 45 to 59, with the overall summary provided in Figure 43 and Figure 44.

Figure 43 - Overall Age Demographics Profile of UG Distribution Assets

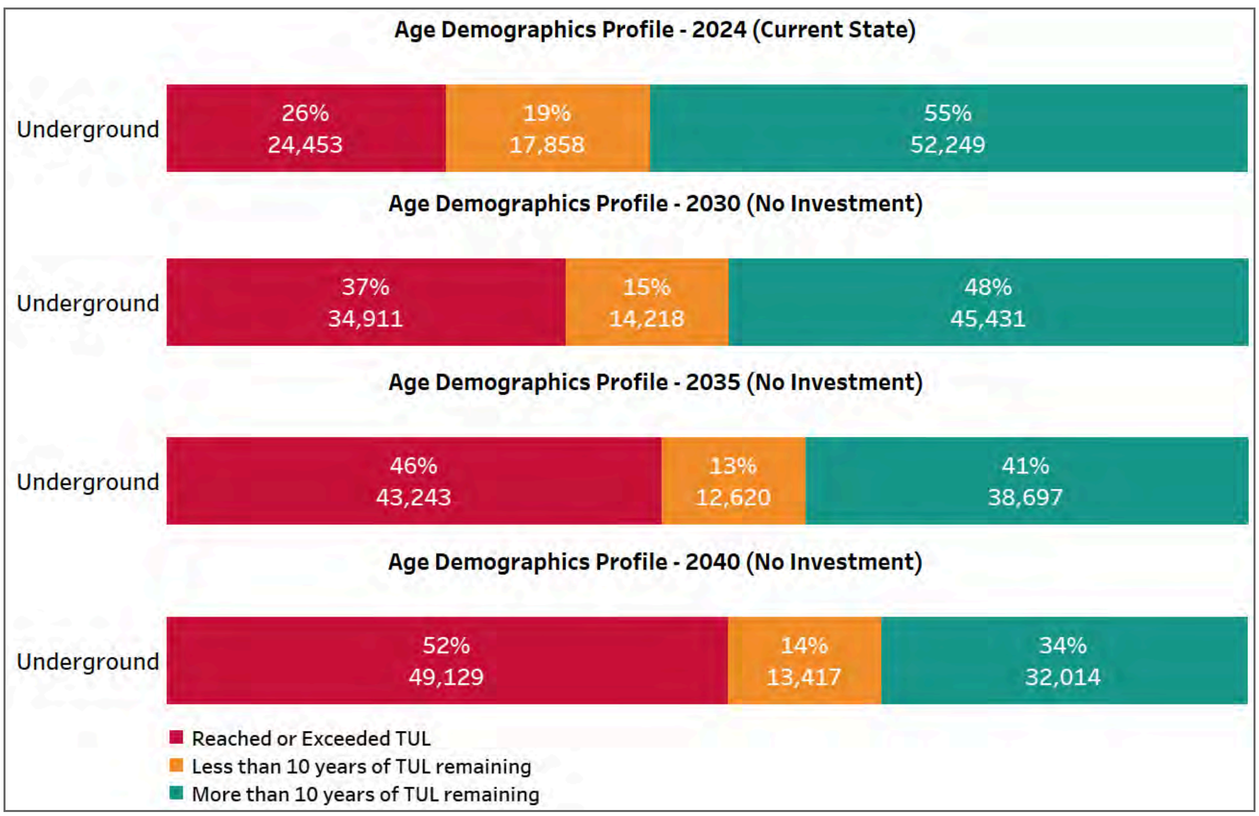
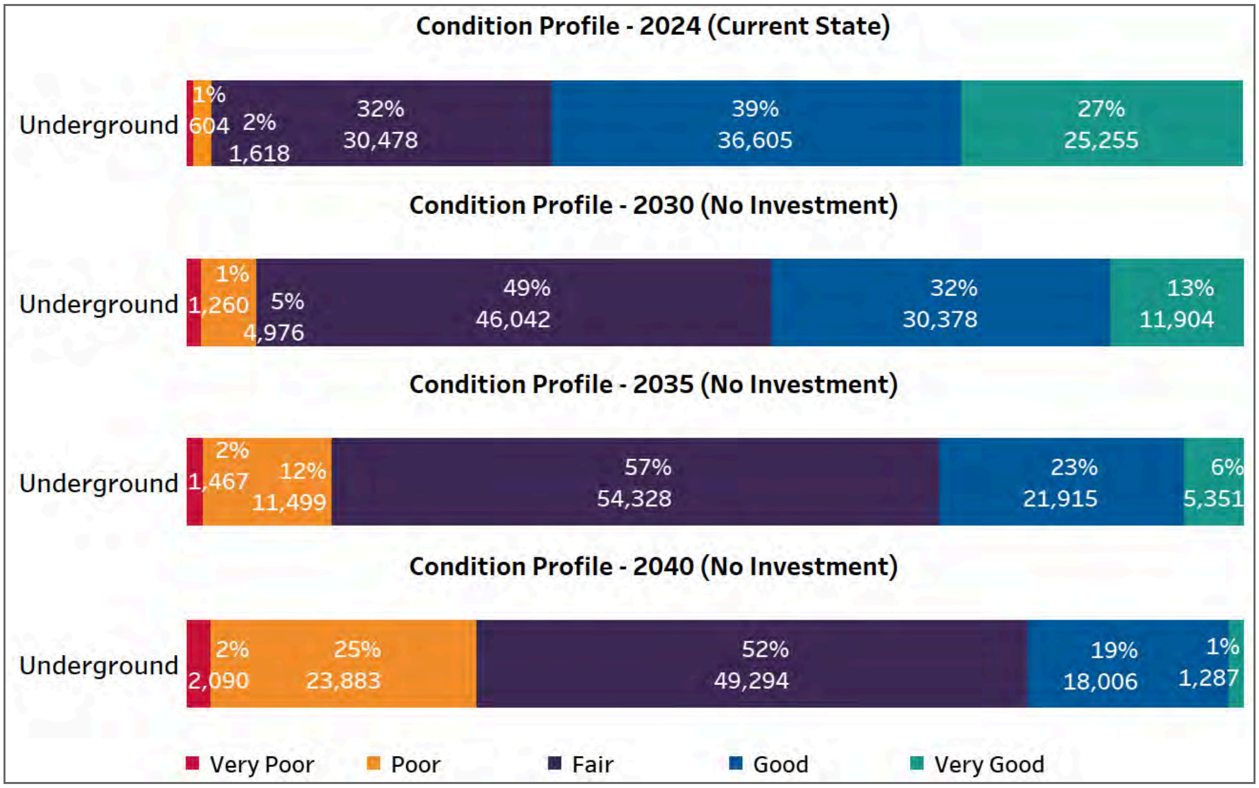


Figure 44 - Overall Condition Profile of UG Distribution Assets



For context, TUL refers to the expected duration an asset can reliably operate before it requires replacement or refurbishment. Condition ranges, in addition, provide a way to assess the state of an asset and determine the urgency of any necessary interventions. To this end, Hydro Ottawa uses a health index, which is a score from 0% to 100%, to evaluate the condition of an asset from Very Poor to Very Good. More details on Hydro Ottawa's condition assessment framework is presented in Section 5.1.2.1 of Schedule 2-5-4 - Asset Management Process.

Through Copperleaf PA, Hydro Ottawa established the unique degradation pattern of each individual asset in the system into 2040. From Figure 43, it can be observed that without intervention the percentage of Hydro Ottawa's UG assets that have reached their end of life will continue to grow at a rate of approximately 9% every five years. Likewise, without intervention, the percentage of assets in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years.

The following sub-sections summarize some of the challenges faced by Hydro Ottawa specific to its existing UG distribution asset fleet.

4.3.3. UG Switchgear

Figures 45 and 46 demonstrate that Hydro Ottawa's UG Switchgear units (mainly air type) are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of UG Switchgear units that have reached their end of life will continue to grow at a rate of approximately 15% every five years. Likewise, without intervention, the percentage of UG Switchgear units in degraded condition (poor or very poor) will continue to grow at a rate of approximately 2% every 5 years.

Figure 45 - Age Demographics Profile of UG Switchgear

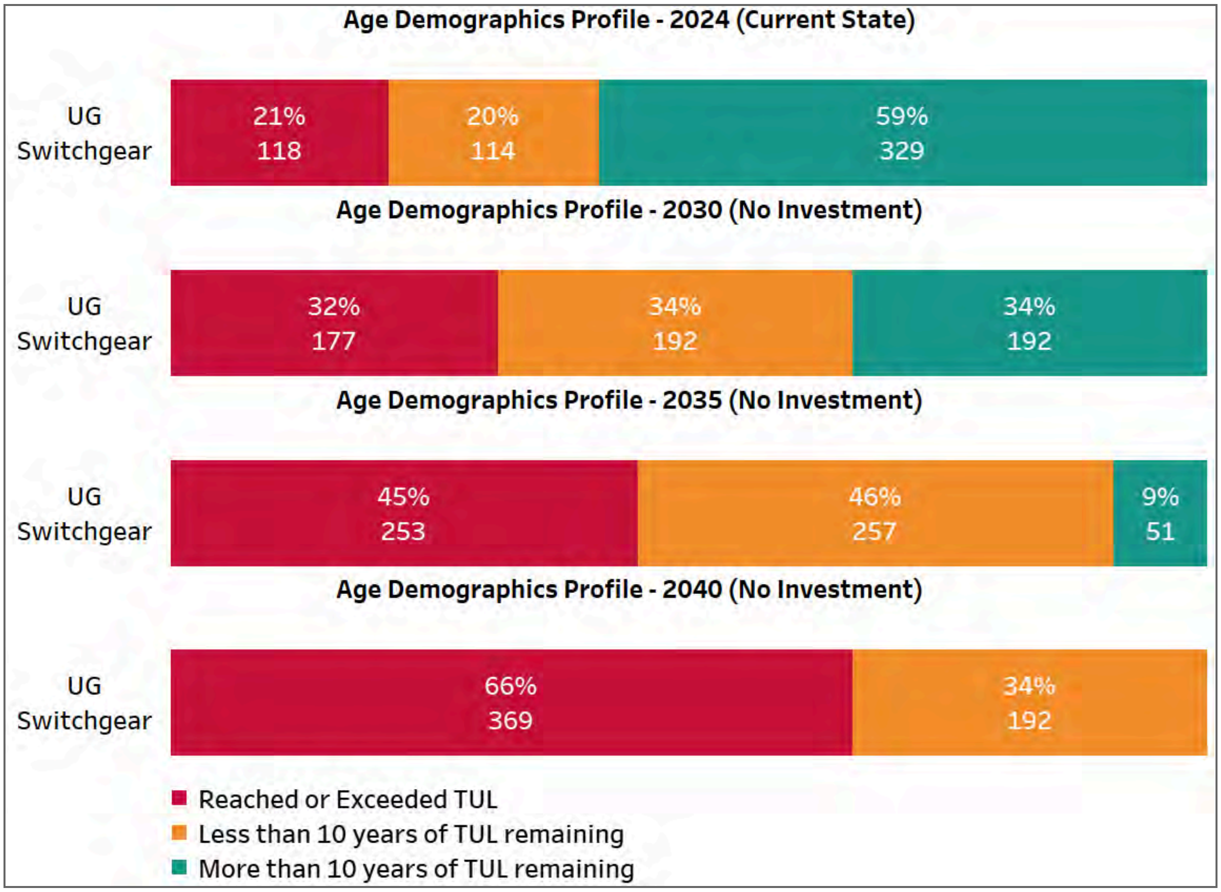
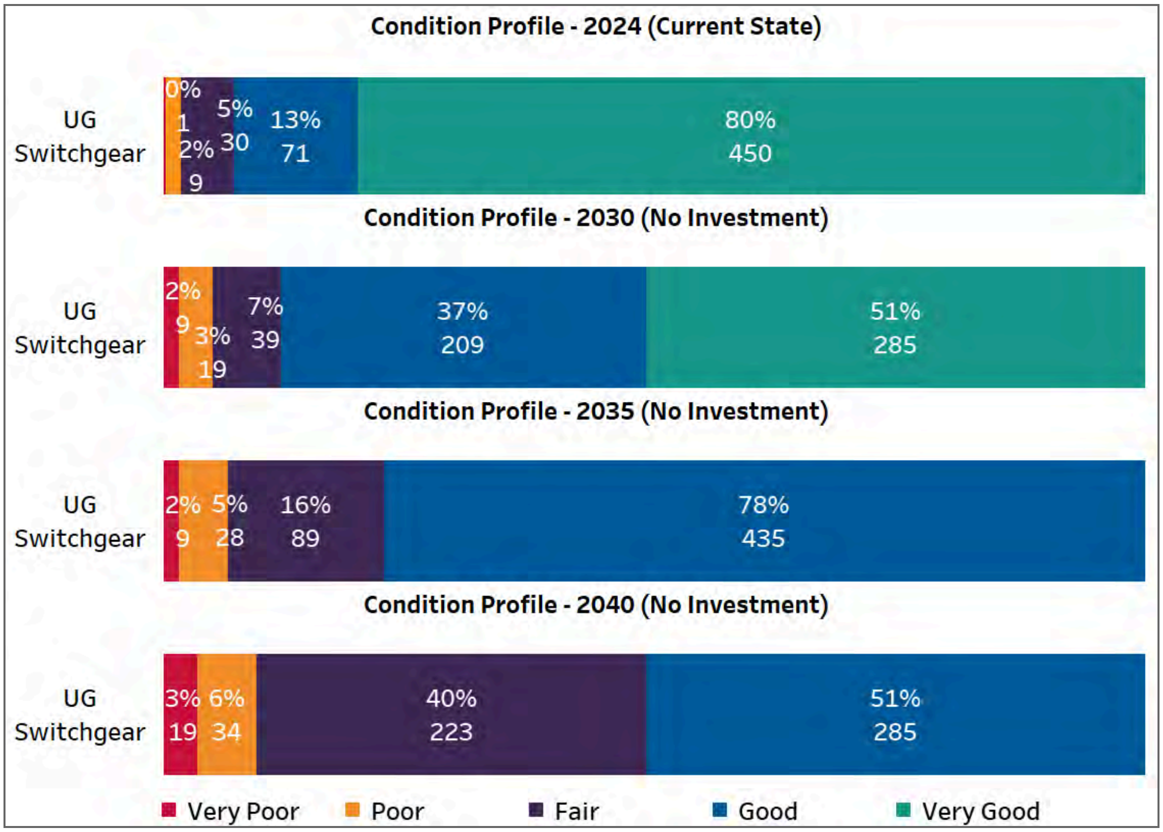


Figure 46 - Condition Profile of UG Switchgear



Hydro Ottawa is experiencing an increase in the number of air-type switchgear failures as compared to previous years since 2022 (with six and three failures in 2022 and 2023 respectively) as outlined in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. These failures have been related to electrical failure as a result of flashover. Hydro Ottawa had implemented inspection enhancements in 2024 to capture more UG switchgear inspection data (down to the component level), which will continue through 2026-2030 to further advance the condition assessment of UG switchgears for preventing unanticipated failures as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

There have also been some premature SF_6 leaks with the UG gas insulated switchgear fleet, tied to a specific manufacturer, thereby increasing the environmental impact due to SF_6 gas emissions. These switchgear failures had to be tackled under the Emergency Renewal budget program, as outlined in Section 6 - Corrective Renewal.

Figure 47 - UG Air Type Switchgear Failure

4.3.4. UG Transformers and Cables

Figures 48 and 49 demonstrate that Hydro Ottawa's UG transformers are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of UG transformers that have reached their end of life will continue to grow at a rate of approximately 10% every five years. Likewise, without intervention, the percentage of UG transformers in degraded condition (poor or very poor) will continue to grow at a rate of approximately 12% every 5 years.

Figure 48 - Age Demographics Profile of UG Transformers

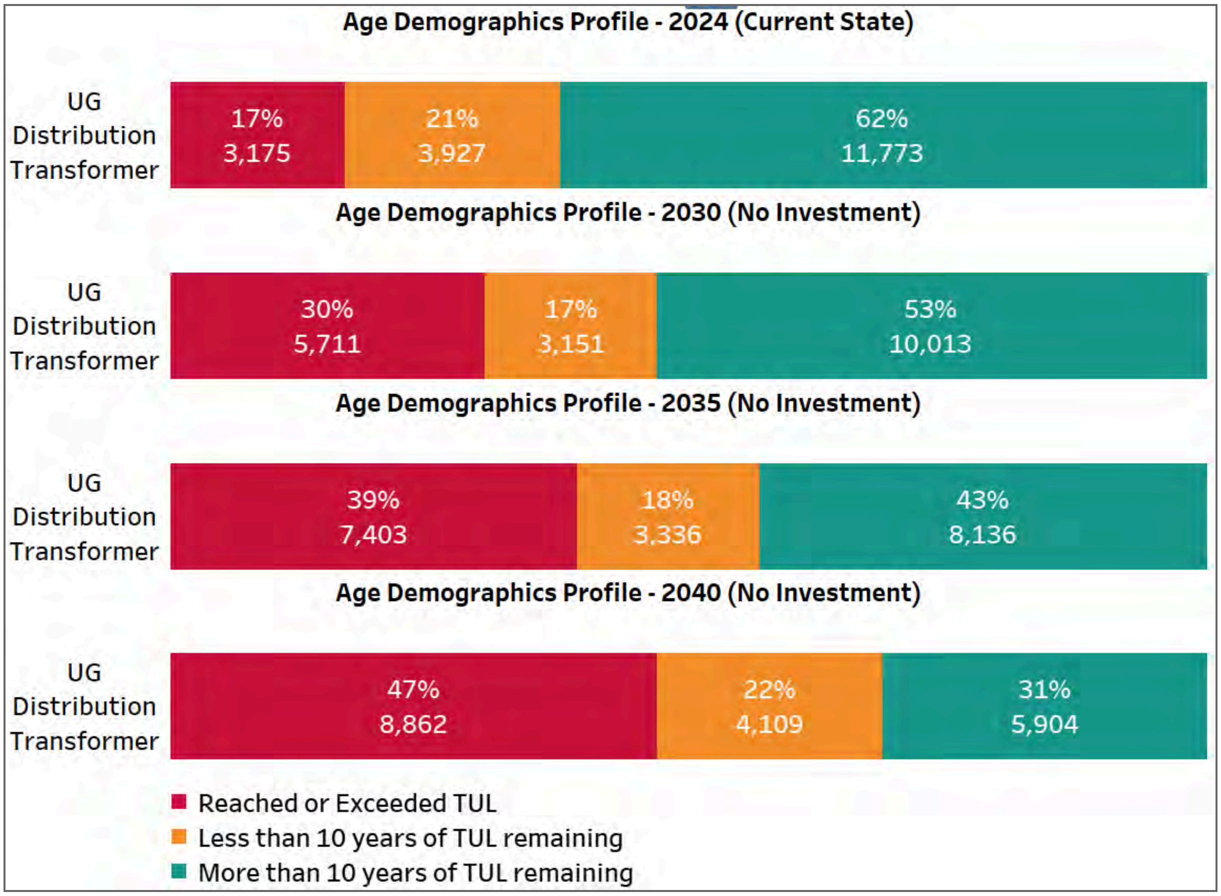
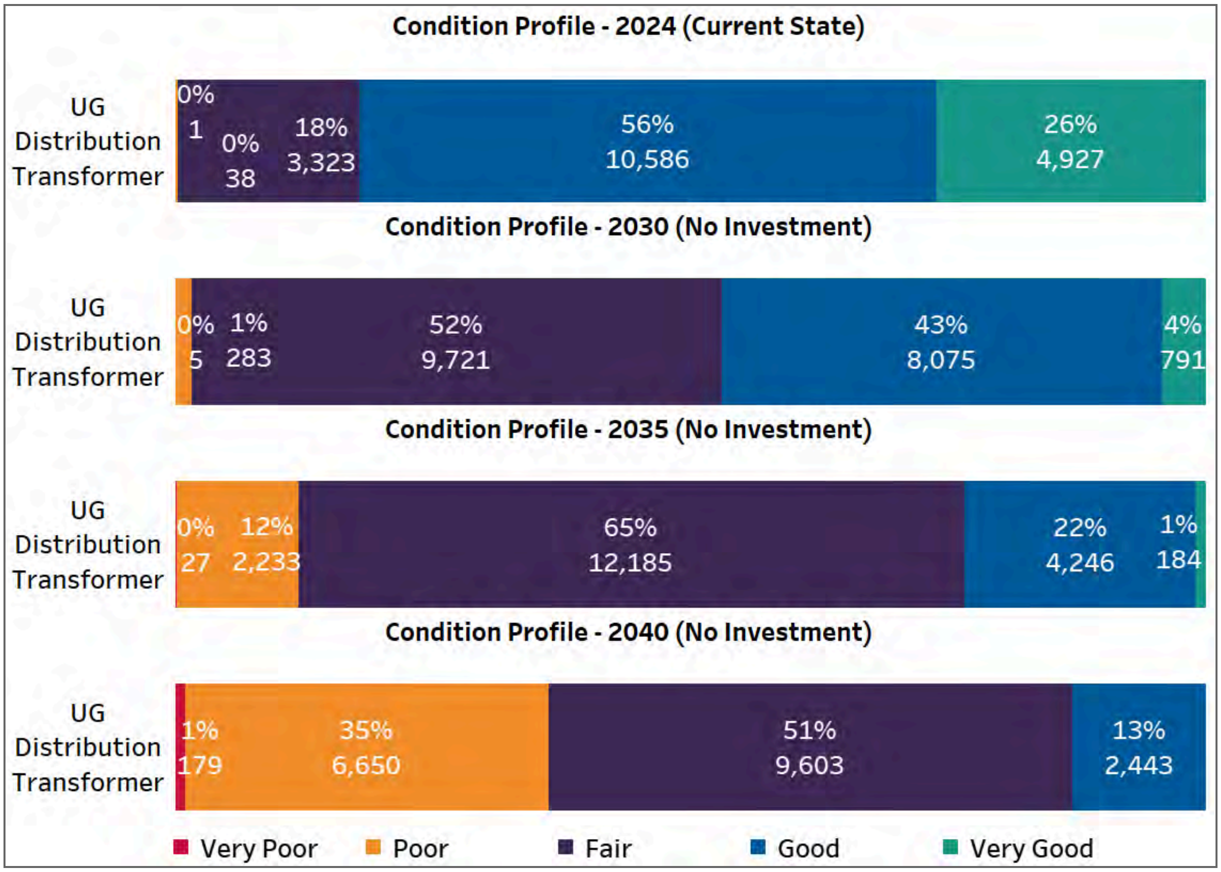
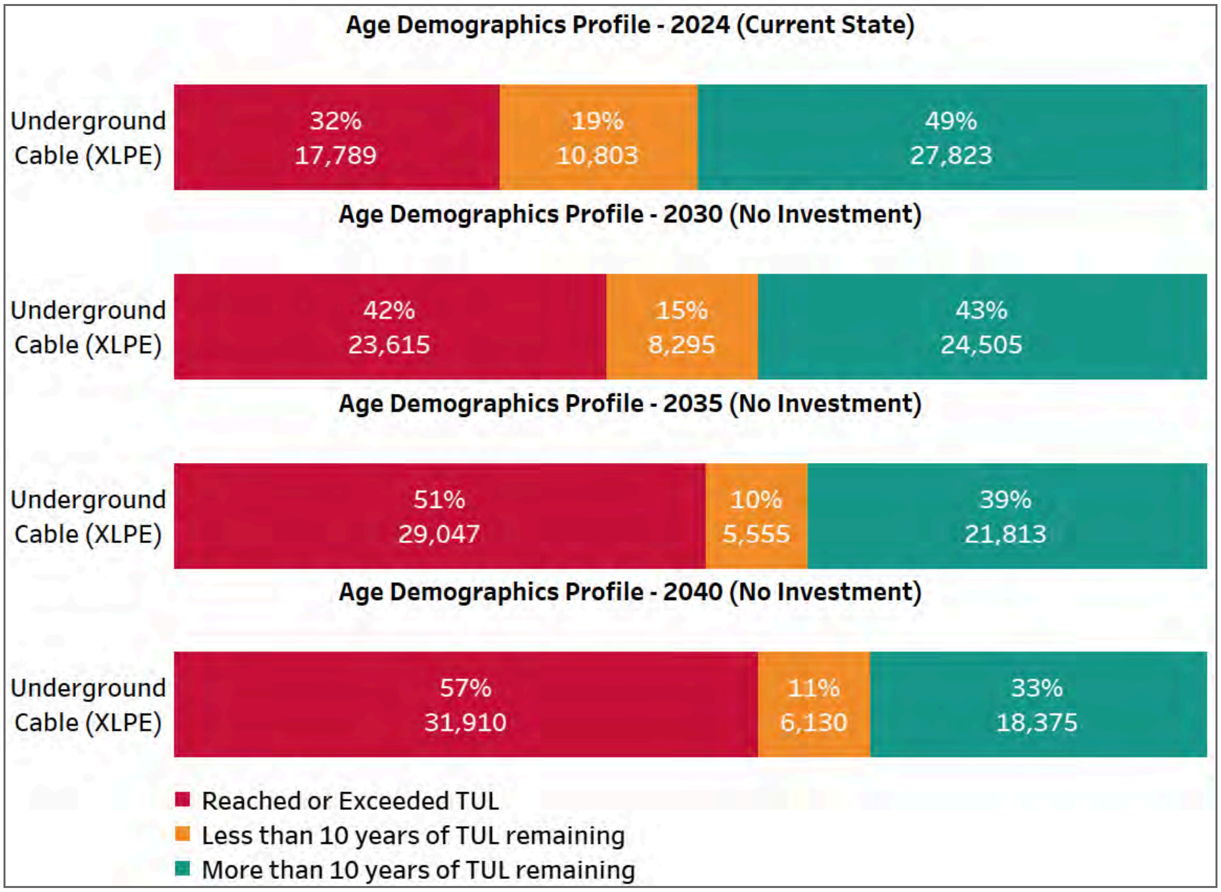


Figure 49 - Condition Profile of UG Transformers



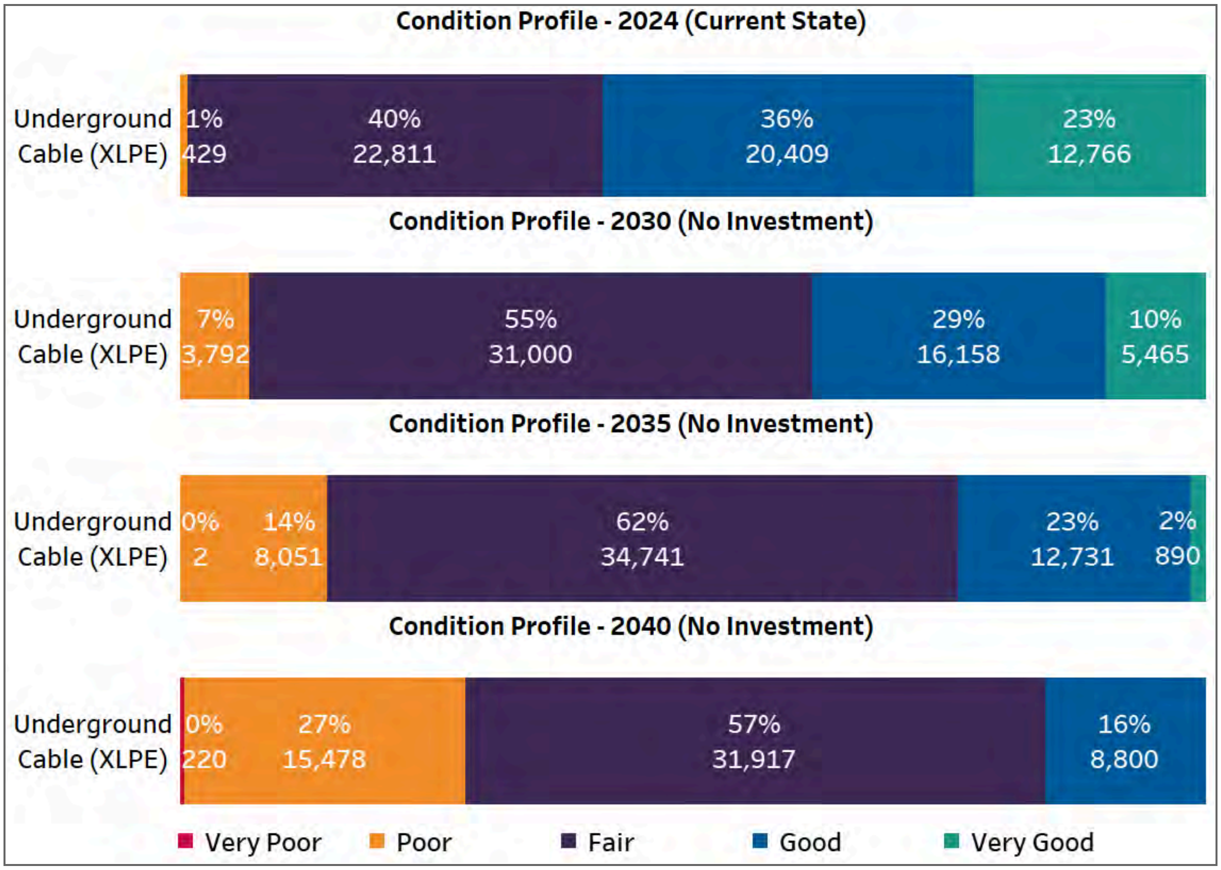
Figures 50 and 51 demonstrate that Hydro Ottawa's Cross Linked Polyethylene (XLPE) cables are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of XLPE cables that have reached their end of life will continue to grow at a rate of approximately 8% every five years. Likewise, without intervention, the percentage of XLPE cables in degraded condition (poor or very poor) will continue to grow at a rate of approximately 9% every 5 years.

1 **Figure 50 - Age Demographics Profile of UG Cables (XLPE)**



2

Figure 51 - Condition Profile of UG Cables (XLPE)



Hydro Ottawa has approximately 3,000 km of XLPE cable infrastructure with many regions having the same vintage of cables and an identical probability of failure. UG transformers and UG cables are one of the major contributors to the number of outages due to equipment failure, as outlined in Section 4.5.6.2 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Hydro Ottawa has seen a major impact due to the number of leaking transformers discovered every year. However these transformer leak issues are localized and confined to a certain manufacturer type and region. Hydro Ottawa's approach is to continue to tackle these issues through the Corrective Renewal program on an as-needed basis (as outlined in Section 6 - Corrective Renewal) and proactively maintain the UG transformer population through regular planned maintenance in addition to addressing any issues through the Cable Renewal program. In addition, there are ongoing conversations with the manufacturer to mitigate the potential risk of failure of in-service assets.

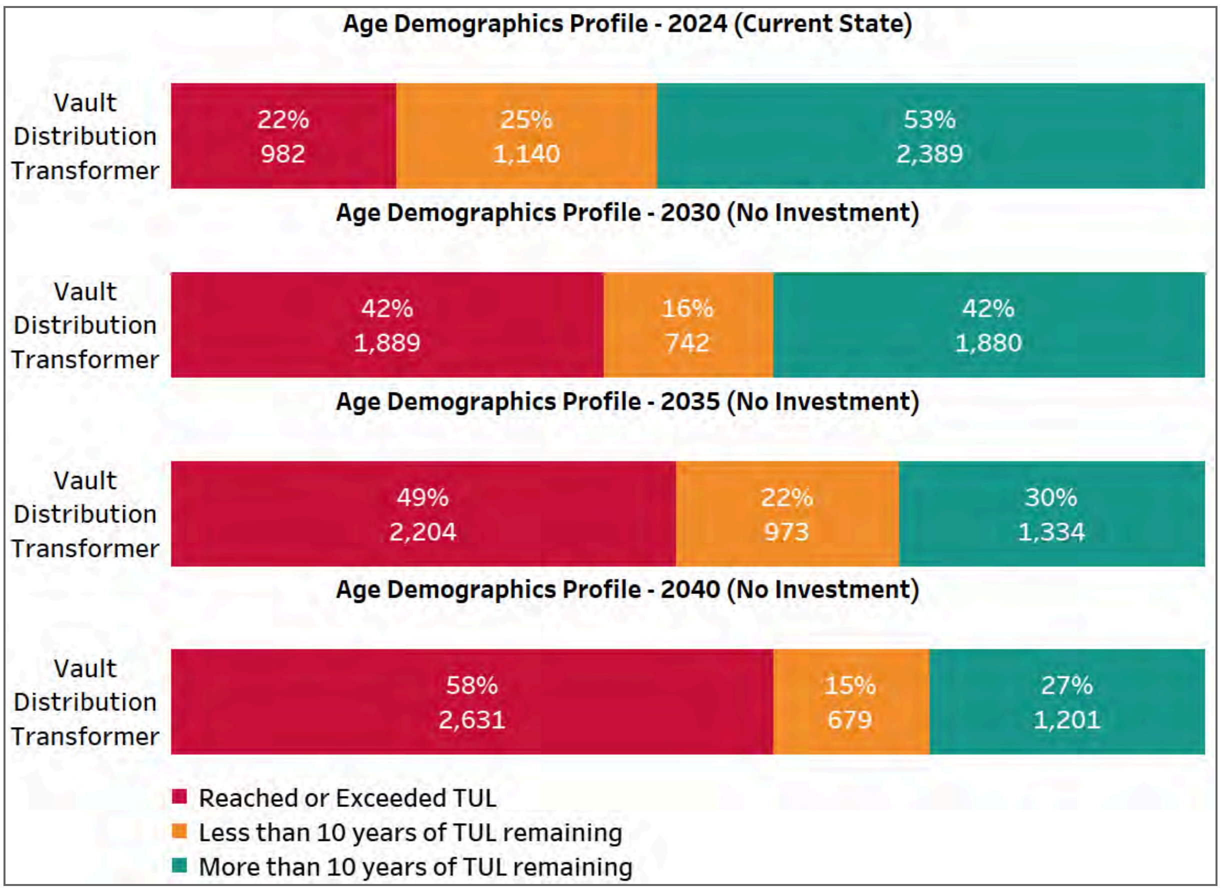
Figure 52 - UG Transformer Failure

Hydro Ottawa implemented inspection enhancements in 2024 to capture more UG transformer inspection data (down to the component level) and perform more advanced UG cable diagnostic tests such as VLF Tan Delta, Partial Discharge and Time Domain Reflectometry which will continue through 2026-2030 to further improve the condition assessment of UG transformers and cables for preventing unanticipated failures as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

4.3.5. Vault Equipment

Figures 53 and 54 demonstrate that Hydro Ottawa's vault transformers are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of vault transformers that have reached their end of life will continue to grow at a rate of approximately 12% every five years. Likewise, without intervention, the percentage of vault transformers in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years. Applying a similar view to vault switchgear (owned by Hydro Ottawa), the percentage of units that have reached their end of life will continue to grow at 14% every 5 years and those in degraded condition (poor or very poor) will increase by 3% every 5 years.

Figure 53 - Age Demographics Profile of Vault Transformers



1 **Figure 54 - Condition Profile of Vault Transformers**

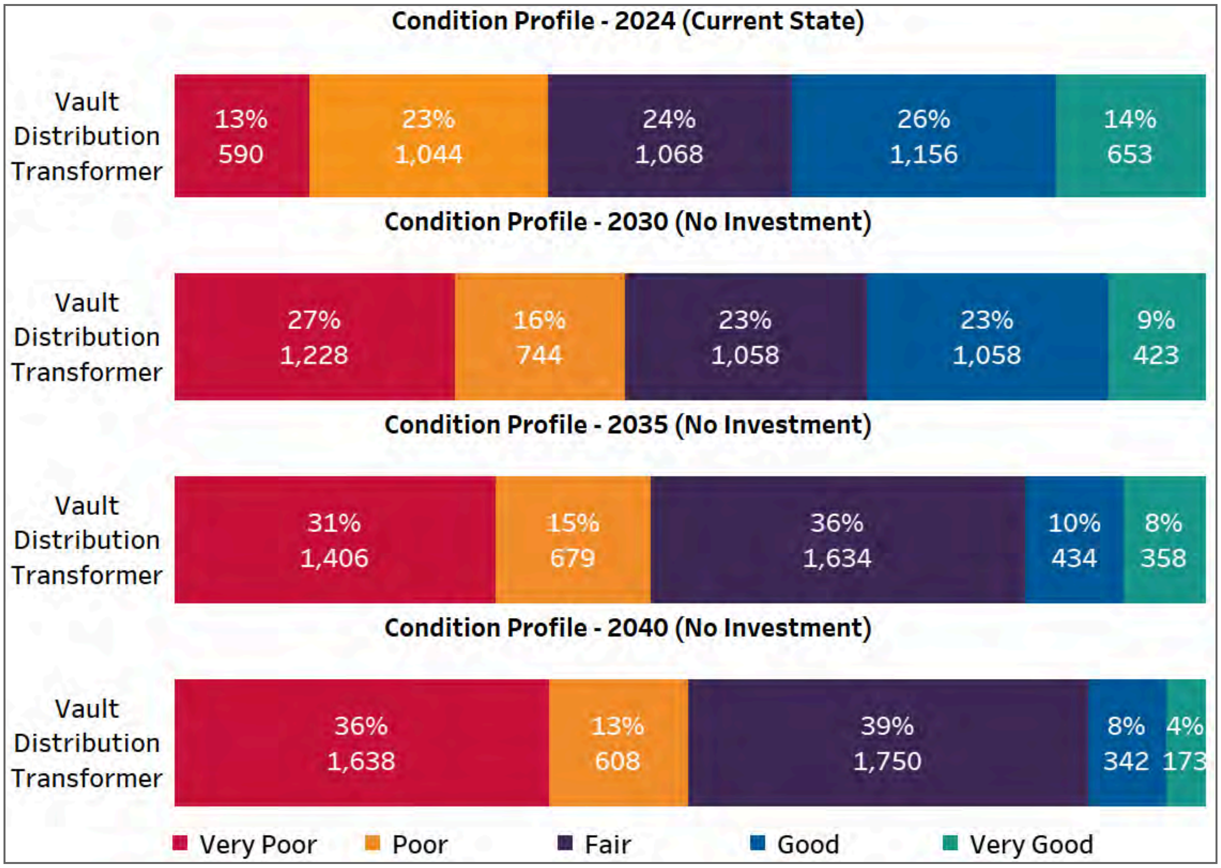
2 

Figure 55 - Age Demographics Profile of Vault Switchgear (excl. customer-owned)

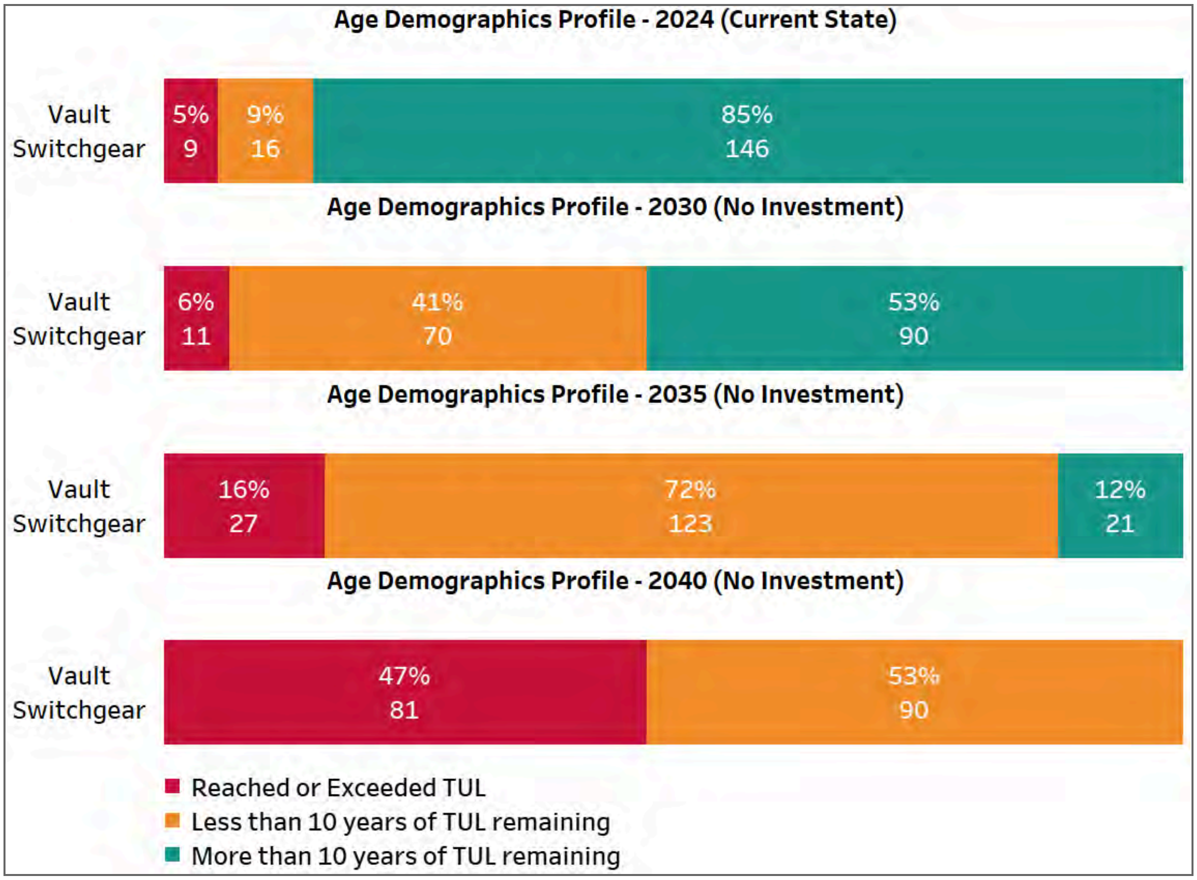


Figure 56 - Condition Profile of Vault Switchgear (excl. customer-owned)

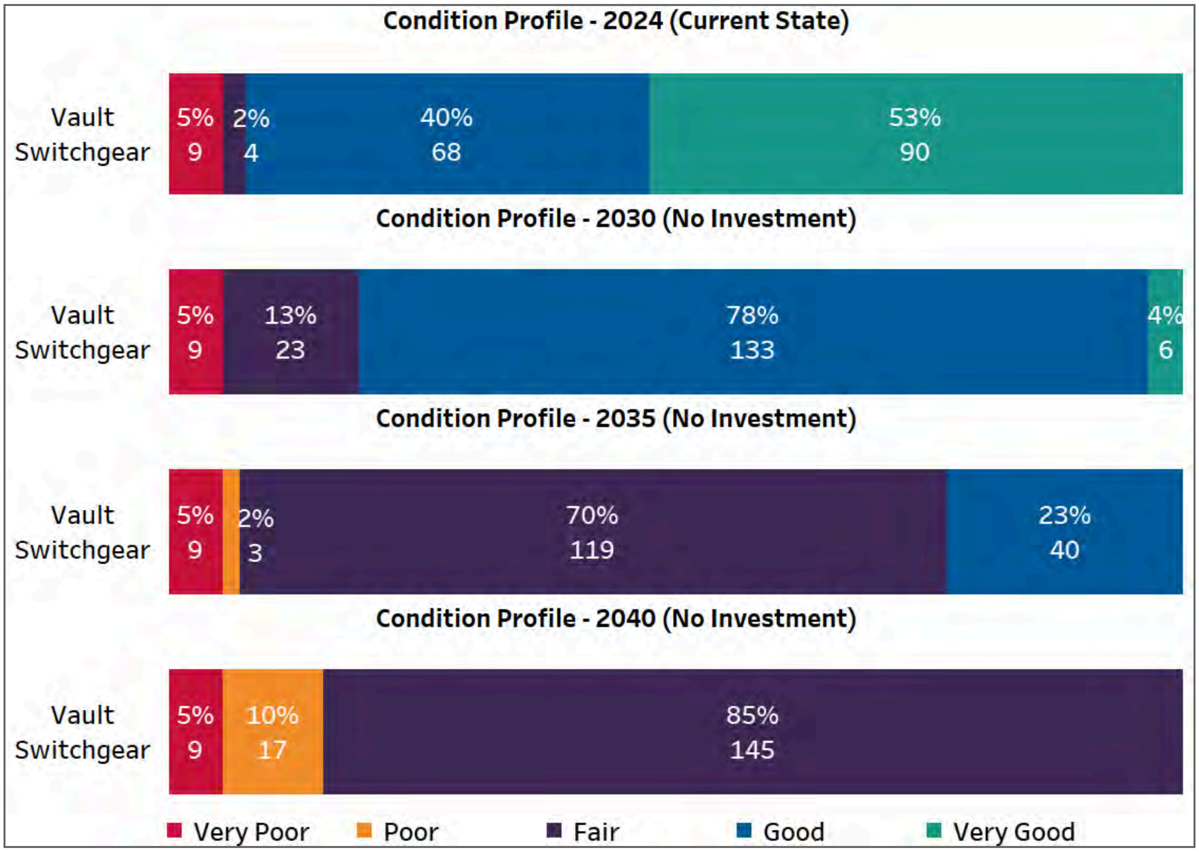


Table 14 displays age demographic projections for customer owned vault switchgear, current state and in 2030 (without investments). Currently, 3% of the vault switchgear units have reached or exceeded their TUL and 8% have less than 10 years of TUL remaining. By 2030, if no investment is made, 5% of customer-owned vault equipment would reach their TUL and 75% with less than 10 years of TUL remaining.

Table 14 - Age Demographic Projections of Customer Owned Vault Switchgear

Asset Type	Number of Units	Age Criterion	2024 Current State	2030 No Investment
Vault Switchgear Customer Owned	964	Reached or Exceeded TUL	3%	5%
		Less than 10 years of TUL remaining	8%	75%
		More than 10 years of TUL remaining	89%	20%

Hydro Ottawa has seen some recent reliability impact due to the failure of customer-owned vault switchgear, with 7 outages observed in 2022 and 2023, primarily due to age deterioration. While analyzing the factors impacting SAIDI between 2019 and 2023, the failure of customer owned equipment has caused delays in restoration due to the coordination involved with the customer and lack of maintenance from their end, as outlined in Section 5 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement.

In responding to outages due to vault equipment failure, Hydro Ottawa has also encountered increasing difficulties replacing vault equipment or accessories (e.g. bushings) due to space limitations in customer-owned vaults. These failures also had to be tackled under the Emergency Renewal budget program, as outlined in Section 6 - Corrective Renewal.

This has necessitated investments as a part of this Application period to intervene on 30 vault switchgear units (including customer-owned ones, contingent on Hydro Ottawa taking ownership of the assets). This selection would be based on customer owned assets that have a high reliability impact on other customers in the system. A more recent outage in 2023 was due to the failure of a vault switchgear unit wherein a phase bushing had completely burned out due to a flashover event, as shown in Figure 57.

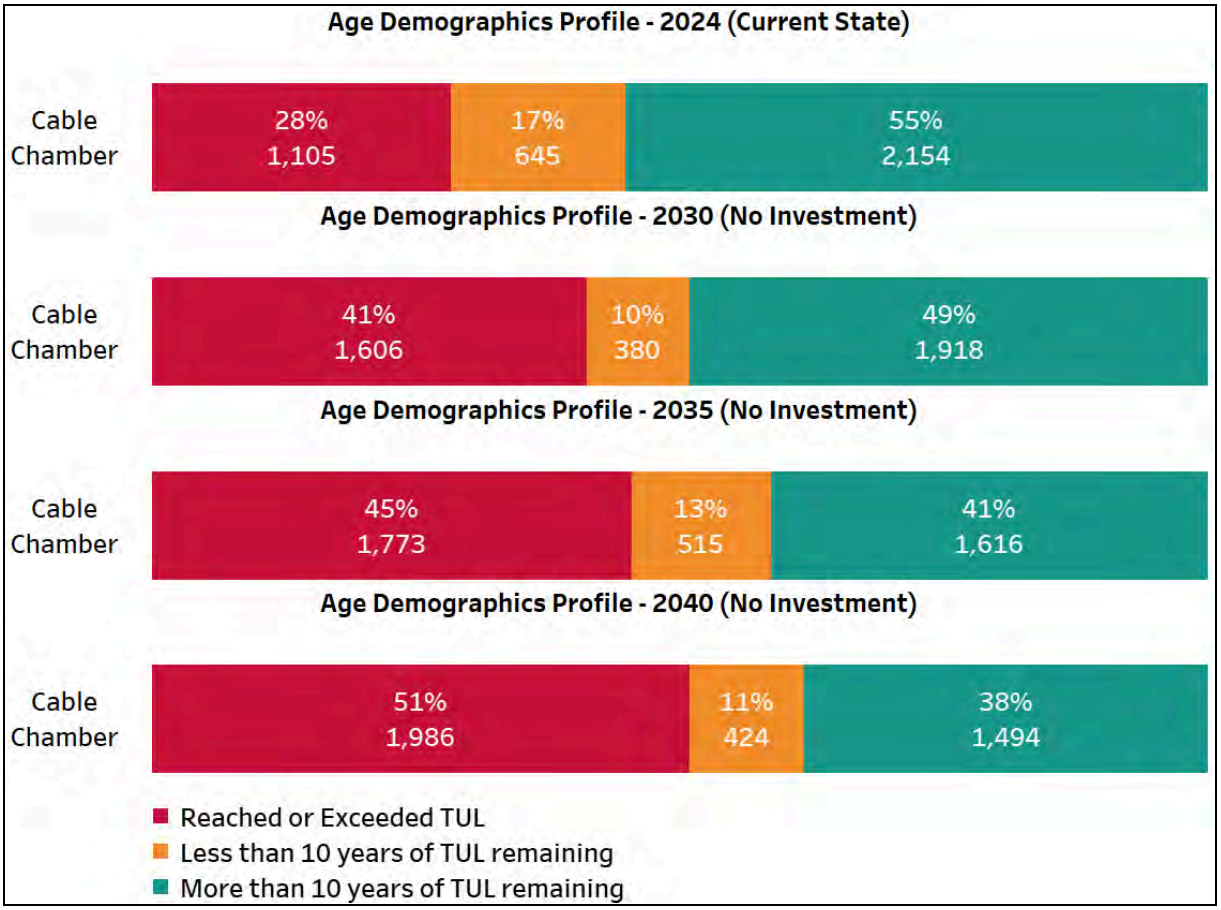
Figure 57 - Vault Switchgear Failure

Hydro Ottawa had proposed inspection enhancements in 2024 to capture inspection data related to vault equipment which will continue through 2026-2030 to further advance the condition assessment of vault equipment for preventing unanticipated failures as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. The data from the condition assessments will be used to determine which vault equipment will be addressed during annual scoping from 2026-2030.

4.3.6. Cable Chambers

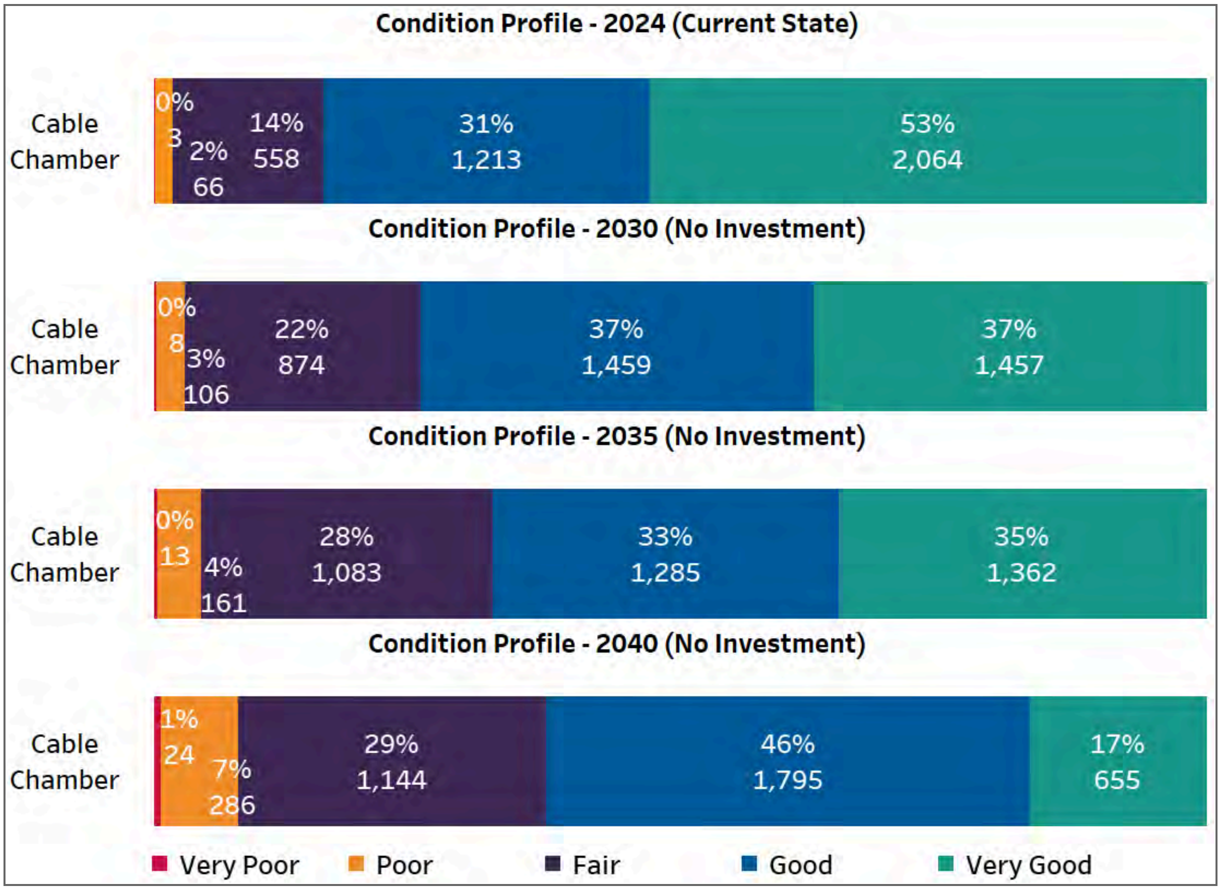
Hydro Ottawa's underground civil structure assets consist of a collection of UG cable chambers (colloquially referred to as manholes), hand holes, and duct banks forming an underground distribution system. Figures 58 and 59 demonstrate that Hydro Ottawa's cable chambers are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of cable chambers that have reached their end of life will continue to grow at a rate of approximately 8% every five years. Likewise, without intervention, the percentage of cable chambers in degraded condition (poor or very poor) will continue to grow at a rate of approximately 2% every five years.

1 **Figure 58 - Age Demographics Profile of Cable Chambers**



2

Figure 59 - Condition Profile of Cable Chambers



Failures have occurred due to concrete deterioration and rebar corrosion. Renewal activities focussing on structural components like collars, roofs, and walls are critical to improving conditions and mitigating safety risks to the public and Hydro Ottawa employees. Through its preventative maintenance program, Hydro Ottawa has observed issues such as the deterioration of concrete and corrosion of rebar among other factors impacting the structural integrity of cable chambers. To mitigate safety risks to the public and Hydro Ottawa employees, continued renewal investment in cable chambers is essential through 2026-2030, alongside exploring the use of sophisticated cameras/tools for the cable chamber inspection program.

4.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the UG distribution assets renewal program are summarized in the section below.

4.4.1. System Operation Efficiency and Cost Effectiveness

Adding remote functionality to UG switchgear will improve system observability, allowing for efficient system operations and control. Additionally, the replacement of deteriorated UG transformers as a part of the UG cable renewal program drives cost savings and efficiencies, by enabling Hydro Ottawa to replace these deteriorated assets in conjunction with UG cable replacement.

4.4.2. Customer

The UG distribution asset renewal program focuses on replacing deteriorating and failing UG distribution assets with the aim to maintain the number of outages due to equipment failures below levels experienced between 2021 to 2025. The program also includes equipment upgrades to increase capacity (specifically around UG transformers), thereby positively impacting customers and supporting load growths.

4.4.3. Safety

The replacement of deteriorated UG distribution equipment reduces the risk of in-service equipment failure and consequently, reduces the potential safety risk to employees and the public from catastrophic equipment failures.

4.4.4. Economic Development

Robust and reliable electric distribution infrastructure is essential for Ottawa's economic stability and growth. Hydro Ottawa's UG distribution asset renewal program contributes to consistent and dependable power which businesses need to thrive, supporting job retention and creation, furthermore the ability to provide stable power will continue to attract commercial investment in Ottawa.

4.4.5. Environment

Hydro Ottawa will be replacing a select population of at-risk UG oil-filled and SF_6-based distribution equipment that have reached or exceeded the TUL and are in a deteriorated condition, minimizing the risk of environmental contamination.

4.5. PROGRAM COSTS

Table 15 shows the historical and future spending by budget program, as a part of the UG distribution asset renewal program. In the 2026-2030 period Hydro Ottawa forecasts investment in this program of $103.0M, compared to $63.2M in the 2021-2025 period. There are considerations around equipment/resource availability as well as project prioritization/scheduling which results in some variability in the projected spending between 2026 and 2030.

Table 15 - Historical, Bridge and Test Year Spending per UG Distribution Assets Renewal Budget Program ($'000 000s)[6]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
UG Transformer Renewal	-	$ 0.1	$ 0.5	-	-	-	-	-	-	-
UG Switchgear Renewal	$ (0.1)[7]	$ 0.8	-	$ 0.5	$ 0.8	$ 1.0	$ 1.0	$ 1.1	$ 1.1	$ 1.2
Cable Renewal	$ 9.7	$ 15.4	$ 10.4	$ 9.1	$ 9.8	$ 16.4	$ 16.9	$ 17.7	$ 18.2	$ 18.8
Civil Renewal	$ 0.5	$ 1.1	$ 1.0	$ 1.1	$ 1.1	$ 1.1	$ 1.1	$ 1.2	$ 1.2	$ 1.3
Vault Renewal	-	$ 0.5	-	$ 0.5	$ 0.5	$ 0.6	$ 0.6	$ 0.6	$ 1.2	$ 0.6
ANNUAL TOTAL	**$ 10.2**	**$ 17.8**	**$ 11.9**	**$ 11.2**	**$ 12.2**	**$ 19.1**	**$ 19.7**	**$ 20.6**	**$ 21.8**	**$ 21.9**
5-YEAR TOTAL					**$ 63.2**					**$ 103.0**

Table 16 shows the detailed historical and future units (either replaced or forecasted) by the underlying asset class, as a part of UG distribution asset renewal program. The UG transformer count shows the forecasted units to be replaced under the cable renewal program.

[6] Totals may not sum due to rounding
[7] Negative balance due to material return and reissue to Critical U/G Switches

Table 16 - Annual Unit Replacements per UG Distribution Assets Renewal Budget Program

Asset Class	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
UG Transformers	94	62	60	72	72	80	80	80	80	80
UG Switchgear	-	6	-	4	5	6	6	6	6	6
UG Cables (km)	19.86	20.24	6.89	13.5	13.5	12.28	12.28	12.28	12.28	12.28
Cable Chambers	1	6	4	6	6	6	6	6	6	6
Vault Transformers	-	6	-	7	5	18	18	18	18	18
Vault Switchgear	-	-	-	-	-	6	6	6	6	6

4.5.1. Cable Renewal

The Cable Renewal program's spending is forecasted to increase from $54.3M in 2021-2025 to $88.2M in 2026-2030. Hydro Ottawa's 2021-2025 cable renewal program unit rate, which was $0.3M/km, proved to be too low due to underestimating the technical complexity of the Ottawa region along with high inflationary costs associated with the civil works. Further information regarding inflationary pressures found in Section 4 of Schedule 1-2-5 - Impact of Inflationary Pressures. Actual costs from 2021-2023 averaged $0.7M/km, with some projects reaching $1M/km. To address this, the 2026-2030 budget includes a higher unit rate of $1.4M/km, accounting for inflation and increased material and contractor costs. The renewal of UG transformers do not have a distinct program budget as the cost for replacement is contemplated within the cable renewal budget.

Through 2026-2030, Hydro Ottawa will evaluate cable replacement across 12 feeders supplying areas such as Bilberry, Beaverbrook, Hiawartha Park, Orleans Village, Convent Glenn, Chapel Hill, Beaconhill South, Pineview, Emerald Meadows, Windsor Park and Blossom Park. The results from the UG cable testing program shall be used to inform the targeted high-risk sections to be renewed within the aforementioned areas.

4.5.2. UG Switchgear Renewal

The UG Switchgear Renewal program's spending is forecasted to increase from $2M in 2021-2025 to $5.4M in 2026-2030, which is due to the increase in volume considered over the 2026-2030 period. The increased investment is essential to tackle the growing trend of UG switchgear units that have reached their end of life and the higher number of air-type switchgear failures resulting in outages since 2022, given that all air-type switchgears that failed had reached or exceeded their TUL. Through 2026-2030, Hydro Ottawa plans to intervene on 30 air-type UG switchgear units, with the ability to introduce remote operability to ten of them.

4.5.3. Vault Renewal

The Vault Renewal program's spending is forecasted to increase from $1.5M in 2021-2025 to $3.5M in 2026-2030. The increased investment is essential to manage the growing number of vault equipment owned by Hydro Ottawa that have reached their end of life. Also, based on the reliability impact observed since 2022, the proposed increase in spending will allow Hydro Ottawa to manage critical customer-owned vault switchgear. Customer-owned vault equipment are integral to Hydro Ottawa's distribution system and their failures result in widespread, complex, and lengthy outages. Therefore, an intervention is necessary in the short term to minimize the related reliability impact. Through 2026-2030, Hydro Ottawa plans to replace 90 single phase vault transformers and 11 vault switchgear units (owned by Hydro Ottawa) requiring an intervention in the short term. The planned replacement of customer-owned vault switchgear causing a significant reliability impact to Hydro Ottawa, will be contingent on a final agreement with the related customers.

4.5.4. Civil Renewal

The Civil Renewal program's spending will increase from $4.9M in 2021-2025 to $5.9M in 2026-2030. The increase in the proposed spending is to address deteriorating and failing cable chambers to address key safety issues around the structural integrity of civil structures. Between 2026-2030, Hydro Ottawa plans to evaluate and potentially replace 30 cable chambers. This evaluation will be based on recommendations from the annual inspection program, focusing on factors like the need for a complete rebuild and other issues such as severe damage to the roof or walls, rusted support beams, and significant cracks near entrances, all of which pose substantial structural risks.

4.5.5. Cost Factors

Cost factors that affect UG distribution asset renewal are listed below:

- Location, condition and compatibility with existing civil support structures
- Type and coordination of replacement with other components
- Nature of renewal: like-for-like or like-for-better (e.g. air type switchgear with an air type switchgear or air type switchgear with an SF_6 type switchgear)
- Material costs

4.6. ALTERNATIVES EVALUATION

4.6.1. Alternatives Considered

In order to address the drivers and achieve the performance objectives of the program, Hydro Ottawa conducted an analysis using Copperleaf PA to optimize the number of units renewed as part of UG distribution asset renewal projects, with the goal of minimizing the number of asset failures and managing long term operational performance. As a result of the high value of mitigated reliability risk mitigated from an UG XLPE cable segment replacement and Copperleaf PA's focus on individual asset performance, the PA analysis recommended that Hydro Ottawa replace 336 km of UG XLPE cables forecasted to be in a degraded condition by 2030, over the 5-year period. To achieve this objective, Hydro Ottawa would need to invest in excess of $300M in the cable renewal program alone, far exceeding the $63.2M investment level proposed by Hydro Ottawa over the 2021-2025 period, across all UG distribution asset renewal programs. This level of investment would result in rate and resourcing impacts that do not align with the overall objectives of the DSP.

In this regard, three investment alternatives were considered, as outlined in Table 17, with varying levels of replacement rates and alignment to the Outcomes described in Table 13 and with the objective of balancing long term-cost impacts with the risks associated with assets in degraded condition.

Table 17 - Summary of Program Investments of Alternatives Considered

Program Investments	Alternative 1: Cost Containment	Alternative 2: Short Term Risk Mitigation (Preferred)	Alternative 3: Long Term Risk Mitigation
UG Cables	15km (7km/year)	61km (12km/year)	100km (20km/year)
UG Transformers	215 (43/year)	400 (80/year)	650 (130/year)
Vault Transformers	45 (9/year)	90 (18/year)	120 (24/year)
Vault Switchgear	None	30 (6/year)	45 (9/year)
UG Switchgear	15 (3/year)	30 (6/year)	65 (13/year)
Civil Rebuild	15 (3/year)	30 (6/year)	60 (12/year)
System Observability Investments	None	10 (2/ year)	20 (4/ year)
TOTAL PROGRAM COST	**$47M**	**$103M**	**$150M**

Alternative 1: Cost Containment (~$47M): This alternative will provide:

- Cost impacts are minimized during the 2026-2030 period, however replacement rates will not allow Hydro Ottawa to balance long term affordability or effectively manage risk associated with assets in degraded condition:
  - A 0.2% increase in the percent of UG transformers in degraded condition compared to 2024 levels (refer to Figure 61) and a net 12% increase in UG transformers that have reached their typical useful life by 2030 (refer to Figure 60), creating a back-log of UG transformers to be replaced in the long term.
  - No reduction in the percent of UG switchgear in degraded condition compared to 2024 levels (refer to Figure 63) and a net 8% increase in UG switchgear that have reached their typical useful life by 2030 (refer to Figure 62), creating a back-log of UG switchgear to be replaced in the long term.
  - A net 6% increase in the length of UG XLPE cables in degraded condition compared to

2024 levels (refer to Figure 65) and a net 10% increase in the length of UG XLPE cables that have reached their typical useful life by 2030 (refer to Figure 64), creating a back-log of UG XLPE cables to be replaced in the long term.
    - A net 7% increase in vault transformers in degraded condition compared to 2024 levels (refer to Figure 67) and a net 19% increase in vault transformers that have reached their typical useful life by 2030 (refer to Figure 66), creating a back-log of vault transformers to be replaced in the long term.
    - No reduction in the percent of Hydro Ottawa-owned vault switchgear in degraded condition compared to 2024 levels (refer to Figure 69) and a net 1% increase in vault switchgear that have reached their typical useful life by 2030 (refer to Figure 68), creating a back-log of vault transformers to be replaced in the long term.
    - A minor 0.7% increase in the cable chambers in degraded condition compared to 2024 levels (refer to Figure 71) and a net 13% increase in cable chambers that have reached their typical useful life by 2030 (refer to Figure 70), creating a back-log of cable chambers to be replaced in the long term.
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- No ability to increase system observability through the UG asset renewal program
- No ability to renew vault switchgear

Alternative 2: Short Term Risk Mitigation (~$103M - Preferred Alternative): This alternative will provide:

- Cost impacts are more significant and replacement rates will allow Hydro Ottawa to balance only short term risk associated with assets in degraded condition.
    - A 0.2% decrease in the percent of UG transformers in degraded condition compared to 2024 levels (refer to Figure 61) and a net 11% increase in UG transformers that have reached their typical useful life by 2030 (refer to Figure 60), moderately reducing the back-log of UG transformers to be replaced in the long term.
    - A 2% decrease in the UG switchgear in degraded condition compared to 2024 levels

(refer to Figure 63) and a net 5% increase in UG switchgear that have reached their typical useful life by 2030 (refer to Figure 62), moderately reducing the back-log of UG switchgear to be replaced in the long term.
  - A net 5% increase in the length of UG XLPE cables in degraded condition compared to 2024 levels (refer to Figure 65) and a net 9% increase in the length of UG cables that have reached their typical useful life by 2030 (refer to Figure 64), moderately reducing the back-log of UG XLPE cables to be replaced in the long term.
  - A net 6% increase in vault transformers in degraded condition compared to 2024 levels (refer to Figure 67) and a net 18% increase in vault transformers that have reached their typical useful life by 2030 (refer to Figure 66), moderately reducing the back-log of vault transformers to be replaced in the long term.
  - A 5% reduction in the number of Hydro Ottawa-owned vault switchgear in degraded condition and having reached their typical useful life by 2030 as compared to 2024 levels (refer to Figure 69 and Figure 68).
  - A minor 0.4% increase in cable chambers in degraded condition compared to 2024 levels (refer to Figure 71) and a net 12% increase in cable chambers that have reached their typical useful life by 2030 (refer to Figure 70), moderately reducing the back-log of cable chambers to be replaced in the long term.
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- Moderate ability to increase system observability through the UG asset renewal program
- Moderate ability to reduce reliability impact tied to the failure risk of customer-owned vault switchgear by taking ownership and also renew aged vault switchgears owned by Hydro Ottawa

Alternative 3: Long Term Risk Mitigation (~$150M): This alternative will provide:
- Cost impacts are highest however replacement rates will allow Hydro Ottawa to most effectively balance long term affordability and risk associated with assets in degraded condition:
  - A 0.2% decrease in the percent of UG transformers in degraded condition compared to 2024 levels (refer to Figure 61) and a net 10% increase in UG transformers that have

reached their typical useful life by 2030 (refer to Figure 60), reducing the back-log of UG transformers to be replaced in the long term.
  - A 2% decrease in the UG switchgear in degraded condition compared to 2024 levels (refer to Figure 63) and a net 1% decrease in UG switchgear that have reached their typical useful life by 2030 (refer to Figure 62), largely reducing the back-log of UG switchgear to be replaced in the long term.
  - A net 4% increase in the length of UG XLPE cables in degraded condition compared to 2024 levels (refer to Figure 65) and a net 8% increase in the length of UG cables that have reached their typical useful life by 2030 (refer to Figure 64), reducing the back-log of UG cables to be replaced in the long term.
  - A net 5% increase in vault transformers in degraded condition compared to 2024 levels (refer to Figure 67) and a net 17% increase in vault transformers that have reached their typical useful life by 2030 (refer to Figure 66), reducing the back-log of vault transformers to be replaced in the long term.
  - A 5% reduction in the number of Hydro Ottawa-owned vault switchgear in degraded condition and having reached their typical useful life by 2030 as compared to 2024 levels (refer to Figure 69 and Figure 68), reducing the back-log of vault switchgear units to be replaced in the long run.
  - A 0.4% decrease in cable chambers in degraded condition compared to 2024 levels (refer to Figure 71) and a net 12% increase in cable chambers that have reached their typical useful life by 2030 (refer to Figure 70), reducing the back-log of cable chambers to be replaced in the long term.
- Ability to manage resourcing levels and to procure long-lead items at the rate required
- High ability to increase system observability through the UG asset renewal program
- High ability to reduce reliability impact tied to the failure risk of vault switchgear and renew aged vault switchgears

Figures 60 to 71 show the proportion of UG distribution assets that will reach the TUL and deteriorating condition by 2030, based on current state and a consideration of the different intervention strategies around managing the UG distribution asset population.

Figure 60 - Number of UG Distribution Transformers Projected to Reach Typical Useful Life by 2030

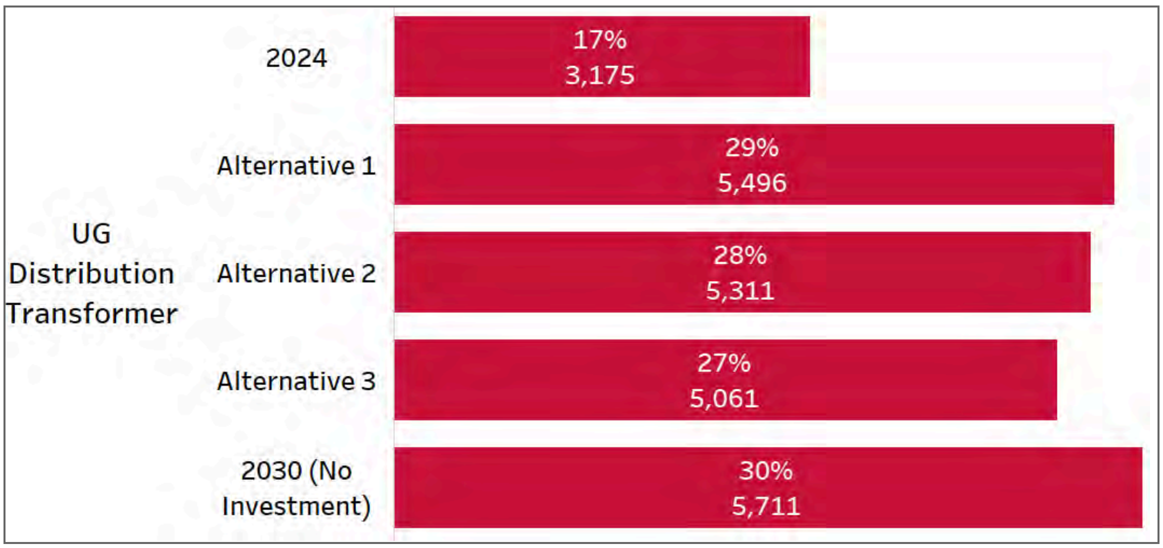


Figure 61 - Number of UG Distribution Transformers Projected to Reach a Deteriorated Condition by 2030

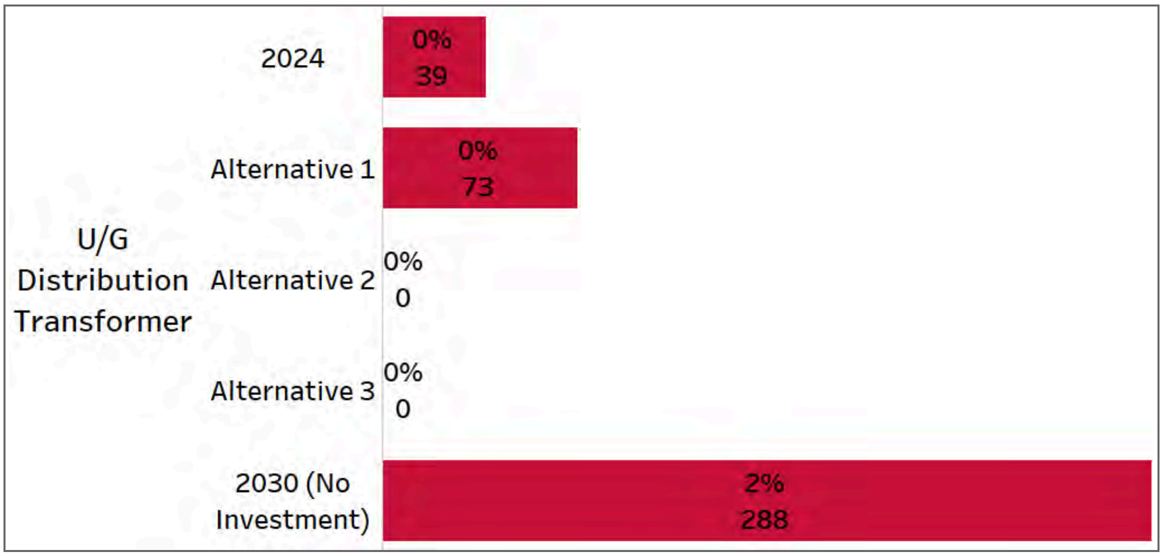


Figure 62 - Number of UG Switchgear Projected to Reach Typical Useful Life by 2030

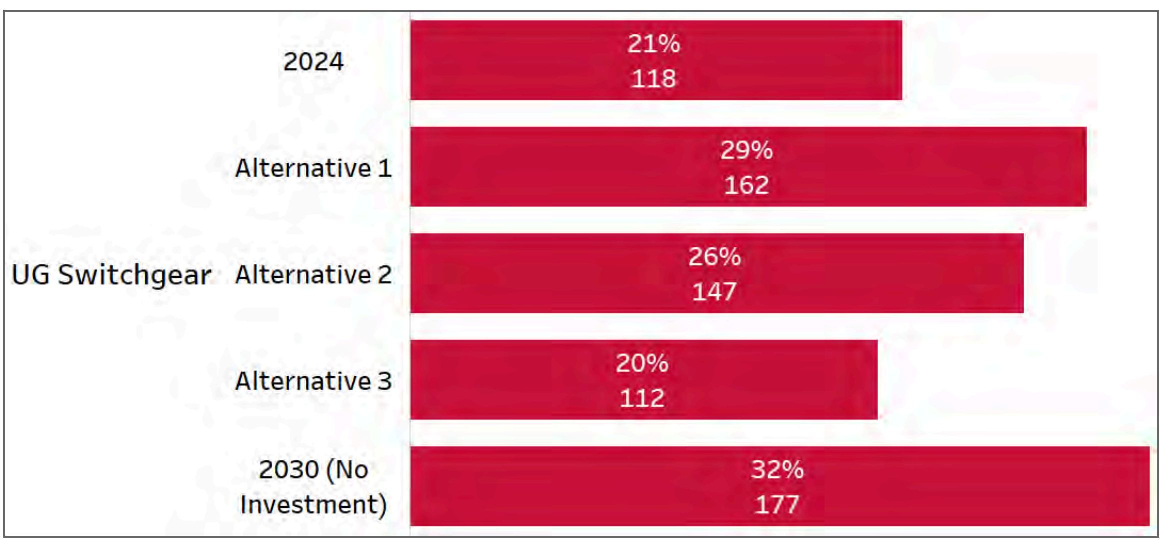


Figure 63 - Number of UG Switchgear Projected to Reach a Deteriorated Condition by 2030

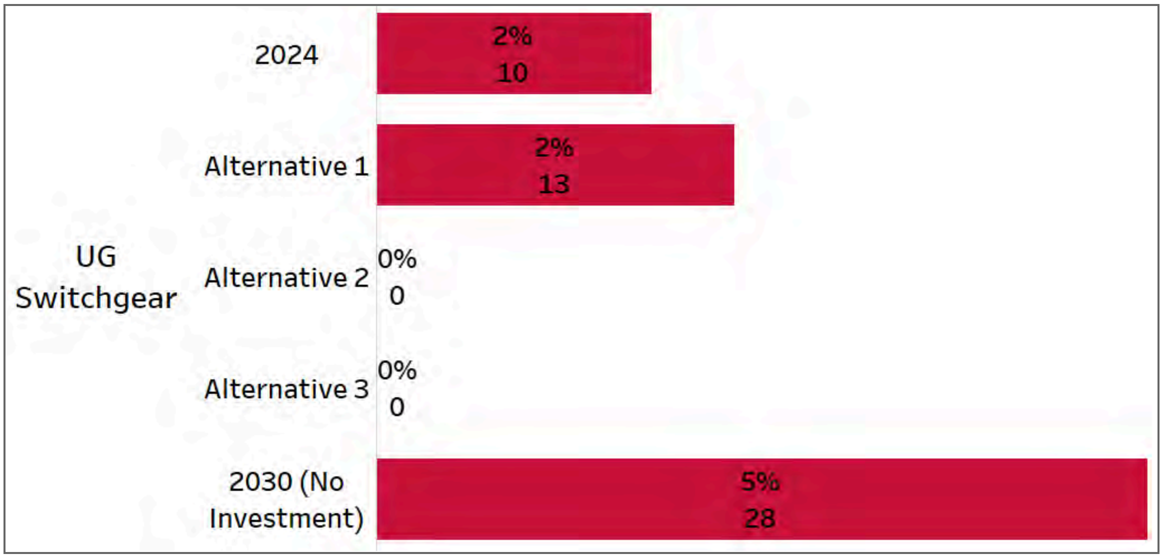


Figure 64 - Length (in km) of UG XLPE Cables Projected to Reach Typical Useful Life by 2030

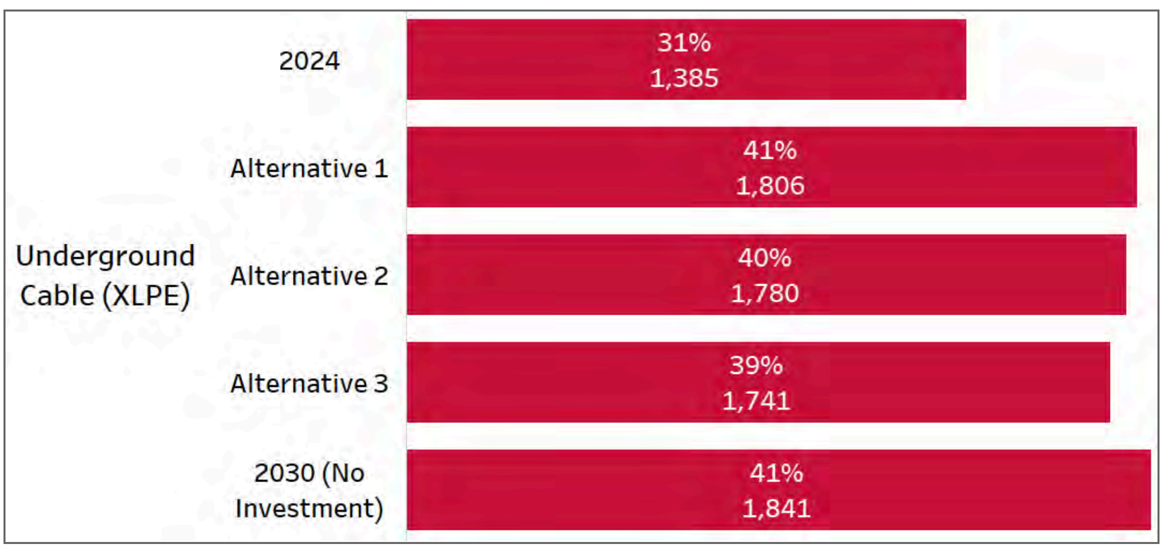


Figure 65 - Length (in km) of UG XLPE Cables Projected to Reach a Deteriorated Condition by 2030

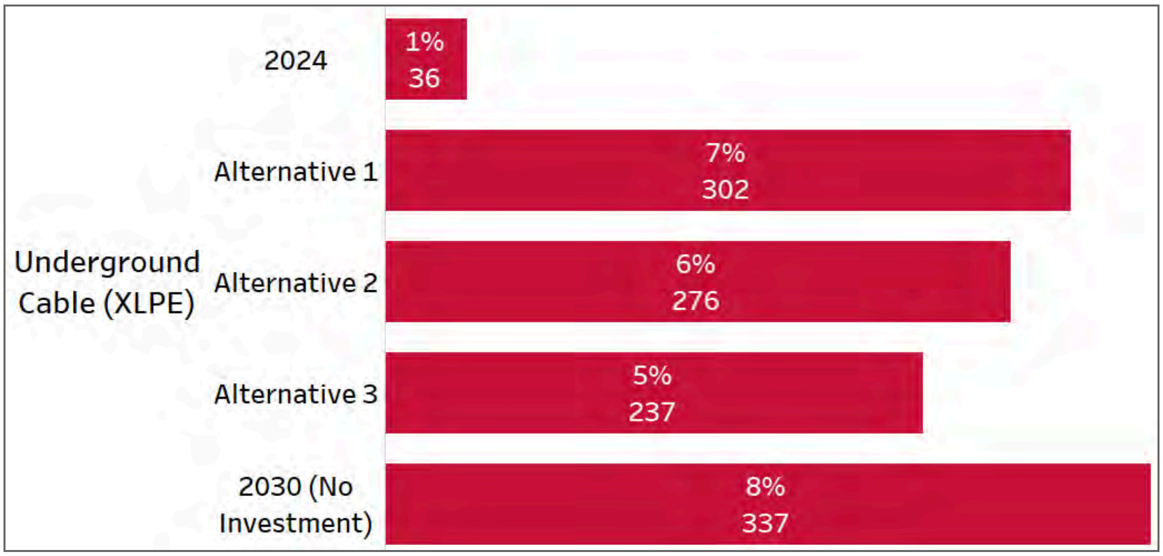


Figure 66 - Number of Vault Distribution Transformers Projected to Reach Typical Useful Life by 2030

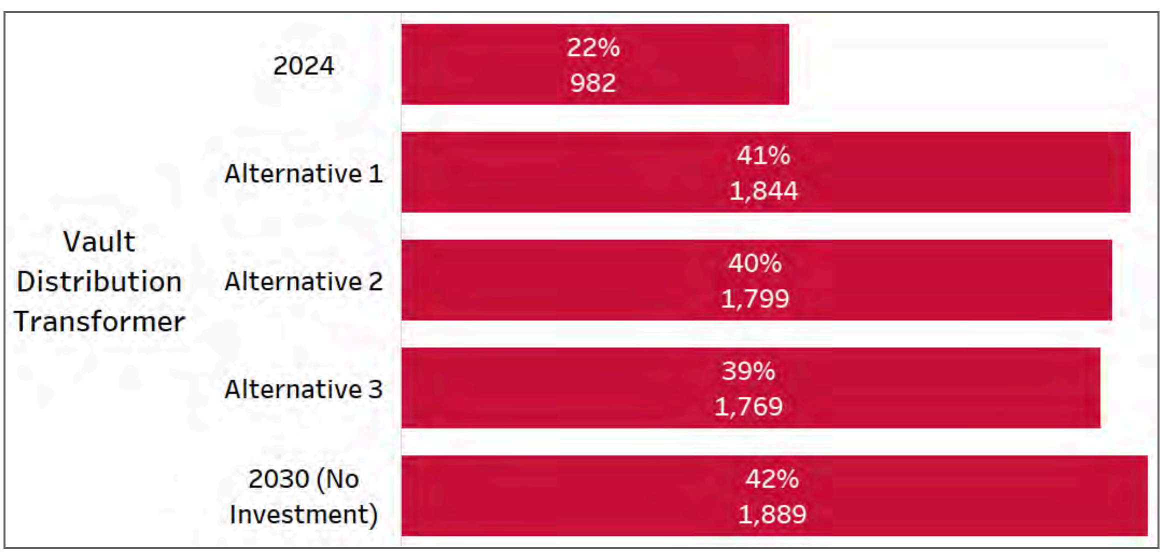


Figure 67 - Number of Vault Distribution Transformers Projected to Reach a Deteriorated Condition by 2030

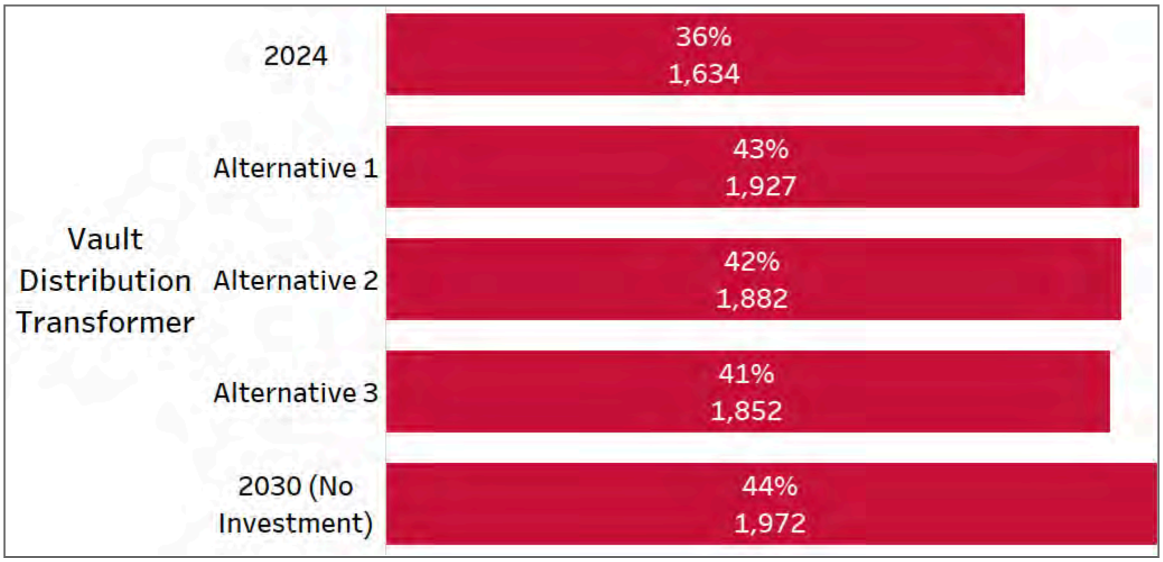


Figure 68 - Number of Vault Switchgear (excl. Customer-Owned) Projected to Reach Typical Useful Life by 2030

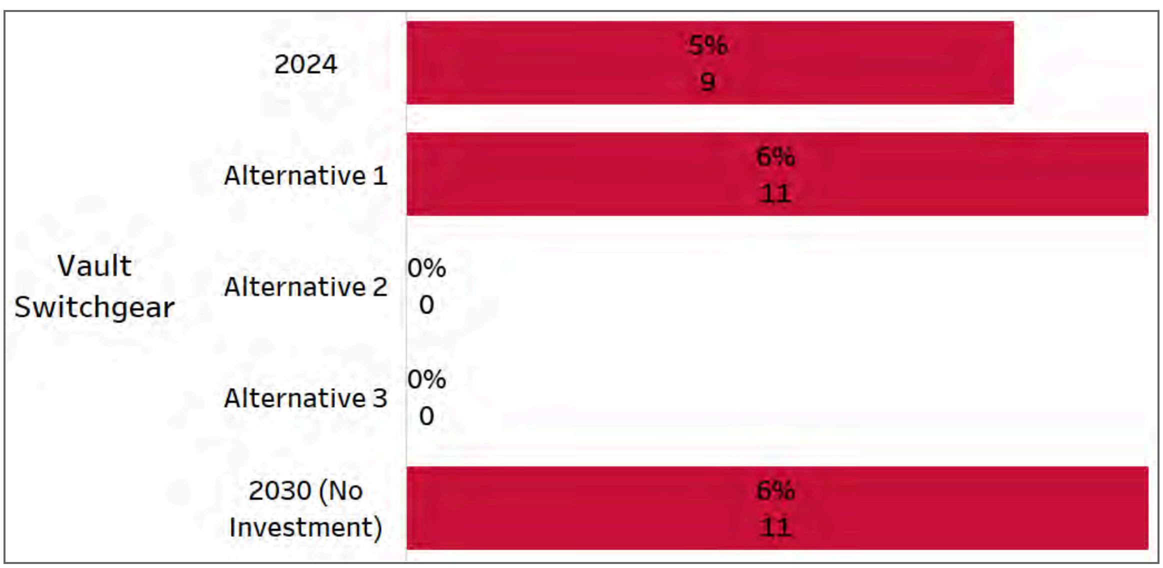


Figure 69 - Number of Vault Switchgear (excl. Customer-Owned) Projected to Reach a Deteriorated Condition by 2030

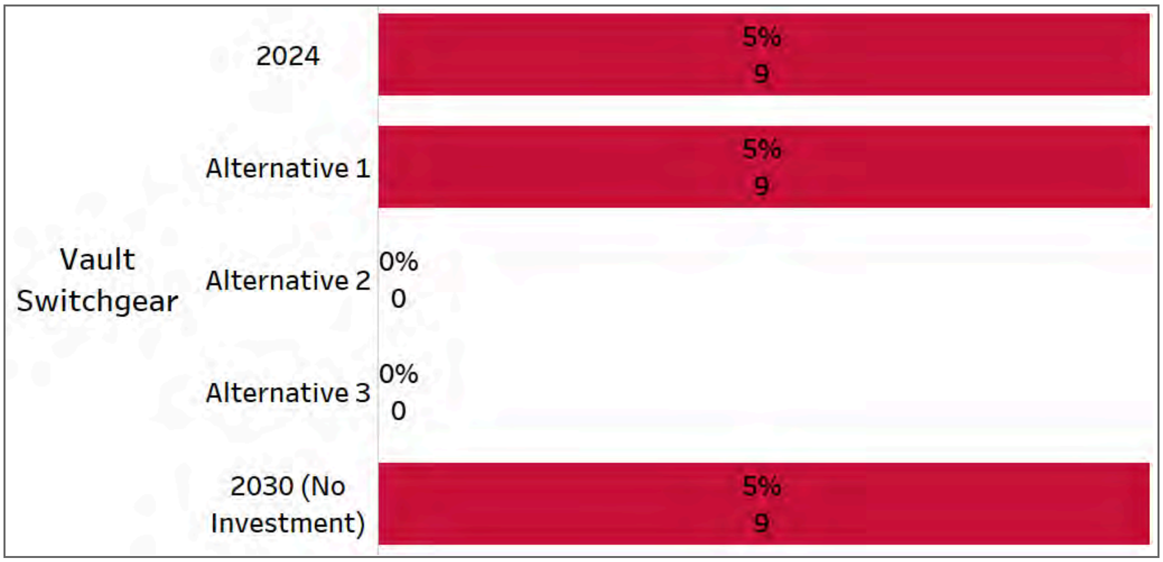


Figure 70 - Number of Cable Chambers Projected to Reach Typical Useful Life by 2030

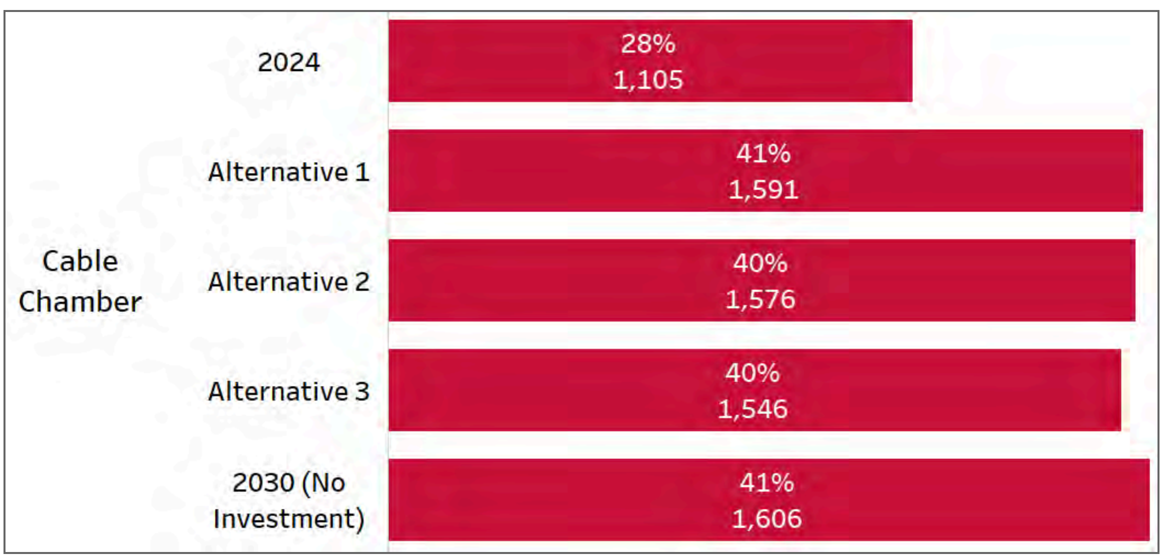
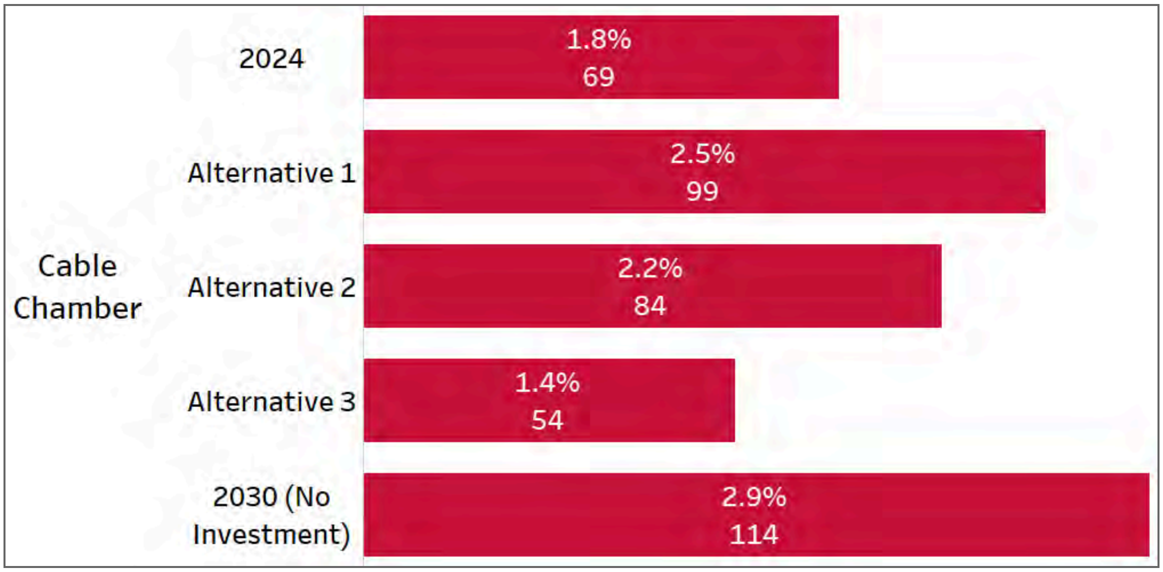


Figure 71 - Number of Cable Chambers Projected to Reach a Deteriorated Condition by 2030



4.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. The increased potential of failure posed by deteriorating UG assets will impact Hydro Ottawa's ability to protect workers and public safety. The selected alternative must maintain or improve the safety of Hydro Ottawa's employees and the public.

Reliability

The increased potential of failure posed by deteriorating UG distribution assets will impact Hydro Ottawa's ability to deliver reliable power. The selected alternative shall help manage asset performance by reducing the reliability risk posed by UG distribution assets and mitigate the risk of failure.

Financial

This criterion assesses the ability to manage long-term financial needs for UG distribution assets. This helps to avoid large spikes in asset renewal spending and the associated rate impacts on customers. The selected alternative should ensure a levelized spending profile, manage long-term asset performance, and prevent significant service disruptions due to deteriorating UG distribution asset failures.

System Observability

The preferred alternative shall also increase the overall system observability and control (through the introduction of remote operability with UG switchgear), in line with Hydro Ottawa's grid modernization initiatives/efforts.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

4.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 4.6.1 - Alternatives Considered under the evaluation criteria of Section 4.6.2 - Evaluation Criteria.

The recommended approach, Alternative Two, involves replacing 61km of UG XLPE cables, 400 UG transformers, 90 vault transformers, 30 vault switchgear, 30 UG switchgear and 30 civil rebuilds. This alternative also includes a strategic approach to improve system observability by considering the replacement of 10 UG switchgears with remote controllable capability.

As shown in Figures 45 and 46, Hydro Ottawa will face a substantial rise in UG switchgear requiring attention by 2030, with 59 additional UG switchgear units reaching their TUL and 18 units in a deteriorated (very poor or poor) condition. The replacement rate of 30 UG switchgears under Alternative Two strategically balances the imperative need to address the short term risks posed by deteriorating UG switchgear units and mitigating the reliability impact of failing air-type switchgears. Alternative Two also results in a moderate increase in UG distribution asset visibility by 2030 compared to the current level, through introducing remote operability in 10 UG switchgear units considered for replacement.

UG transformers and UG XLPE cables are reaching end of life and degrading rapidly with projected increases in excess of 8% every five years. The recommendation from Copperleaf PA was to intervene on all UG XLPE cables in a degraded condition by 2030, requiring a significant capital investment. UG transformers and cables are also major contributors to the number of outages due to the related failures.

In 2022, Hydro Ottawa saw a significant overspend of $7M, following the resumption of the cable renewal program, post COVID-19. This substantial increase was attributed to the significant increases in material costs and higher civil contractor prices, driving up the actual cost per km to $0.7M/km from the budgeted $0.3M/km. Given the major cost increase, Hydro Ottawa has budgeted the replacement of 61 km down from 74 km replaced in 2021-2025 and not replace widespread, to manage the short-term failure risk of major UG cable sections. Therefore, Alternative Two allows for a strategic balance between the urgent need to address short term risks due to deteriorating UG transformers and cables and the necessity of reducing the associated reliability impact.

Hydro Ottawa had also implemented enhancements to inspection programs in 2024, to gather better condition information for accurate assessments and planning interventions. Hydro Ottawa intends to continue the proposed inspection program enhancements through 2026-2030 as further explained in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs.

Hydro Ottawa-owned vault equipment (both transformers and switchgear) are reaching end of life, with major projected increases for vault transformers, in particular. Customer-owned vault switchgears are also aging, with a significant increase in units nearing end of life by 2030. Hydro

Ottawa had advanced the vault equipment inspection program in 2024 (to capture component level information) and there is a continued focus on investing in the proposed inspection enhancements through 2026-2030, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. Customer-owned vault switchgear failures have caused outages and there are replacement challenges due to space limitations within vaults. The vault renewal program is resource intensive and costly, as described in Section 3.1.2.2 of Attachment 4-1-3(C) - Workforce Growth. To this end, Alternative Two is optimized to account for resource management considerations that can handle the increase in the number of vault equipment slated for replacement. It is also in alignment with Hydro Ottawa's workforce growth strategy for 2026-2030, to execute on the vault renewal program. Therefore, Alternative Two strikes a strategic balance between the urgent need to address short term risks due to aging vault equipment and the need to reduce the associated impact on reliability.

Cable chambers are reaching end of life and degrading (from a condition perspective) at a rate of 8% and 2% every five years, respectively. The failure of cable chambers introduces safety risks to the public and Hydro Ottawa personnel. Alternative Two allows Hydro Ottawa to moderately reduce the back log of cable chamber replacements required in the long run and relatively maintains the proportion of cable chambers in a deteriorated condition by 2030, as compared to 2024 (limiting the increase to only 0.4%).

The condition information of certain UG distribution assets such as vault transformers and vault switchgear are evolving based on the inspection enhancements introduced in 2024. Hydro Ottawa intends to continue to implement these enhancements through 2026-2030, as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs. In this background, Hydro Ottawa's need in renewing UG distribution asset infrastructure is two-fold:

- Without intervention, the percentage of Hydro Ottawa's UG assets that have reached their end of life will continue to grow at a rate of approximately 9% every five years resulting in a back-log of replacements required in the long run.

- High number of outages due to UG equipment failures between 2019-2023 (specifically UG cables, UG transformers and more recently vault equipment and UG switchgear) as outlined in Section 4.5.6.1 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement, requiring an intervention to mitigate the short term failure risk

Therefore, Alternative Two allows for the best use of capital by moderately decreasing the back-log of underground distribution assets that have reached their TUL or deteriorated condition while primarily mitigating the short term risk of failure. The data from ongoing condition assessments based on the enhancements introduced in 2024 and continued through 2026-2030 will be used to determine which equipment will be addressed during annual scoping from 2026-2030. As Hydro Ottawa's maintenance programs advance further, that would support more enhanced condition assessments down to the component level and further support future renewal decisions.

4.7. PROGRAM EXECUTION AND RISK MITIGATIONS

4.7.1. Implementation Plan

Planned UG distribution replacements are prioritized based on the related equipment's condition and level of risk posed to Hydro Ottawa. Using the recommended rate of planned renewal, a program of planned renewal will begin in 2026 addressing UG equipment whose condition poses an increased risk compared to the others. If any UG distribution assets are found in a deteriorated condition, through the planned programs of inspection or through the day-to-day activities of internal resources, that warrants replacement, these will be performed reactively on an as-needed basis, or the planned renewal program adjusted accordingly.

4.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its UG distribution asset renewal program, Table 18 outlines the key risks and corresponding mitigation strategies.

1 **Table 18 - Key Risks of UG Distribution Asset Renewal Program and Mitigation Strategies**

Category	Risk	Mitigation
Distribution System Upgrades	System reconfigurations, upgrades, or expansions may be required, posing a risk to project delivery schedule and scope.	Develop long-term infrastructure plans and allocate resources efficiently to manage the costs and timing of necessary system modifications, minimizing financial impacts on customers.
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

5. METERING RENEWAL

5.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $11.8M

2026-2030: $86.4M

Budget Programs: Metering Upgrades

Main Driver: Functional Obsolescence

Secondary Driver: Mandated Service Obligation, Failure Risk, Observability

Outcomes: Customer Focus, Public Policy Responsiveness, Operational Effectiveness

Hydro Ottawa's metering fleet is a critical component of the distribution system, essential for accurate customer billing, settlement with the Independent Electricity System Operator (IESO), and effective grid operations. Continued reliable and accurate metering is fundamental to ensuring accurate billing, regulatory compliance, and the ability to manage the distribution grid effectively. Hydro Ottawa's first large-scale deployment of smart meters began as a result of Ontario Bill 21 - Energy Conservation Responsibility Act in 2006. This deployment saw the complete replacement of over 277,000 electro-mechanical meters to electronic smart meters, with the major portion completed by 2011.

Today, as a result of this aging metering fleet, Hydro Ottawa is proactively addressing the challenges presented by functional obsolescence in this metering infrastructure. A significant portion of the existing metering assets are nearing the end of their typical useful life, driven by the increasing challenges of supporting aging metering technologies. The Metering Renewal Program is essential to maintain the accuracy and reliability of meters, which is critical for revenue collection, regulatory compliance, supporting evolving customer needs and Hydro Ottawa's grid modernization strategy.

To this end, Hydro Ottawa has proposed to invest $86.4M in the Metering Renewal Program over this Application period. This will include the replacement of 161,000 meters, which is approximately 43% of the total fleet. The replacement of the remaining meters will be carried out in the subsequent rate period, thereby distributing the deployment and associated costs across multiple rate periods, minimizing the financial impact to ratepayers. As part of the phased replacement strategy, the age of meters in service will be the primary criterion for prioritizing replacements.

This Metering Renewal Program addresses the metering fleet needs under the following budget programs over the 2026-2030 period:

- **Revenue Meter Compliance:** This program focuses on initiatives impacting all of Hydro Ottawa's customers, including:
    - Planned replacement of residential and small commercial meters with next-generation Advanced Metering Infrastructure (AMI) 2.0 meters.
    - Upgrading supporting metering infrastructure.
- **Metering Element Conversion Initiatives:** This program focuses on upgrading or replacing end-of-life meters for 3-phase customers and legacy single element customers, while ensuring compliance with Measurement Canada standards:
    - **2.5 Element to 3.0 Element Upgrades (Measurement Canada Policy E-24):**
        - Existing 2.5 Element Metering: Measures current and voltage using two elements and calculates power factor using a third element.
        - Conversion to 3.0 Element Metering: Directly measures current and voltage for each phase of the electricity supply using three elements.
    - **1.0 Element to 1.5 Element Upgrades:**
        - Existing 1.0 Element Metering: Measures a single electrical quantity, the current flowing through the meter.
        - Conversion to 1.5 Element Metering: Measures two electrical quantities, both current and voltage.

5.2. PERFORMANCE OUTCOMES

Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. With the implementation of the Metering Renewal Program, improvements are expected in the outcomes shown in Table 19 below.

Table 19 - Metering Renewal Program Performance Outcomes

OEB Performance Outcome	Target
Customer Focus	Ensures continuous and reliable metering service by mitigating the risk of functional obsolescence, thereby minimizing billing interruptions and enhancing customer satisfaction. Maintain Meter Billing Accuracy Target of 98%.
Operational Effectiveness	Hydro Ottawa's system reliability objectives are supported by replacing the aging metering fleet with meters that have near-real-time grid observability features
Public Policy Responsiveness	Contributes to maintaining Hydro Ottawa's compliance objectives by conforming with Measurement Canada's Electricity and Gas Inspection Act and Regulations, the Weights and Measures Act, and the IESO's Market Rules, ensuring accurate and timely meter reading, billing, and market settlements

5.3. PROGRAM DRIVERS AND NEED

5.3.1. Main and Secondary Drivers

Primary Driver - Functional Obsolescence is the primary driver for the Metering Renewal Program. As a result of Ontario Bill 21 - Energy Conservation Responsibility Act in 2006, Hydro Ottawa quickly replaced its entire electromechanical fleet of meters over 4 years. This technology is now approaching end-of-life and requires upgrades to keep pace with customer expectations, maintain functionality and compliance. The aging metering fleet poses a risk to Hydro Ottawa's ability to ensure customer service, accurate billing, and regulatory compliance. This impacts regulatory requirements for various customer rate classes, as accurate metering is crucial for ensuring fair and transparent billing practices.

Furthermore, aging meters may fail in the field, leading to a loss of automated billing capability, forcing estimations, which negatively impacts customer service.

Secondary Drivers - Customer Focus, Operational Effectiveness, and Public Policy Responsiveness: The Metering Renewal Program is primarily driven by functional obsolescence, which poses significant risks to secondary drivers, including customer focus, public policy responsiveness, and operational effectiveness. Associated with this is cyber security which ensures the security of customer data.

This program contributes to enhanced operational effectiveness and grid observability. For example, the introduction of AMI 2.0 technology improves grid observability by providing customer outage data from the meter. This enhancement supports Hydro Ottawa's Grid Modernization Strategy, as outlined in Section 3.4.2 of Schedule 2-5-4 - Asset Management Process.

From a customer focus perspective, replacing the aging metering fleet minimizes the occurrence of non-communicating meters, thereby reducing estimated bills, customer disputes, and enhancing overall customer satisfaction. AMI 2.0 technology also enables greater customer visibility and control of energy consumption. These improvements contribute to a more reliable, efficient, and customer-centric electricity grid.

Cyber security considerations are also important to consider as it pertains to customer satisfaction. Robust cyber security measures are important to protect sensitive customer data, as functional obsolescence progresses, associated cyber security vulnerabilities are likely to increase.

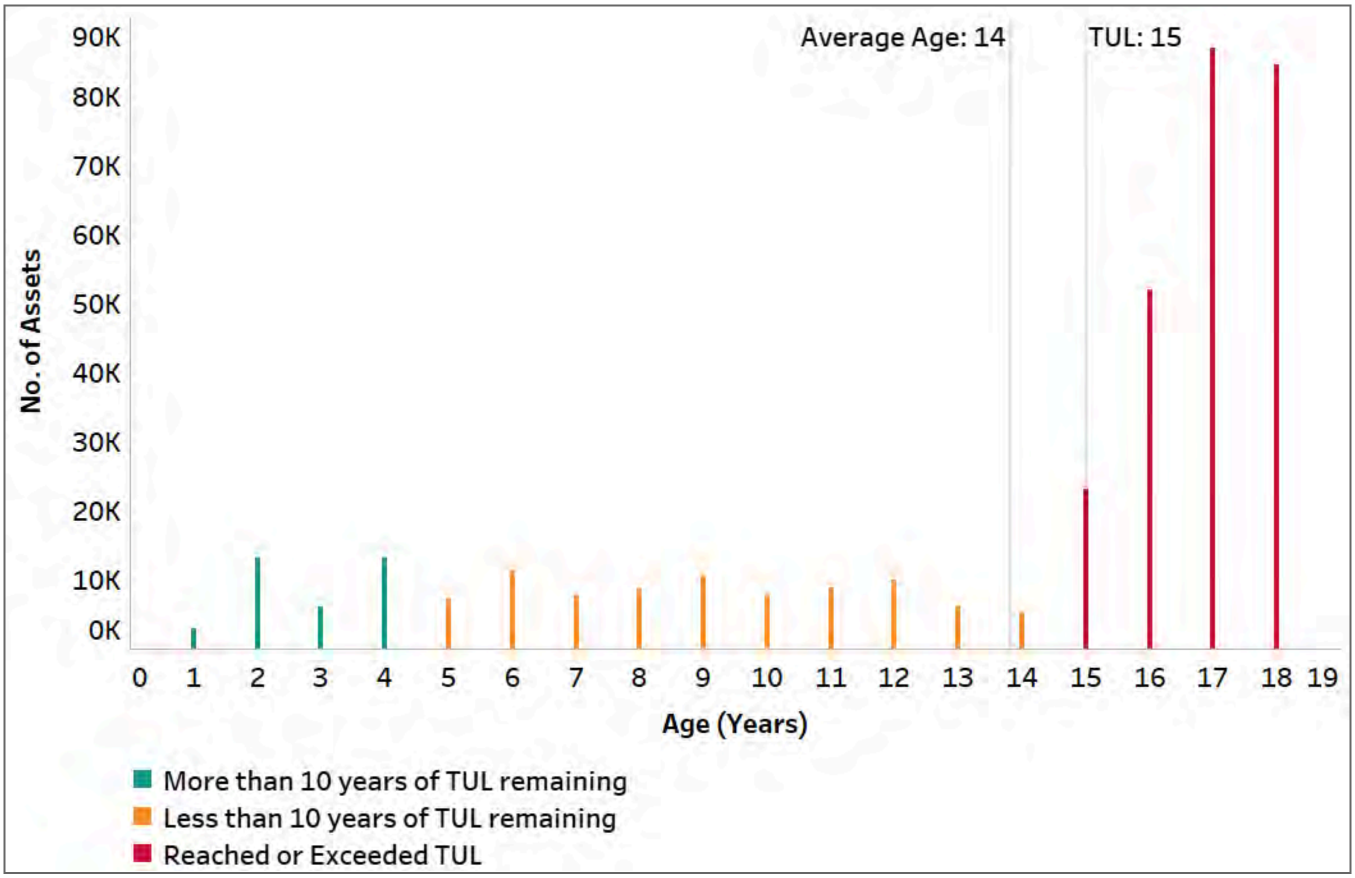
5.3.2. Current Issues

Aging Metering Assets

The primary focus of the Metering Renewal program is to mitigate the impact of functional obsolescence and continued deterioration of the existing metering fleet (installed as early as 2006), which pose a growing risk to customer focus, operational effectiveness, and public policy responsiveness. Revenue meters are one of the largest Hydro Ottawa asset classes, both in terms of installed quantity and overall cost. Figure 72 shows the current meter fleet demographics as of

2024, Figure 73 demonstrates the forecasted age demographics in 2030 for residential and small commercial revenue meters, should no action be taken. Figure 74 demonstrates the summary of the current and forecasted demographics of the metering fleet if no replacement occurs.

Figure 72 - Current Age Demographics Profile of Residential and Small Commercial Meters (as of 2024)



1 **Figure 73 - 2030 Forecast Age Demographics Profile of Residential and Small Commercial**
2 **Meters (No Replacement Action)**

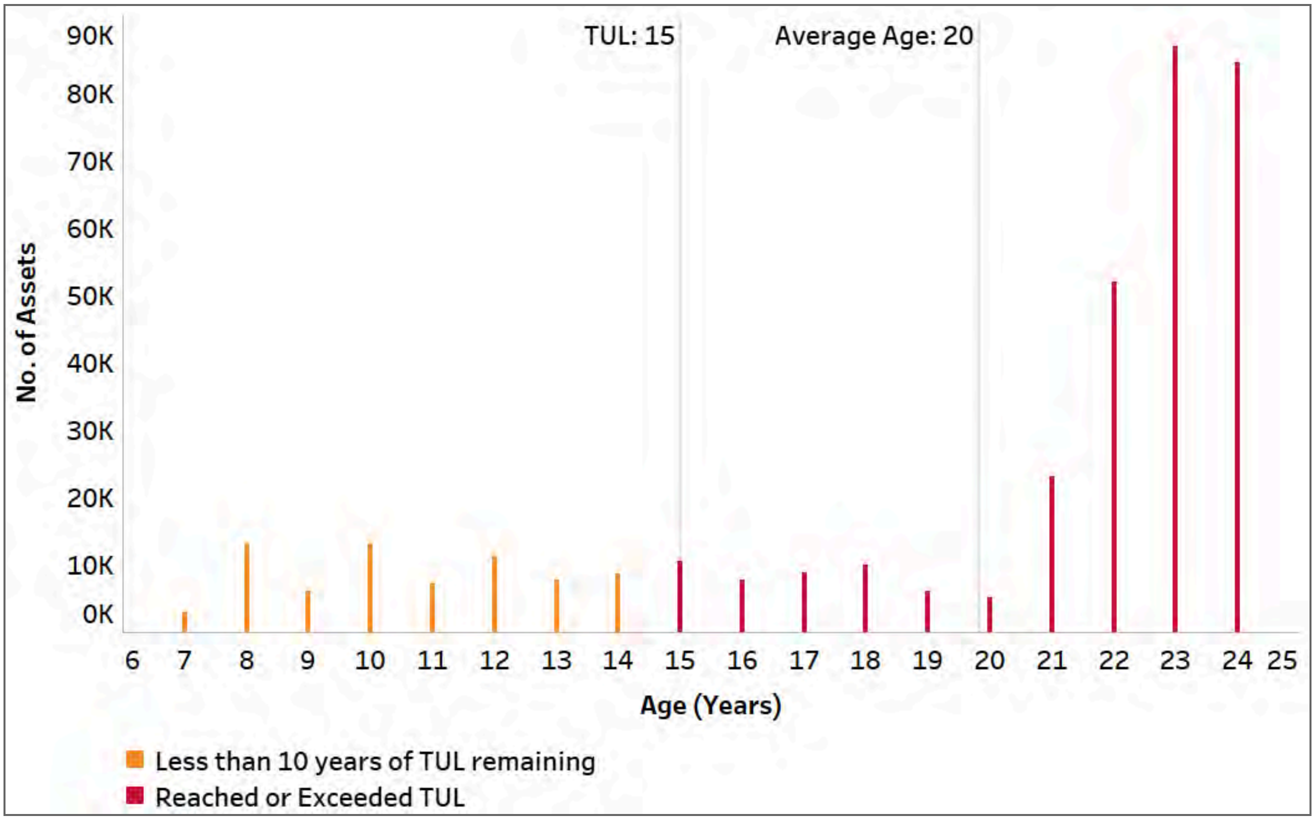
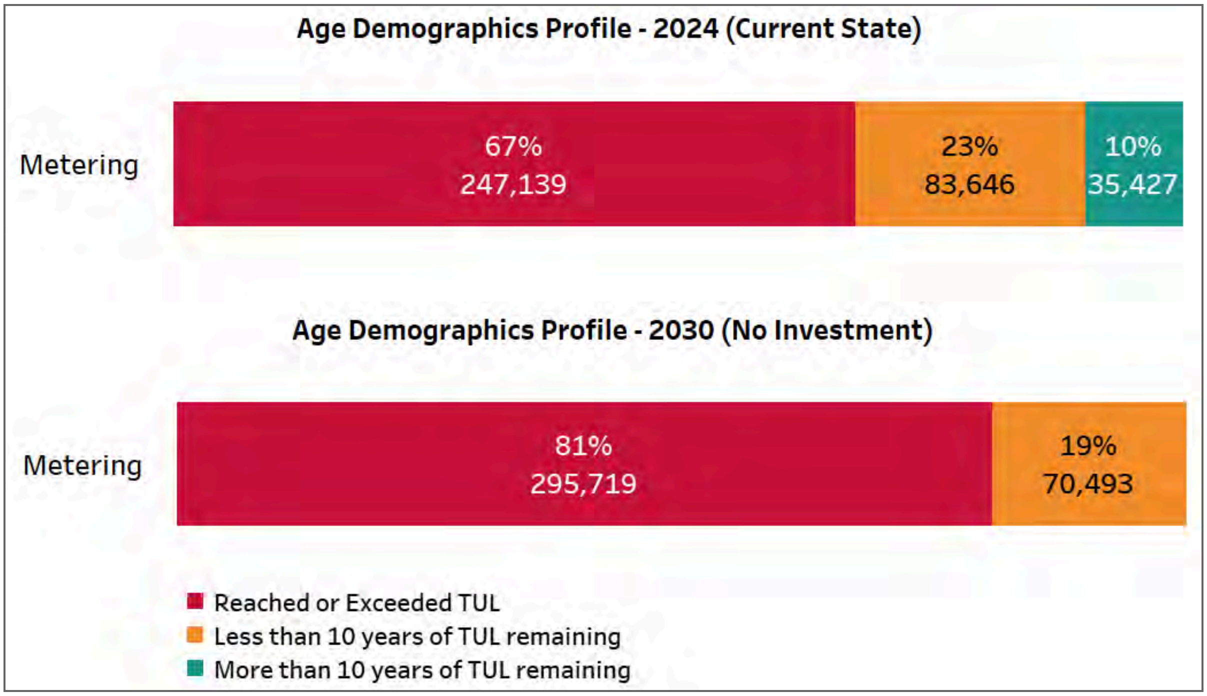
3 

Figure 74 - Age Demographics Profile of Residential and Small Commercial Meters Summary



Approximately 81% of the revenue meters will reach the end of their typical useful life by 2030 if no replacement action is taken. Deteriorating meters are increasingly prone to in-field failure, leading to inaccurate or missing meter reads. This can result in estimated bills, billing disputes, and customer dissatisfaction.

Hydro Ottawa has experienced increasing meter failures in the field such as from accidental physical damage, internal meter circuit board failures, meter communication failures, and meter memory (EEPROM) failures. Table 20 shows the field activities issued and completed based on suspected failure type for meter installations through 2021-2024.

Table 20 - Completed Revenue Meter Field Activity by Failure Type (2021-2024)

Revenue Meter Field Activity by Failure Type	Count (2021-2024)
Collector Check	274
Emergency Meter Check	6
Interval Meter - Communication Check	187
Interval Meter - Gatekeeper Check	256
Interval Meter - Gatekeeper Check (with nodes)	37
Meter Check Communication	2,080
Meter Check/Repair	1,024
Meter Voltage Check	259
Orphan Meter	231
Smart Meter Chip Error Change	798
Residential Smart Meter Change	2,420

- **Meter Communication Issues/Checks:** Since 2021, Hydro Ottawa has responded to 2,080 events related to meter communication issues, highlighting the need for reliable communication infrastructure to ensure accurate and timely data transmission.
- **Residential Smart Meter Changes:** Hydro Ottawa has performed a significant number of residential smart meter changes, including installations, replacements, and repairs, to maintain accurate metering and customer satisfaction.
- **Smart Meter Chip Error Issues:** The utility has addressed smart meter chip errors through repairs and replacements to ensure accurate meter readings and prevent billing discrepancies.
- **Meter Delivery Issues:** Hydro Ottawa has experienced challenges with meter delivery, which can impact project timelines and the timely replacement of aging assets.
- **Operational Issues with Router Communications Module:** Critical failures encountered during shop testing of a specific router communications module required prompt resolution to prevent potential communication disruptions.
- **Performance Issues with Daily Read Schedules:** Issues with daily read schedules limited data collection to register readings, impacting billing processes and delaying revenue collection.

Hydro Ottawa's aging meters and communication structure is functionally configured to read billable data once per day. This legacy metering infrastructure cannot provide the necessary high-resolution data at the intervals necessary for grid modernization efforts, impedes the integration of DERs, and compromises Hydro Ottawa's ability to optimize grid operations and deliver innovative customer-centric solutions. Addressing these challenges requires a strategic investment in a modernized metering infrastructure that prioritizes reliability, accuracy, and future-proofing capabilities.

3-Phase Metering Element Compliance

Driven by Measurement Canada Policy E-24 Policy on Approval and Use of 2.5 Element Metering, Hydro Ottawa proposes to upgrade its remaining 3-phase 2.5 Element (2.5 EL) metering population from a 2.5 Element to a 3 Element (3.0 EL) service. As well, Hydro Ottawa will also upgrade self-contained 1.0 Element services to 1.5 Element. The elimination of these nonstandard 1.0 element meter installations from Hydro Ottawa's system will reduce inventory overhead costs.

5.4. PROGRAM BENEFITS

The Metering Renewal Program will result in benefits across several key areas:

5.4.1. System Operation Efficiency and Cost Effectiveness

The proposed leveled-pace replacement of Hydro Ottawa's aging metering technology with AMI 2.0-capable equipment enhances operational efficiency by enabling remote meter management, grid feedback, and data collection, thereby reducing meter communication errors, as demonstrated in Table 20, and additional operational field activities.

Proactive meter replacement also minimizes the risk of billing estimation and customer disputes, further contributing to cost savings.

AMI 2.0 infrastructure, with enhanced data analytics, enables grid observability, enabling quicker identification and resolution of grid issues. This investment supports the data integration requirements necessary to effectively manage DERs, unlocking efficiencies such as demand response programs for peak load and asset stress management.

5.4.2. Customer

The replacement of Hydro Ottawa's aging metering technology with AMI 2.0-capable equipment directly benefits customers through enhanced service reliability and power quality. The advanced technology of AMI 2.0 enables faster and more precise outage detection, leading to shorter outage durations and quicker restoration times; meaning fewer disruptions to customers' daily lives and businesses. The proposed phased replacement pace benefits the customer by distributing the required investment across multiple rate periods. This strategy also avoids recurring end-of-life whole-fleet replacement burdens such as the original 2006 implementation.

Hydro Ottawa considered the results from the customer engagement survey, where there was strong support for Hydro Ottawa's proposed investments towards ensuring a reliable and modern electrical distribution system.

5.4.3. Safety

The Metering Renewal Program enhances safety by addressing potential hazards associated with less advanced metering equipment such as:

Enhanced Detection of Tampering and Fraud: Aging meters replaced with AMI 2.0 systems provide improved capabilities for detecting meter tampering and electricity theft. Tampering can create dangerous conditions, such as exposed wiring or bypassed safety mechanisms. By facilitating the identification and correction of tampering, the program contributes to a safer environment for both customers and the general public.

Support for Emergency Response: AMI 2.0 infrastructure can provide more timely and accurate information during power outages and emergencies. This information can help Hydro Ottawa and emergency responders to better assess situations, prioritize responses, and ensure the safety of both the public and field personnel.

5.4.4. Cyber Security and Privacy

The replacement of Hydro Ottawa's aging metering technology with AMI 2.0-capable equipment has cyber security and data privacy as core principles. The advanced AMI 2.0 system is designed with next-generation security measures to safeguard customer data and protect the grid infrastructure from cyber threats:

- **Encryption Protocols:** Data communication between meters and the central system is encrypted, making it unreadable to unauthorized parties in case of interception.
- **Secure Authentication:** Authentication protocols ensure only authorized devices and personnel can access the AMI network, preventing unauthorized access and data manipulation.
- **Vulnerability Management:** The system is continuously monitored and updated with the latest security patches to address potential vulnerabilities and mitigate cyber risks.

By implementing these robust security measures, Hydro Ottawa strengthens its commitment to data privacy and ensures customer information remains secure within the metering replacement program.

5.4.5. Coordination and Interoperability

Hydro Ottawa's AMI 2.0 Metering Renewal Project prioritizes the seamless integration and coordination of the advanced metering infrastructure with existing grid operations. The AMI 2.0 system will adhere to open standards and protocols, fostering interoperability with other utility systems such as the Outage Management System (OMS), Advanced Distribution Management System (ADMS) - refer to Section 5 of Schedule 2-5-8 - System Service Investments. This integration enables real-time data exchange, streamlined communication, and enhanced operational efficiency across all aspects of grid management.

Furthermore, the AMI 2.0 system's interoperability supports the integration of DERs like solar panels and battery storage. By seamlessly communicating with these DERs, Hydro Ottawa can monitor and optimize their performance, enabling a more dynamic and flexible grid that can adapt to changing energy demands and supply conditions. This integration is key to supporting decarbonization by facilitating the adoption of renewable energy sources and enabling greater customer participation in energy programs.

The enhanced coordination between AMI 2.0 and other grid systems leads to improved outage management and faster restoration times. With real-time data on outage locations and power status, crews can be dispatched more efficiently, minimizing disruptions to customers. Additionally, the AMI 2.0 system can remotely detect meter tampering and theft, enhancing grid security and protecting revenue.

By leveraging the coordinated and interoperable nature of the AMI 2.0 system, Hydro Ottawa gains valuable insights into grid performance, load patterns, and customer behavior. This data-driven approach enables better decision-making, more effective resource allocation, and the development of innovative programs and services that benefit both the utility and its customers. Ultimately, the improved coordination and interoperability fostered by the AMI 2.0 Metering Renewal Project will contribute to a more reliable, efficient, and resilient grid, well-equipped to meet the evolving needs of the community and support a sustainable energy future.

5.4.6. Economic Development

The multi-period implementation of the aging meter replacement program represents a prudent investment for Hydro Ottawa and its ratepayers. The technological advancements embedded in AMI 2.0 have the potential to yield long-term cost savings through increased operational efficiency, reduced meter reading expenses, and improved outage management.

Furthermore, AMI 2.0's advanced capabilities, such as detailed energy usage data, can empower customers to make informed decisions about their energy consumption patterns. This increased awareness and control may lead to behavioral changes that result in lower energy bills for consumers.

Additionally, the integration of AMI 2.0 with DERs can create a more dynamic and flexible grid, potentially reducing the need for costly infrastructure upgrades and further mitigating upward pressure on rates. The ability to manage and optimize DERs can lead to improved voltage regulation, reduced peak demand, and the potential for new customer programs and services, all of which contribute to a more efficient and cost-effective energy system that benefits both the utility and its ratepayers.

5.4.7. Environment

The AMI 2.0 Metering Renewal Project contributes to environmental benefits by facilitating a more efficient and sustainable energy system. Replacement of the aging meter fleet with AMI 2.0 capable meters, optimizing grid operations, enabling better integration of renewable energy sources, and empowering customers to manage their energy use. Additionally, the replacement of end-of-life meters reduces maintenance truck rolls, leading to a decrease in vehicle emissions, promoting a cleaner environment.

5.5. PROGRAM COSTS

Table 21 shows the historical and future spending by the underlying budget programs, as a part of the Metering Renewal program including capital expenditures, operations, management and administration (OM&A) and derecognition costs. The 2026-2030 period will see an increase in spending, reaching $86.4M, compared to $11.8M in the 2021-2025 period. Considerations around equipment/resource availability as well as project prioritization/scheduling resulted in some variability in the projected spending between 2026 and 2030.

Table 21 - Historical, Bridge and Test Year Expenditures for the Metering Renewal Program ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Metering Upgrades	$ 1.5	$ 0.3	$ 1.3	$ 4.6	$ 4.1	$ 15.4	$ 14.6	$ 16.2	$ 19.3	$ 20.9
5-YEAR SUBTOTAL					**$ 11.8**					**$ 86.4**
OM&A	-	-	-	-	-	$ 0.7	$ 1.0	$ 1.2	$ 1.6	$ 2.0
Derecognition costs	-	-	-	-	-	$ 0.4	$ 0.8	$ 0.8	$ 0.8	$ 0.8
ANNUAL TOTAL	**$ 1.5**	**$ 0.3**	**$ 1.3**	**$ 4.6**	**$ 4.1**	**$ 16.4**	**$ 16.4**	**$ 18.2**	**$ 21.6**	**$ 23.7**
5-YEAR TOTAL					**$ 11.8**					**$ 96.4**

Table 22 shows the historical and preferred alternative future units to be replaced as a part of the metering renewal program.

Table 22 - Preferred Alternative Metering Unit Replacements Overview

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Metering Replacements	408	1,488	3,764	2,912	1,377	11,000	29,300	32,950	40,250	47,500

5.5.1. Metering Replacements

81% of the metering fleet have currently reached or will exceed the TUL by 2030. The Metering Renewal program's spending is forecasted to increase significantly, from $11.8M in 2021-2025 to $86.4M in 2026-2030. This increase in spending is essential to address the growing challenge of functional obsolescence within Hydro Ottawa's metering infrastructure. The increased spending will enable Hydro Ottawa to replace a substantial portion of end-of-life metering infrastructure, invest in AMI 2.0 technology, and enhance grid observability to support grid modernization efforts. This investment represents a strategic initiative by Hydro Ottawa to mitigate these risks, ensure the long-term performance and reliability of the metering system, and support evolving customer needs.

5.5.2. Cost Factors

Cost factors that affect the Metering Renewal program are listed below:

- Physical location and configuration of the meter on customer's premise
- Communication type and system integration complexity
- Project delays and unit lead times
- Skilled labour availability
- Material & equipment cost

5.6. ALTERNATIVES EVALUATION

5.6.1. Alternatives Considered

To address the drivers and achieve the performance objectives of the program, Hydro Ottawa undertook an analysis to determine the optimal number of metering units to replace, focusing on minimizing functional failures, enhancing overall system performance, and balancing the financial impact on ratepayers. This analysis considered several key factors, including regulatory compliance, assessment of the current metering infrastructure (prioritizing replacement of units nearing or past their end-of-life), financial impact, and the ability to support advanced grid functionalities through observability.

Three alternatives were considered for this program. These alternatives were designed to achieve a balance between rate impact and service quality performance, both in the near and longer term, while readying the grid with prudent investments to serve the evolving needs of its customers.

Alternative 1 - Run to Failure:

This alternative takes a reactive approach to meter replacement, addressing meters only upon failure, enduring functional obsolescence of the meters for several future rate periods. While this alternative appears to minimize immediate capital outlay, it poses significant challenges to Hydro Ottawa's system integrity, grid modernization objectives, and long-term efficiency. Replacing meters solely upon failure increases the risk of billing estimations and reactive operational costs, while hindering grid observability objectives. This approach also eliminates cost savings associated with purchasing meters in bulk, prevents a competitive procurement process, and presents significant technical risk to success due to a need to integrate with obsolete technology. This alternative poses risks to regulatory compliance, operational efficiency, system reliability, and effective grid modernization. The metering element upgrade programs driven by Measurement Canada Policy E-24 are included in this alternative.

- AMI 2.0 deployment replacement upon unit failure
- 2.5 Element to 3.0 Element Upgrade - 50 units upgraded per year
- 1.0 Element to 1.5 Element Upgrade - $50k per year

Alternative 2 - Phased Metering Renewal:

This alternative takes a customer-centric approach to meter renewal by upgrading Hydro Ottawa's metering infrastructure over two rate periods (10 years). While the entire metering fleet would not be replaced within this timeframe, and some meters may reach their typical useful life, this phased implementation prioritizes overall meter TUL for replacement. This strategy allows for the progressive introduction of advanced metering technologies and grid observability. By spreading the investment, Hydro Ottawa seeks to mitigate the immediate impact on customer rates and prevent the cyclical major investment patterns caused by mandated smart metering initiatives.

There is no proposed change to the element upgrade programs driven by Measurement Canada Policy E-24 in this alternative.

- AMI 2.0 deployment at a moderate pace to reduce the ratepayer burden through a 10-year implementation plan (161,000 Meters by 2030)
- 2.5 Element to 3.0 Element Upgrade - 50 units upgraded per year
- 1.0 Element to 1.5 Element Upgrade - $50k per year

Alternative 3 - Aggressive Metering Renewal:

This alternative proposes an accelerated renewal of Hydro Ottawa's metering infrastructure, with the replacement of all meters occurring within a single rate period (5 years). This approach offers the benefit of a rapid transition to advanced metering technologies, potentially maximizing the speed of realizing associated grid modernization benefits. However, it also presents significant challenges, particularly concerning cost impacts on ratepayers and the creation of a cyclical investment pattern.

There is no proposed change to the element upgrade programs driven by Measurement Canada Policy E-24 in this alternative.

- AMI 2.0 deployment at an aggressive pace based on a 5-year implementation plan (366,000 Meters by 2030)
- 2.5 Element to 3.0 Element Upgrade - 50 units upgraded per year
- 1.0 Element to 1.5 Element Upgrade - $50k per year

Table 23 - Comparison of Metering Renewal Alternatives

Alternative	Age Demographics Impact Asset Condition Impact Reliability Risk Reduction	Outcome/Customer Impact
Run to Failure	Deterioration	Low investment level. Functional obsolescence. Increased risk of meter failures leading to billing estimations. negatively impacting customer trust. Higher operational costs, increased reactive maintenance. Delays in outage restoration and issue resolution due to reduced system observability. Limited ability to offer customers new services or programs that rely on advanced metering data.
Phased Metering Renewal	Moderate Improvement	Moderate investment level. Phased replacement. Mitigate failure risk of aging metering assets and ensure continued quality of service to customers. Progressive realization of benefits from advanced metering technologies. Balances affordability and system modernization.
Aggressive Metering Renewal	High Improvement (Complete Replacement)	High investment level, near-term rate impacts on customers. Ability to mitigate failure risk of most metering assets and enable realization of advanced metering benefits. Risk of creating future cyclical investment needs.

5.6.2. Evaluation Criteria

Compliance

Hydro Ottawa prioritizes compliance with all applicable regulatory requirements and industry standards governing metering. The selected alternative must ensure adherence to the Electricity and Gas Inspection Act, the Weights and Measures Act (Measurement Canada), and the IESO Market Rules, while also meeting OEB requirements for accurate billing and data provision.

Safety

Hydro Ottawa places the safety of its employees and the public at the forefront of its decision-making process. The selected alternative must maintain or improve the safety of Hydro Ottawa's employees and the public.

Reliability and Observability

The selected alternative shall reduce the risk posed by aging metering assets and mitigate the impact of in field failure. The preferred alternative shall promote the grid modernization strategy through improved grid observability.

Cyber Security

Data security and privacy are paramount concerns. The selected solution shall adhere to the highest industry standards for cyber security, including encryption protocols, secure authentication, and vulnerability management, to protect customer data and safeguard the grid from potential cyber threats.

Resources

The chosen alternative shall optimize resource utilization across the project lifecycle. It shall demonstrate efficient deployment strategies, streamline integration with existing systems, and minimize the need for manual interventions and troubleshooting. Additionally, the solution shall reduce the number of reactive metering projects.

Financial

The preferred alternative shall reduce emergency or reactive renewal costs through the execution of planned metering asset renewal work, while ensuring customer affordability.

Environmental

The solution shall aim to minimize its environmental footprint throughout its lifecycle. This includes considering the energy efficiency of the meters and communication devices, the use of recyclable shipping materials, and responsible disposal of replaced equipment. The solution shall also reduce the impact of unnecessary maintenance field activity, reducing Hydro Ottawa's carbon footprint.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

5.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 5.6.1 under the evaluation criteria of Section 5.6.2.

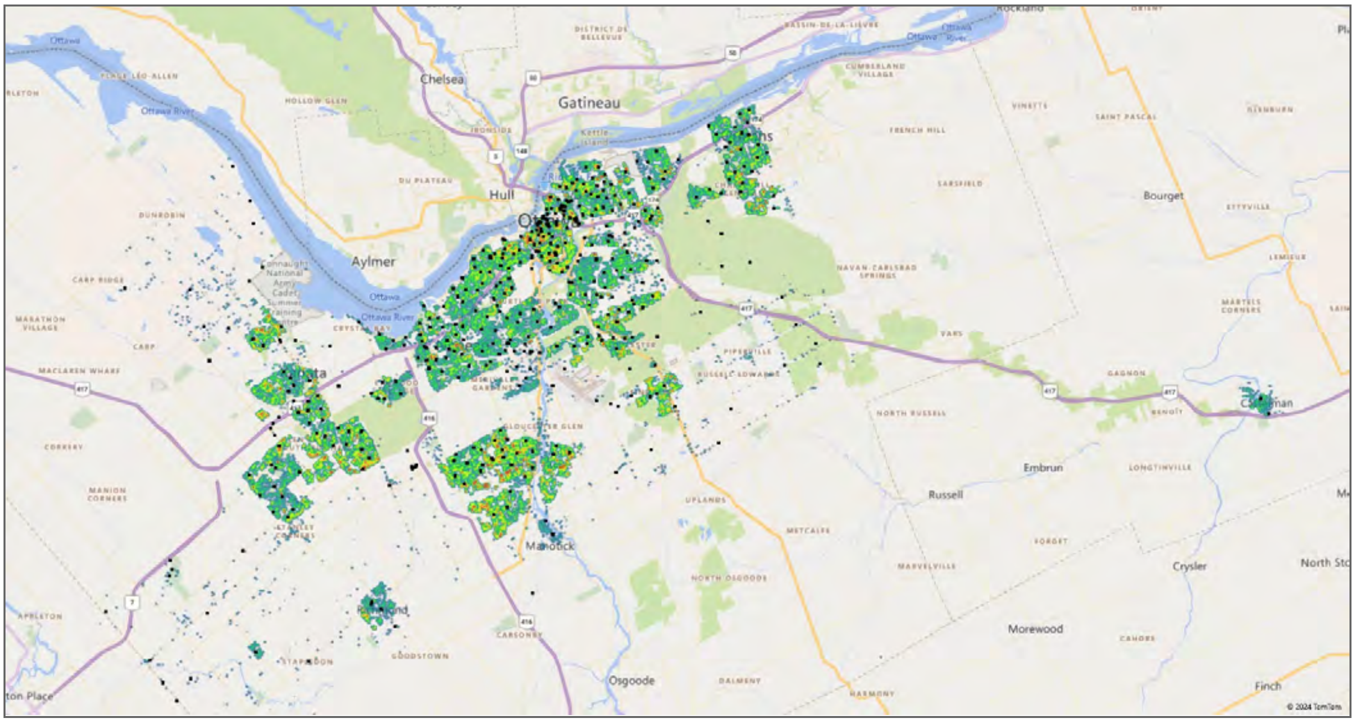
The recommended approach, Alternative 2, addresses Hydro Ottawa's aging metering fleet through a phased renewal of metering infrastructure, balancing the need for replacement with customer affordability and preventing future cyclical investment patterns. This approach creates a pathway for the progressive deployment of advanced metering technologies, empowering enhanced grid management and improved customer services. By strategically addressing aging infrastructure and investing in new capabilities, Hydro Ottawa can optimize its metering operations and better serve its customers.

This strategy also positions Hydro Ottawa to respond to grid modernization requirements, such as integrating new technologies and adapting to the evolving energy landscape. Ultimately, this investment translates to a more affordable, reliable, and efficient metering system, supporting enhanced grid functionality and enabling new opportunities for customer engagement and energy management.

5.7. PROGRAM EXECUTION AND RISK MITIGATION

5.7.1. Implementation Plan

Figure 75 - Existing Hydro Ottawa Metering Fleet Locations



Based on the preferred alternative 2, the AMI 2.0 Metering Renewal Project will be implemented through a phased, 10-year deployment to manage costs effectively. Meter replacement prioritization will be based on a multi-faceted approach, considering factors such as:

- **Meter Age:** Meters exceeding or approaching their useful life**.**
- **Meter Seal Date:** Meters approaching or exceeding their Measurement Canada-approved lifespans will be prioritized for replacement to ensure regulatory compliance instead of resealing.

- **Geographical Location:** Areas experiencing frequent outages, voltage fluctuations, or other reliability issues.
- **Critical Infrastructure:** Meters serving critical infrastructure or essential services may be prioritized to maintain uninterrupted power supply.
- **Grid Modernization Initiatives:** Areas with planned or ongoing DER integration or distribution automation projects will be considered for early deployment to leverage AMI 2.0 capabilities.
- **Customer Density:** Regions with high customer density or anticipated load growth will be targeted to ensure grid capacity and support future energy needs.

The phased AMI 2.0 deployment will be optimized for maximum benefit, balancing modernization with cost and minimizing customer disruption. Hydro Ottawa will use a strategic, data-driven prioritization approach combined with efficient implementation. This includes leveraging internal expertise for project management and commissioning supplemented by external partnerships for installation and system integration. To maximize efficiency and minimize disruptions, meter replacements will be prioritized and coordinated, including bundling work geographically to reduce truck rolls and customer interruptions. Resource allocation, progress tracking, delay management and costs, will be monitored using key performance indicators, with regular reporting to stakeholders and a post-implementation review to identify improvements.

5.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Meter Renewal Program. Table 24 outlines the key risks and corresponding mitigation strategies.

1 **Table 24 - Key Risks of Metering Renewal Program and Mitigation Strategies**

Category	Risk	Mitigation
Systems Integration	Issues with integration with existing IT and OT infrastructure, including legacy systems poses a risk to program delivery schedule, scope, and cost.	Implement thorough planning and testing to mitigate compatibility issues and data migration challenges
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather	Create and where required implement contingency plans to account for

Category	Risk	Mitigation
	events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

6. CORRECTIVE RENEWAL

6.1. PROGRAM SUMMARY

Investment Category: System Renewal

Capital Program Costs:

2021-2025: $82.6M

2026-2030: $66.9M

Budget Programs: Critical Renewal, Emergency Renewal, Damage to Plant

Main Driver: Failure

Secondary Driver: Failure Risk

Outcomes: Operational Effectiveness and Customer Focus

The Corrective Renewal Program consists of three Budget Programs: Emergency Renewal, Critical Renewal, and Damage to Plant. The Emergency Renewal Program includes replacement of assets that have failed and must be replaced immediately. The Critical Asset Replacement Program involves replacement of assets that have degraded to a point of functional failure, and pose an imminent failure risk, but are able to be repaired or replaced in a planned fashion. The Damage to Plant Budget Program also falls under the Corrective Renewal Program to cover the unplanned replacement of damaged assets caused by a third party.

Hydro Ottawa's distribution system consists of a variety of asset classes. The corrective renewal program categorizes work into emergency and critical within the following asset types: Overhead Switches, Underground Switches, Overhead Transformers, Underground Transformers, Polymer Cable, Paper Insulated Lead Cable (PILC), Overhead Primary Conductor and Insulators, Underground Secondary Service, Overhead Secondary Service, Underground Civil, Poles, Station Transformer, Station Switchgear, Station DC System, and Station P&C.

The asset classes above are covered by one of Hydro Ottawa's Renewal Programs (refer to Stations, Overhead and Underground System Renewal sections) with exception to the Overhead and Underground Secondary Services which are "run to failure".

This Corrective Renewal Program addresses the needs under the following Budget Programs over the 2026-2030 period:

Emergency Renewal: This budget program is related to immediately replacing assets that have failed and resulted in an outage or have been found to pose a definite and immediate safety or environmental risk. Some of the criteria to qualify under Emergency Renewal for the various asset classes is shown in Table 25.

Table 25 - Emergency Renewal Criteria

Asset Class	Emergency Renewal Criteria (Immediate Risk)
Station Transformers	Internal fault
	Bushing failure
	Tank rupture (loss of oil)
	Major issue found during maintenance
	Health index of 0%
Station Switchgear	Damaged beyond repair
	Inoperable
	Extreme corona discharge
	Time/travel tests above operable limits
	Health index of 0%
Station Batteries	Battery charger failure
	Multiple battery cells fail testing
	Leaking batteries
Station P&C Equipment	Relay failed
	Power supply failed
	Software error
	Input/Output board failed
Poles	Pole on the ground
	Detached pole (non-securable)
	Detached or Broken cross arm
	Health index of 0%
	Corroded conductor
OH Switches	Damaged Beyond Repair
	Inoperable
	Extreme Corona Detected
	Health index of 0%
OH Transformers	Damaged beyond repair
	Leaking oil
	Overheating (identified through IR scan)
	Popped pressure indicator
	Health index of 0%
UG Transformers	Damaged beyond repair
	Inoperable

Asset Class	Emergency Renewal Criteria (Immediate Risk)
	Exposure of live components to public
	Significant loss of oil
	Health index of 0%
UG Switchgear	Damaged beyond repair
	Inoperable
	Exposure of live components to public
	Extreme corona detected
	Health index of 0%
UG Cables (PILC)	Cracked Pothead
	Dielectric Breakdown (Fault)
UG Cables - Cross Linked Polyethylene (XLPE/TRXLPE)	Unacceptable Cable Testing Value
	Failed Hi-Pot Test
	Dielectric Breakdown (Fault)
UG Cables - Ethylene Propylene Rubber (EPR)	Dielectric Breakdown (Fault)
	Failed Hi-Pot Test
Vault Transformers	Damaged beyond repair
	Significant loss of oil
	Extreme corona detected
	Failed IR scan (overheating)
	Operated (popped) pressure flag
UG Civil Structures	Collapsed member (wall, roof, collar)
	Crack / gap permitting access to energized component
	Health index of 0%

Critical Renewal: This budget program is related to replacing assets that have functionally failed, requiring urgent intervention in the short-term. Some of the criteria to qualify under Critical Renewal for the various asset classes is shown in Table 26.

Table 26 - Critical Renewal Criteria

Asset Class	Critical Renewal Criteria (Imminent Risk)
Station Transformers	Tap-changer failure
	Heavy gassing
	Overheated bushing (found with IR scan)
	High furan level
	Significant issues found in testing
	Insufficient health index (very poor / < 30%)
Station Switchgear	Dielectric breakdown
	Irreplaceable component
	Loss of pressure (vacuum or SF6)
	Contact resistance test failed
	Insufficient health index (very poor / < 30%)
Station Batteries	Battery charger overheating
	Single cell fails testing
	Irreplaceable component fails
Station P&C Equipment	SCADA communications failed
Poles	Rotten butt
	Detached pole (engineered securable)
	Excessive lean (> 15 degrees)
	Insufficient health index (very poor / < 30%) including damage from woodpeckers
	Cracked insulator
OH Switches	Loss of Dielectric / Dielectric Breakdown
	Irreplaceable Component(s)
	Insufficient health index (very poor / < 30%)
OH Transformers	Cracked / broken bushing
	Insufficient health index (very poor / < 30%)
UG Transformers	Minor oil leak cannot be repaired
	Irreplaceable component
	Insufficient health index (very poor / < 30%)
UG Switchgear	Dielectric breakdown / loss of dielectric

Asset Class	Critical Renewal Criteria (Imminent Risk)
	Irreplaceable component
	Insufficient health index (very poor / < 30%)
UG Cables (PILC)	Leaking Splice
	Swollen / Flat Sleeve
	Leaking Pothead
	Multiple Failures (Faults) in Same segment (AM Decision)
UG Cables (XLPE/TRXLPE)	Overheating
	Multiple Failures (Faults) in Same segment (AM Decision)
	Corroded Concentric Neutral
UG Cables (EPR)	Overheating
	Multiple Failures (Faults) in Same Length (AM Decision)
	Corroded Concentric Neutral
Vault Transformers	Cracked bushing
	Minor oil leak cannot be repaired
	Irreplaceable component
UG Civil Structures	Imminent collapse
	Sunken base impeding access/affecting asset management objectives
	Insufficient health index (very poor / < 30%)

Damage to Plant: This budget program is related to replacing assets that have failed due to damage caused by third parties. The damage must be severe enough to cause the asset to functionally fail. In some cases, the party responsible for the damage is unknown.

6.2. PERFORMANCE OUTCOMES

The objective of the Corrective Renewal program is to reactively repair, refurbish, or replace assets in critical or emergency condition. Since this program involves employing immediate or near-term action, the proposed budget must be sufficient to cover all Emergency and Critical replacements that occur throughout the year. Hydro Ottawa employs key performance indicators for measuring and monitoring its performance. With the implementation of the corrective renewal program, improvements are expected in the outcomes shown in Table 27 below due to the replacement of assets that pose an immediate/imminent risk.

Table 27 - Corrective Renewal Program Performance Outcomes

OEB Performance Outcome	Target
Operational Effectiveness	Contributes to the improvement of reliability metrics (SAIDI and SAIFI) by reducing the percentage of distribution assets in poor and very poor condition and/or operating beyond their typical useful life (varies by asset type), posing an immediate/imminent risk
	• Contributes to Hydro Ottawa's Environmental metrics by reducing the Environmental risk measured by the number of oil leaking distribution equipment per year • Contributes to Hydro Ottawa's Environmental metrics by reducing the Environmental risk measured by the number of gas leaking distribution switchgear per year
Customer Focus	Contributes to Customer Satisfaction by maintaining system reliability

6.3. PROGRAM DRIVERS AND NEED

6.3.1. Main and Secondary Drivers

Primary Driver: Failure. The primary driver for corrective renewal is that the replacement of assets under Emergency Renewal is crucial as the assets are in a failed state.

Secondary Driver: Failure Risk. The secondary driver for corrective renewal is that the replacement of assets replaced under Critical Renewal is crucial as the assets are in a state of high failure risk.

6.3.2. Current Issues

The following sub-sections summarize some of the challenges highlighting the need for the underlying budget programs.

6.3.3. Critical and Emergency Renewal

Asset age and condition primarily impact the overall health and largely result in failures. End-of-life and deteriorated assets (those in Poor/Very Poor condition) dictate the need for emergency/critical replacements. Hydro Ottawa requires a corrective renewal program outside of the planned renewal program as there is a need to replace/manage electrical assets which pose an immediate or imminent risk to Hydro Ottawa's asset management objectives. Such equipment (in Poor/Very Poor condition) are identified through yearly inspections by completing a comprehensive asset condition assessment, to be managed in the short term.

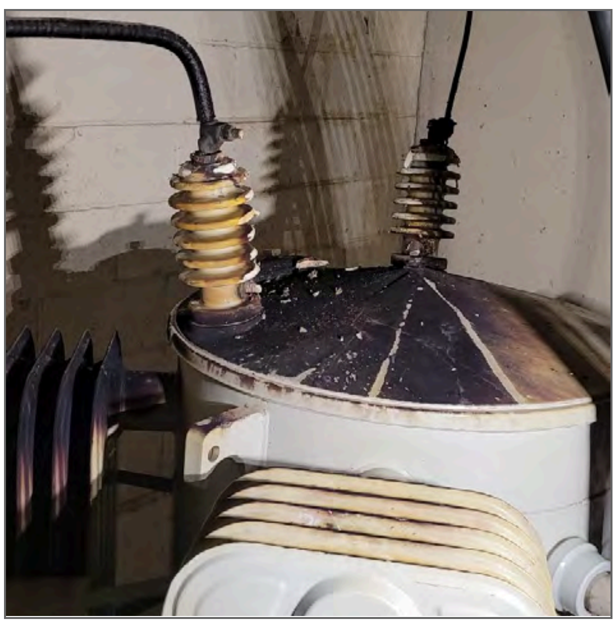
Table 28 shows the existing proportion of distribution assets in a deteriorated condition, requiring some form of intervention in the short term. In line with the proportion of assets in a bad condition, Hydro Ottawa has faced issues with metalclad station switchgear (air and SF_6), OH distribution apparatus (primarily poles), UG cables (XLPE), leaking UG transformers, air type switchgear and vault equipment.

Table 28 - Overview of Distribution Assets in a Deteriorated Condition[8]

Distribution Asset Category	Number of Assets in Poor/Very Poor Condition	Proportion
Stations	164	13%
Overhead	7,385	12%
Underground	2,222	3%
Overall	9,771	6%

Electrical asset failures on Hydro Ottawa's distribution system result in reliability risks, which further cause outages and impact customers. There are other key considerations such as environmental impacts (due to oil/SF_6 leaks) and safety risks due to arc flash conditions/fires. The timely replacement of such failed equipment is crucial to ensure that the system is not left in an abnormal state. Figure 76 shows the example of a vault transformer failure event.

Figure 76 - Vault Transformer Failure



[8] As of December 2023.

The Emergency renewal budget is also used to support the reactive emergency replacement of meters. Some of the issues resulting in the emergency replacement of meters (inclusive of smart meters, suite meters, interval and primary meters) include blown instrument transformer fuses, communication loss, functional defects etc. Being unable to replace failed meters can lead to inaccurate/delayed customer billing.

Hydro Ottawa experiences impacts and degradation to its distribution asset infrastructure due to various factors such as foreign interference, equipment failure and weather (e.g. major storms). Hydro Ottawa's service territory has been impacted by adverse weather events in recent years as described in Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. Hydro Ottawa faced increased spending under the Emergency Renewal budget program, due to the Derecho storm event. Attachment 2-1-1(A) - May 2022 Derecho - After Storm Report is the report published by Hydro Ottawa around the scale of damages and the asset replacements required, as a result of the 2022 Derecho event.

Hydro Ottawa's deteriorating OH asset population has also been negatively affected by extreme weather. Some assets, such as wood poles, haven't completely failed due to adverse weather, but certain components (e.g. pole top, OH switchgear, OH conductor etc.) are degrading faster than expected, which could result in power outages if not proactively managed, as outlined in Section 3.3.3 - Poles and OH Distribution Transformers. To this end, Hydro Ottawa has proposed additional investments to leverage drones to capture more accurate condition information on OH distribution assets as outlined in Section 3.1 of Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs, so they can be managed proactively.

6.3.4. Damage to Plant

Electrical distribution assets owned by Hydro Ottawa that are damaged due to third parties are replaced immediately after the area is made safe, under the Damage to Plant budget program. Historically, this has been due to motor vehicle accidents or construction equipment.

Figure 77 shows a damaged pole due to a vehicular accident (foreign interference).

Figure 77 - Pole Damaged Due to Motor Vehicle Accident

6.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the corrective renewal program are summarized in the section below.

6.4.1. System Operation Efficiency and Cost Effectiveness

Reactively attending to assets in need of Emergency Renewal eliminates the damaging effect of failed assets in the system. The distribution system is then able to operate properly when newer, better rated, or more suitable assets are installed in a way which increases the efficiency of the system. It is more cost effective to repair emergency assets immediately to avoid increasing the risk, danger, and cost due to leaving assets in a failed state.

6.4.2. Customer

Replacing failed equipment restores system back-up capability, or enables power restoration directly affecting customer reliability. When an asset is replaced, system enhancement is often considered which benefits both system reliability and reduces customer disruption.

6.4.3. Safety

Acting upon failed assets ultimately facilitates safety with regards to the system, employees, and the public. Eliminating safety risks associated with failed assets also improves reliability metrics and Key Performance Indicators (KPIs).

6.4.4. Economic Development

Maintaining a reliable and stable power supply encourages industries to begin, creates more job opportunities, and more taxes to the Government overall.

6.4.5. Environment

The environment is benefitted by replacing failed assets which could otherwise cause an environmental impact (due to oil/SF_6 gas leaks).

6.5. PROGRAM COSTS

Table 29 shows the detailed historical and future spending by the underlying budget programs, as a part of Corrective Renewal. The budget allocated for Corrective Renewal projects in the 2026-2030 period is based on historical expenditures, normalized for the impact of the 2022 Derecho storm. As such, the forecasted expenditures for the 2026-2030 period are lower than the expenditures in the current 2021-2025 period.

Table 29 - Corrective Renewal Historical, Bridge and Future Spending Overview ($000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Critical Renewal	$ 4.1	$ 3.5	$ 3.2	$ 4.6	$ 4.7	$ 4.0	$ 4.1	$ 4.3	$ 4.5	$ 4.6
Emergency Renewal	$ 8.6	$ 21.9	$ 8.5	$ 9.2	$ 9.3	$ 7.5	$ 7.6	$ 8.0	$ 8.2	$ 8.4
Damage to Plant	$ 0.6	$ 1.1	$ 1.0	$ 1.1	$ 1.2	$ 1.0	$ 1.1	$ 1.1	$ 1.2	$ 1.2
ANNUAL TOTAL	**$ 13.3**	**$ 26.5**	**$ 12.7**	**$ 14.9**	**$ 15.2**	**$ 12.5**	**$ 12.8**	**$ 13.4**	**$ 13.9**	**$ 14.2**
5-YEAR TOTAL					**$ 82.6**					**$ 66.9**

6.5.1. Critical Renewal

The Critical Renewal program's spending will slightly increase from $20.1M in 2021-2025 to $21.5M in 2026-2030, to mainly account for inflation. Hydro Ottawa's asset renewal strategy is not to replace all aged or deteriorated assets. Rather, it aims to mitigate and manage asset failure risks by strategically replacing deteriorating infrastructure. To this end, Hydro Ottawa has largely maintained the critical renewal spending observed through 2021-2025. Hydro Ottawa aims to ensure asset performance through increased spending in planned renewal programs (while considering rate impact to customers) and more focused spending in OM&A. .

6.5.2. Emergency Renewal

The Emergency Renewal program's spending will decrease from $57.5M in 2021-2025 to $39.7M in 2026-2030. Unforeseen impacts like high material cost increases and material delays due to COVID-19 and major storms affected the 2021-2025 actuals, which have not been considered in the 2026-2030 budget. However, there is still a high failure risk associated with the deteriorating asset infrastructure combined with specific issues around certain asset types such as leaking UG transformers, UG switchgear, station equipment etc.

6.5.3. Damage to Plant

The Damage to Plant program's spending will slightly increase from $5M in 2021-2025 to $ 5.6M in 2026-2030. Hydro Ottawa must maintain the proposed spending in this program to address damage to its asset infrastructure caused by third parties.

6.5.4. Cost Factors

Additional cost factors that need to be considered are potential physical barriers that cause access issues, or unforeseen circumstances such as aged equipment failing while the work is being done. Cost may also be altered if the area of work overlaps with a separate planned capital project. The occurrence of high impact low frequency events such as the 2022 Derecho storm will impose a huge burden and impact on Hydro Ottawa's electrical infrastructure.

6.6. ALTERNATIVES EVALUATION

6.6.1. Alternatives Considered

There are two alternatives considered for this program:

Alternative 1: Do Nothing

"Do nothing" is not feasible because the asset has already failed and the operation of the distribution system is dependent on the functionality of the asset. As a result this option reflects no allocated budget for Emergency or Critical Renewal projects. At the point of asset failure, immediate work would still need to be done to repair, refurbish, or replace the failed asset. This would impact the overall spending and timing of Hydro Ottawa's planned capital projects. Option 1 results in several consequences: resources may be limited due to unplanned replacements, capital projects would need to be deferred in order to accommodate unexpected spending on assets in need of Emergency or Critical Renewal. This ongoing deferral of planned work would be ineffective and in-efficient.

Alternative 2: Allocate Budget Based on Historical Spending and Planned Renewal Program Needs ($ 66.9M - Preferred Alternative)

This option allocates the budget where future yearly spending has been determined from historical average spending, for the major part, except for poles and UG transformers. The critical renewal budget considers the replacement of 75 poles each year and 10 UG transformers, while the emergency renewal budget accounts for the replacement of 25 poles and 40 UG transformers. This approach allocates resources to address deteriorated/failed assets without deferring planned work, supporting overall more efficient program delivery. The Emergency Renewal budgeting doesn't account for once in 50 years storms such as the 2022 Derecho event.

6.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. The preferred alternative must mitigate any risks to Hydro Ottawa's employees and public safety.

Reliability

The increased potential of failure or actual failure of distribution assets will impact Hydro Ottawa's ability to deliver reliable power. The selected alternative shall help manage asset performance by mitigating the risk of failure of assets in a critical condition and promptly responding to unanticipated failures.

Financial

The selected alternative should manage short-term financial needs, manage long-term asset performance, and prevent significant service disruptions to customers due to deteriorating or failed distribution equipment.

Resources

Resources are reserved in order to act reactively towards failed assets in need of emergency replacement. The future reliability of the system, safety of employees and the public, the environment, and the utility's economics are considered when using internal or external resources. The alternative which is a prudent use of resources will be selected.

6.6.3. Preferred Alternative

Alternative 2, the preferred alternative, allocates the Corrective Renewal budget based on historical spending, with the exception of poles and UG transformers. This strategy ensures that all critical deteriorated or failed distribution assets are covered by either the Emergency or Critical budget. As a result, this alternative effectively addresses failed assets that have caused outages or other risks that could harm the system if not promptly replaced. By having a budget allocated for unplanned failures, Hydro Ottawa will be able to maintain asset performance. With resources available through this reserved budget, Hydro Ottawa can react quickly to address failed assets, ensuring system reliability and the safety of both employees and the public.

6.7. PROGRAM EXECUTION AND RISK MITIGATIONS

6.7.1. Implementation Plan

The first step of implementation is determining whether the asset belongs in the Corrective Renewal Program. If the asset has functionally failed and falls into one of the categories, then the project is classified as either in the Emergency Renewal Program or the Critical Renewal Program. If the project falls into the Emergency Asset Replacement category, action must be taken as soon as possible. At this stage, a decision is made towards repairing, refurbishing, or replacing the failed asset. Factors such as the age, maintenance history, new standards, and immediate availability of spare parts are used to make the decision. The method of replacement is evaluated for opportunities to increase system efficiency. This may involve replacing assets in proximity in conjunction, coordinating this project with another project covering the same assets, accommodating future growth and demand, and possibly decommissioning the asset.

6.7.2. Risks to Completion and Mitigation Strategies

Hydro Ottawa faces several risks in managing its corrective renewal program, Table 30 outlines the key risks and corresponding mitigation strategies:

Table 30 - Key Risks of the Corrective Renewal Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires	Create and where required implement contingency plans to account for weather-related delays and environmental factors.

Category	Risk	Mitigation
	reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labor which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

SYSTEM SERVICE INVESTMENTS

1. SUMMARY

Hydro Ottawa's planned System Service net capital investments for 2026-2030 total $469.1M, focusing on six key programs designed to increase capacity of the distribution system to meet forecasted demand, improve system reliability and resilience, and increase grid modernization in the distribution system.

System Service Capital Programs:

Section 2. Capacity Upgrades ($342.6M - CAPEX, $13.3M - OM&A, $10.0M - Costs included in Other Income and Deductions):

The capacity upgrades program addresses system capacity needs through station capacity, distribution capacity and non-wire capacity upgrades. Station capacity upgrades, designed to meet forecasted demand, focus on expanding existing Hydro Ottawa substations or building new ones. To fully utilize the increased capacity provided by the station projects, the distribution capacity upgrades program will enhance the electrical distribution network through feeder expansion and upgrades. The Non-Wires Capacity Upgrade program is a new initiative which aims to improve grid capacity and reliability by implementing alternatives to traditional infrastructure upgrades, such as utility owned battery energy storage solutions and Non-Wires Customer Solutions.

Section 3. Distribution Enhancements ($92.8M):

The Distribution Enhancement program modernizes the grid and addresses climate change risks through four key programs: Reliability, Enhancements, Resilience and Observability. The Reliability program improves efficiency and reliability through feeder reconfiguration and phase balancing. The Enhancements program supports DER integration through infrastructure upgrades and pilot projects, leveraging federal funding for innovation. The Resilience program strengthens weather resilience with strategic undergrounding, storm hardening, and line relocation, aligning with the OEB's VASH initiative. The Observability program enhances grid management through real-time data, remote switching, and advanced technologies like the Advanced Distribution Management System (ADMS), improving reliability and flexibility.

Section 4. Station Enhancements ($3.0M):

This program will improve distribution system observability and operability through cyber security investments and station modifications, including enhanced monitoring. Specifically, online transformer monitoring will proactively identify faults, improving asset observability and reliability by reducing unexpected failures. Addressing vulnerabilities, the program will also deploy OT Cyber Security sensors at all IP connected substations to bolster cyber security at vulnerable substations, improving threat detection and response to prevent disruptions and maintain reliable power delivery.

Section 5. Grid Technologies ($6.4M):

This program modernizes grid management by enhancing observability and controllability through data acquisition, monitoring, and control capabilities. Focusing on ADMS, it enhances grid troubleshooting and asset monitoring, supporting data-driven decisions for preventative and predictive maintenance, and integrating with other systems. Driven by system efficiency, it addresses integration complexities, optimizes data handling, enhances reliability and security, and improves performance through a unified platform, seamless data exchange, and simplified maintenance. This upgrade reduces single points of failure, strengthens cyber security, and enables advanced analytics for better grid management.

Section 6. Field Area Network ($20.8M):

The Field Area Network (FAN) program is essential for Hydro Ottawa's digital and grid modernization, providing the communication backbone for grid devices and central systems.

Four key initiatives—OTN Fiber Network Resilience, Wireless Communication (PLTE pilot), Intelligent Electronic Device Management, and OTN Cyber Security—enhance reliability, security, and efficiency. Driven by system efficiency, the FAN enables real-time data access for grid modernization and DER integration, strengthens cyber security, and improves outage response by providing grid visibility and control.

Section 7. Control and Optimization (\$3.6M):

This program focuses on Distributed Energy Resources Management Systems (DERMS) implementation to manage the growing complexity of DERs, improving grid stability, reliability, efficiency, and resilience. This program aims to improve operational effectiveness by increasing DER visibility and control, accommodating higher DER penetration, and improving grid efficiency. It also supports customer focus by facilitating DER adoption and improving grid flexibility, and public policy responsiveness by enabling electrification. These upgrades and enhancements support grid flexibility, enabling more efficient use of existing grid capacity.

These investments are designed to address critical challenges, including evolving capacity requirements, the integration of advanced grid technologies and distributed energy resources, and the enhancement of grid resilience against the increasing frequency and severity of weather-related disruptions. Hydro Ottawa is committed to providing safe, reliable, and sustainable electricity service to the residents and businesses of Ottawa, and these investments are crucial to fulfilling that commitment.

These investments will deliver tangible benefits to Hydro Ottawa's customers:

- **Support for Growing Demand:** Increased grid capacity to accommodate the growing electricity needs of residential and commercial customers.
- **Facilitation of Renewable Energy Integration:** Enhanced grid infrastructure to support the integration of distributed energy resources, enabling customers to participate in a cleaner energy future.
- **Enhanced Grid Observability and Control:** Advanced technologies and monitoring systems will allow for more proactive management of the grid, leading to faster response times during outages and improved overall system performance.
- **Increased Resilience to Climate Change:** Investments in grid hardening and resilience measures will better protect customers from the impacts of extreme weather events.
- **More Efficient and Secure Grid:** Upgraded technologies and cyber security measures will ensure a more efficient and secure electricity supply.

Hydro Ottawa recognizes the complex undertaking involved in executing these System Service investments, encompassing the modernization of deteriorating infrastructure to bolster reliability, the fortification of the network against increasing climate volatility, and the strategic deployment of advanced technologies to optimize grid performance. This document details how these investments will address these challenges to deliver safe, reliable, and sustainable electricity service to the Ottawa community.

2. CAPACITY UPGRADE

2.1. PROGRAM SUMMARY

Investment Category: System Service

Program Costs:

2021-2025: $108.2M

2026-2030: $342.6 Net Capex, $13.3M (OM&A) $10.0M (Costs included in Other Income and Deductions)

Budget Program: Station Capacity Upgrades, Distribution Capacity Upgrades, Non-Wire Upgrades

Main Driver: Capacity Constraint

Secondary Driver: Reliability

Outcomes: Customer Focus, Operation Effectiveness, Public Policy Responsiveness

The Capacity Upgrade program allocates spending to address the need for increased capacity resulting from growth and electrification to keep pace with the electricity demand in the growing community. The program encompasses projects that utilize existing capacity through infrastructure enhancements and system reconfiguration, as well as the addition of new stations. Additionally, Non-Wire Upgrades are utilized for peak load management in capacity-constrained areas, thereby supporting grid reliability and the integration of renewable energy resources. System capacity needs and required upgrades are determined through the System Capacity Assessment as outlined in Section 9 of Schedule 2-5-4 - Asset Management Process and Integrated Regional Resource Planning, as detailed in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

The Capacity Upgrade Program addresses capacity needs of the system under the following budget programs over the 2026-2030 period:

Station Capacity Upgrade

This program focuses on increasing capacity at existing Hydro Ottawa stations or building new stations to address immediate needs in areas with committed load requirements and capacity constraints. These investments are also strategically aligned with long-term needs for system accessibility and reliable power supply to ensure efficient capital deployment. They include planned enhancements to adapt the grid for increased demand driven by electrification. For more details refer to Section 9 of Schedule 2-5-4 - Asset Management Process.

As a result of the committed loads and existing capacity constraints, Hydro Ottawa plans to energize four new stations and upgrade three existing stations. This involves upgrading transformers, switchgear, and other substation equipment. The new and upgraded stations proposed in the 2026-2030 period are:

- **Riverdale TS:** continued from previous rate period with energization in 2027
- **Piperville MTS:** continued from previous rate period with energization in 2026
- **Mer Bleue MTS:** continued from previous rate period with energization in 2028
- **Kanata North MTS:** new station to support the West 28 kV (North) System with energization in 2028
- **Greenbank MTS:** new station to support the South 28 kV and Nepean and Barrhaven 8 kV Systems with energization in 2028
- **Cyrville MTS upgrade:** station upgrade to support the East 28 kV System with energization in 2028
- **Bronson DS upgrade:** voltage conversion from 4 kV to 13 kV to support the Core and West 13 kV Systems with energization planned beyond this rate period

In addition to upgrades to Hydro Ottawa stations and assets, upgrades to Hydro One Networks Inc. (Hydro One) equipment in stations jointly owned by Hydro One and Hydro Ottawa will help increase capacity in the distribution system primarily in Downtown Ottawa and suburban regions where growth is driven by intensification, transit development and large infrastructure projects such as the new Ottawa Hospital campus. Investments in jointly owned stations in the 2026-2030 period will be proposed under the Connection Cost Recovery Agreement program as per Section 7 of Schedule 2-5-9 - General Plant Investments, these investments are:

- Secondary cable upgrades at Carling TS, Lisgar TS and King Edward TS
- Transformer upgrades at Russell TS, Albion TS and South March TS

Distribution Capacity Upgrade

Distribution capacity upgrades are required to enhance the capacity of the electrical distribution system. This includes upgrading or installing new power lines, distribution transformers, and other distribution equipment. Distribution capacity upgrades are proposed to leverage the capacity from new and existing stations through feeder integration, reduce demand on existing feeders to below planning ratings; enable forecasted growth with reduced system expansion requirements for customers; and defer more expensive alternatives, such as new station builds.

The major investments proposed under this program includes:

- Feeder integration for all the new station builds to leverage capacity- Piperville MTS, Mer Bleue MTS, Kanata North MTS, Greenbank MTS and Cyrville MTS upgrade.
- The feeder integration will also support reduction of load on some of the highly loaded stations such as Kanata MTS, Marchwood MTS and Lietrim DS
- Introduction of 28kV in the capacity constrained Nepean 8kV system
- Enable 4kV conversions to 13kV in a phased manner for energization of the Bronson 13kV station in 2032

Non-Wires Capacity Upgrade

This program involves implementing alternative solutions to traditional infrastructure upgrades to increase capacity and improve grid reliability. These solutions include utility-owned battery energy storage systems (BESS) and Non-Wires Customer Solutions, as discussed in more detail in Section 9.2 of Schedule 2-5-4 - Asset Management Process.

- **Utility-Owned Battery Energy Storage Solutions (BESS)**
  - 2.5MW BESS in the West 28 kV system
  - 7MW BESS in the Bells Corners/Bayshore 8 kV system
  - 5MW BESS at Casselman DS
  - 10MW BESS in the Core 13 kV/West 13kV system

- **Non-Wires Customer Solutions:** Hydro Ottawa will offer a portfolio of energy efficiency, generation, and demand response programs that can also leverage customer DERs, to be deployed as its Non-Wires Customer Solutions Program to help address system needs in both the short and long term. These programs will be launched and operated in:
  - Kanata North region
  - West and Core 13kV region

In total, Hydro Ottawa plans to invest an estimated $342.6M in capacity upgrades in the 2026-2030 rate period compared to a historical spending of $108.2M in the 2021-2025 period. Hydro Ottawa expects to add over 577MVA[1] in station capacity to Hydro Ottawa's distribution system as a result of these projects, as compared to 160MVA over the previous period. This would allow Hydro Ottawa to manage capacity constraints and meet immediate needs of large load customers to maintain its service obligations as well as provide reliable power supply.

[1] Piperville MTS—120MVA, Mer Bleue MTS—120MVA, Kanata North MTS—120MVA, Greenbank MTS—120MVA, Cyrville MTS—70MVA, Beckwith BESS—2.8MVA, Casselman BESS—5.6MVA, Bells Corners/Bayshore BESS—7.8MVA, Core 13 kV BESS—11MVA

2.2. PERFORMANCE OUTCOMES

Table 1 outlines the expected performance outcomes associated with the system capacity upgrade programs. It details how these programs are expected to impact operational effectiveness, customer focus, and public policy responsiveness.

Table 1 - Performance Outcomes for Capacity Upgrade Program

OEB Performance Outcomes	Outcome Description
Customer Focus	Hydro Ottawa's Customer Focus objectives are supported by: ● Increasing system capacity by 577MVA through new station construction and upgrades and associated new distribution circuits, upgrades to limiting station cables, and BESS unit installations. ● Improving DER Hosting Capacity by installing substation transformers that have been designed to accommodate injection of renewable energy into the grid. ● Increasing system flexibility by investing in NWSs such as BESS and Non-Wires Customer Solutions.
Operational Effectiveness	Hydro Ottawa's Reliability objectives are supported by: ● Contributing to the improvement of reliability metrics by increasing capacity, especially in capacity-constrained regions that provide alternate supply options during N-1 contingencies and improve station load index.
Public Policy Responsiveness	Hydro Ottawa's Public Policy Responsiveness objectives by: ● Supporting government initiatives for sustainable energy solutions. ● Enabling electrification by investing in additional capacity and operational flexibility. ● Supporting the economic development of the community.

2.3. PROGRAM DRIVERS AND NEED

2.3.1. Main and Secondary Drivers

Primary Driver: Capacity constraints;

This program is structured to address Hydro Ottawa's most capacity-constrained areas. The program targets constraints at both the feeder and station level by:

1. Building new stations to add capacity and upgrading capacity at existing stations;

2. Extending existing or new feeders to:
    a. transfer load between stations, alleviating both feeder and station limitations,
    b. add new capacity into an area with committed growth, or
    c. add back-up capacity to allow additional growth on existing feeders;
3. Implementing NWSs to support peak load management through both utility-owned technologies and customer-owned resources.

Secondary Driver: Reliability;

Lack of sufficient capacity has a direct impact on system reliability. Maintaining feeders and stations at or below planning ratings reduces system constraints and provides additional options to System Operators when isolating outages and restoring load. Furthermore, lack of capacity in nominal conditions as well as contingency scenarios will have a negative impact on reliability.

2.3.2. Current Issues

2.3.2.1 Station Capacity Needs

For identifying station capacity needs Hydro Ottawa prioritized investments in areas with existing capacity constraints and immediate, confirmed, and committed load requirements. Given the four- to six-year lead time required for station upgrades and even longer lead times for transmission upgrades, focus on the medium to long-term outlook beyond 2030 (informed through the IRRP forecast) was used to validate that capacity investments for immediate needs (informed through Hydro Ottawa's planning forecast) strategically align with indications of long-term needs, ensuring efficient capital deployment and optimizing asset utilization. Hydro Ottawa will continuously monitor the impact of electrification to minimize disruptions and ensure the ability to connect new customers.

The need and justification for each of Hydro Ottawa's station capacity upgrade investments are detailed below. It is important to note that all capacity upgrade investments align with the preliminary recommendations identified by the IRRP working group as part of the regional planning process, please refer to Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

Piperville MTS

To accommodate the growing load forecast in the South-East region, shown in Figure 1 below, the new Piperville MTS is under construction, with planned energization in 2026. This project, approved as part of the 2021-2025 Rate Application, will be a 230 kV-connected station with two 100 MVA transformers and capacity for eight new feeders.

Figure 1 - South-East 28 kV Region with Under-Construction Piperville MTS

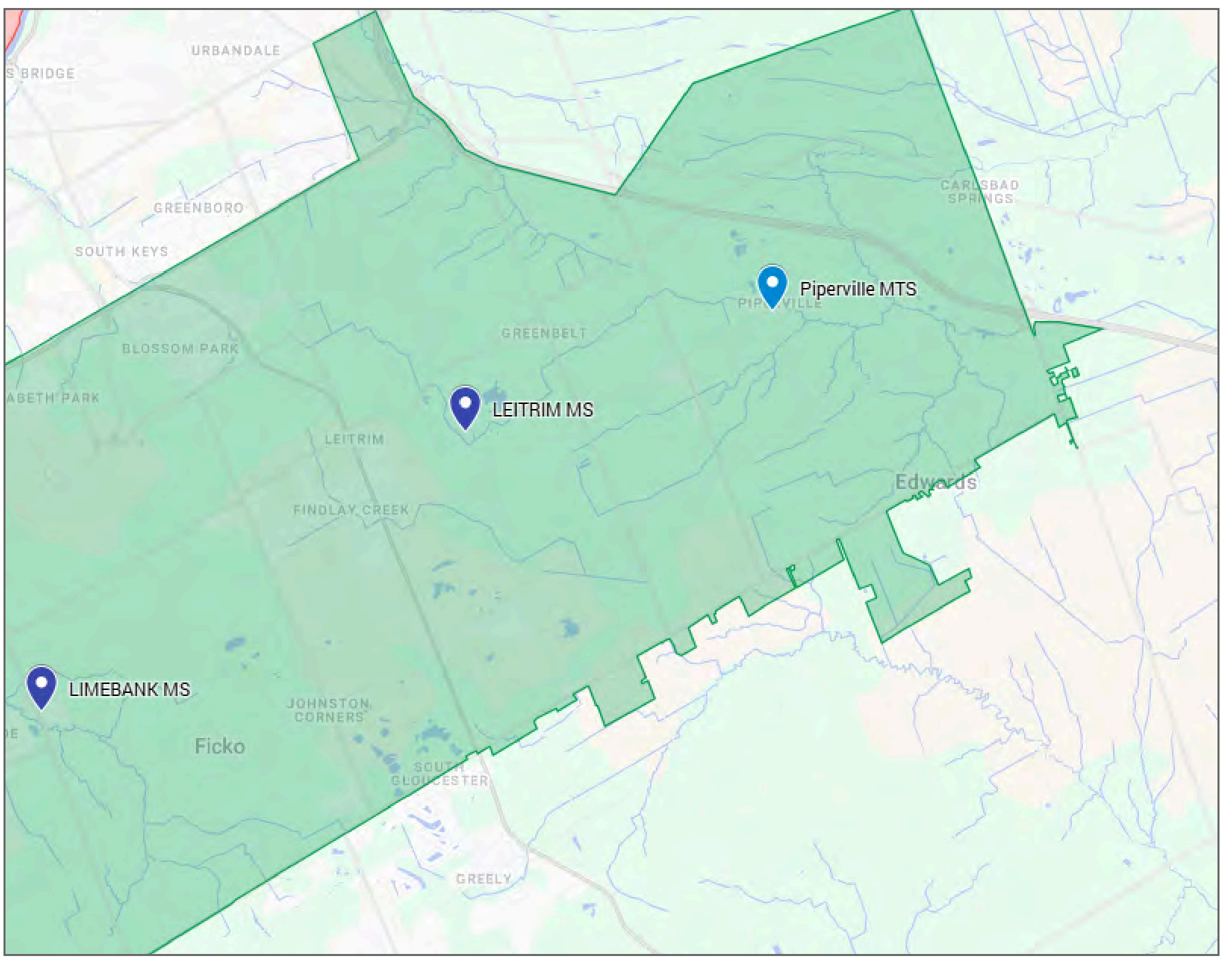
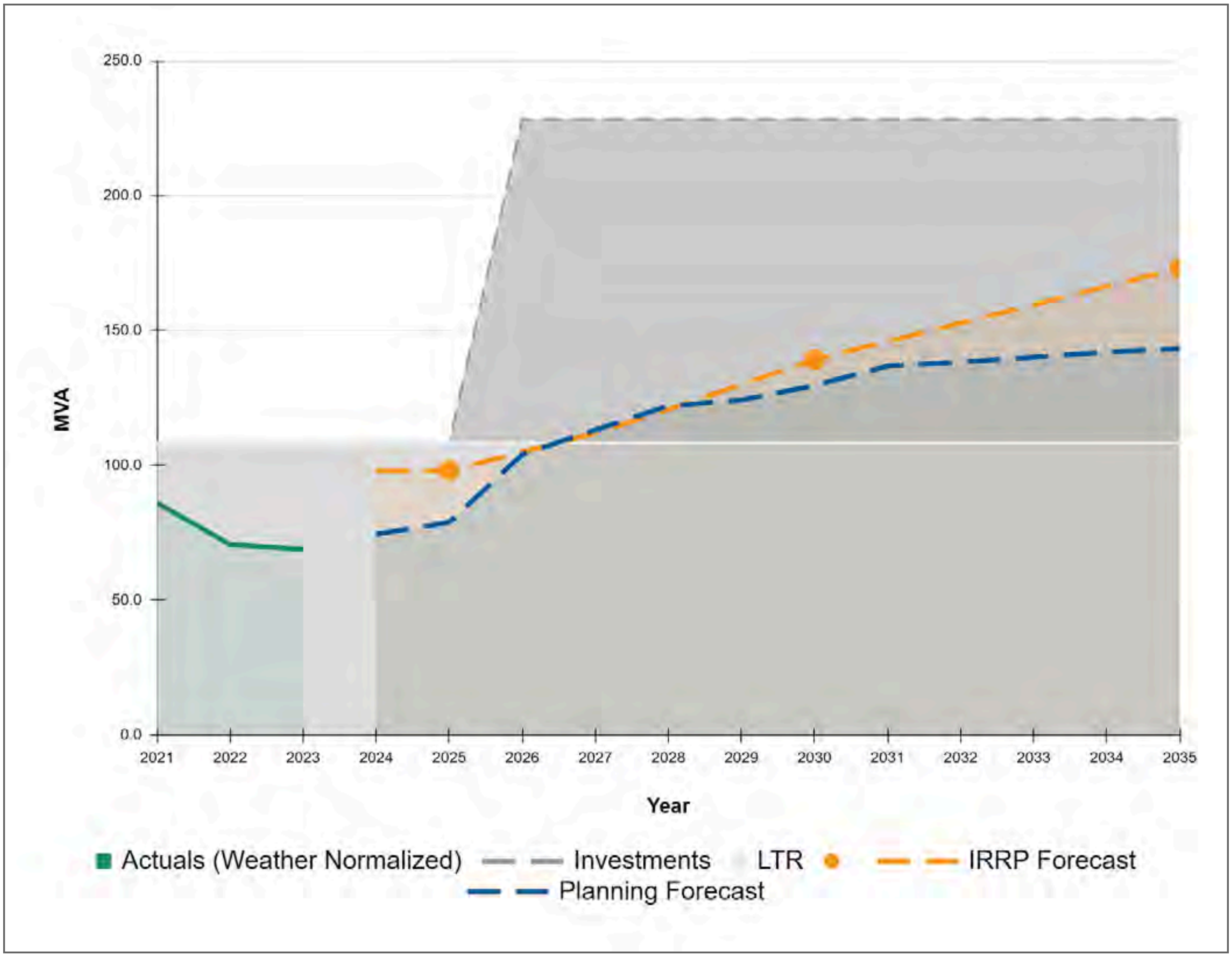


Figure 2 presents the load forecast against planned capacity, factoring the energization of Piperville MTS in 2026, which will increase the region's LTR to 230 MVA. The figure compares the IRRP Forecast and Planning Forecast of the region supported by Limebank MTS, Leitrim DS and Piperville MTS.

Figure 2 - South-East 28 kV Forecast



The issues that this new station helps address are elaborated below.

- Piperville MTS will alleviate capacity constraints by supporting Leitrim DS which is already operating above its planning capacity. It will also facilitate residential and commercial growth in this region.
- In addition to capacity needs, reliability in the Leitrim supply area is also of concern. The distribution feeders extending towards the eastern boundary of Hydro Ottawa's service territory cover a large area which was previously mostly rural with minimal load on these feeders. In recent years, this area has seen an uptake of new commercial and industrial customers driving further expansion of suburban development in former rural areas. The addition of these new loads decrease the tie transfer capacity of the system during contingency scenarios. Piperville MTS will support during contingency scenarios through inter-station ties.
- In addition, Leitrim DS is fed from a single 44 kV supply and must rely on adjacent stations to resupply in case of a loss of station supply. However, loads east of Leitrim DS cannot be fully restored with ties from Limebank MTS due to the distance between the loads and the station breakers. The lack of an alternate source, more local to the load pocket, leads to longer lasting outages. The new Piperville MTS will help mitigate these reliability issues.
- Piperville MTS, served by a 230kV transmission supply with redundant backup, exhibits superior reliability compared to Leitrim DS, which relies on a single 44 kV sub-transmission feed. This redundancy contributes to improved transmission-level reliability across the region.

As per the forecasted demand shown in Figure 2, construction of Piperville MTS will ease capacity constraints and improve reliability of the south east region of Ottawa.

Mer Bleue MTS

The proposed station is a 230 kV-connected 28 kV station with 100 MVA capacity and will supply up to eight new feeders in the East 28 kV region. The proposed location of the new station is shown in Figure 3. With the decommissioning of Bilberry TS, this new station will introduce a Hydro Ottawa owned 28 kV station in the eastern boundary of the 28 kV system.

Figure 3 - East 28 kV Region with under-construction Mer Bleue MTS

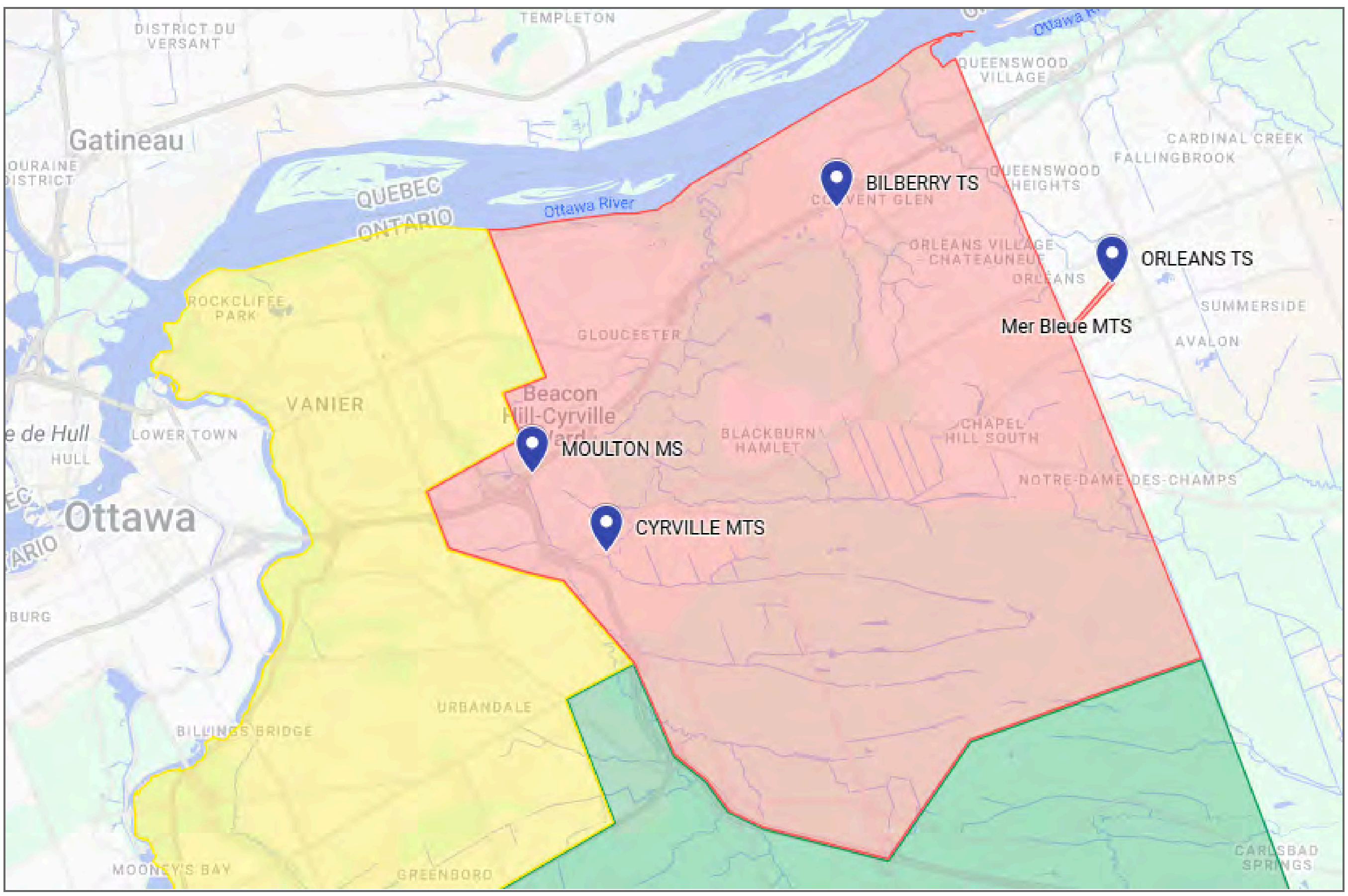
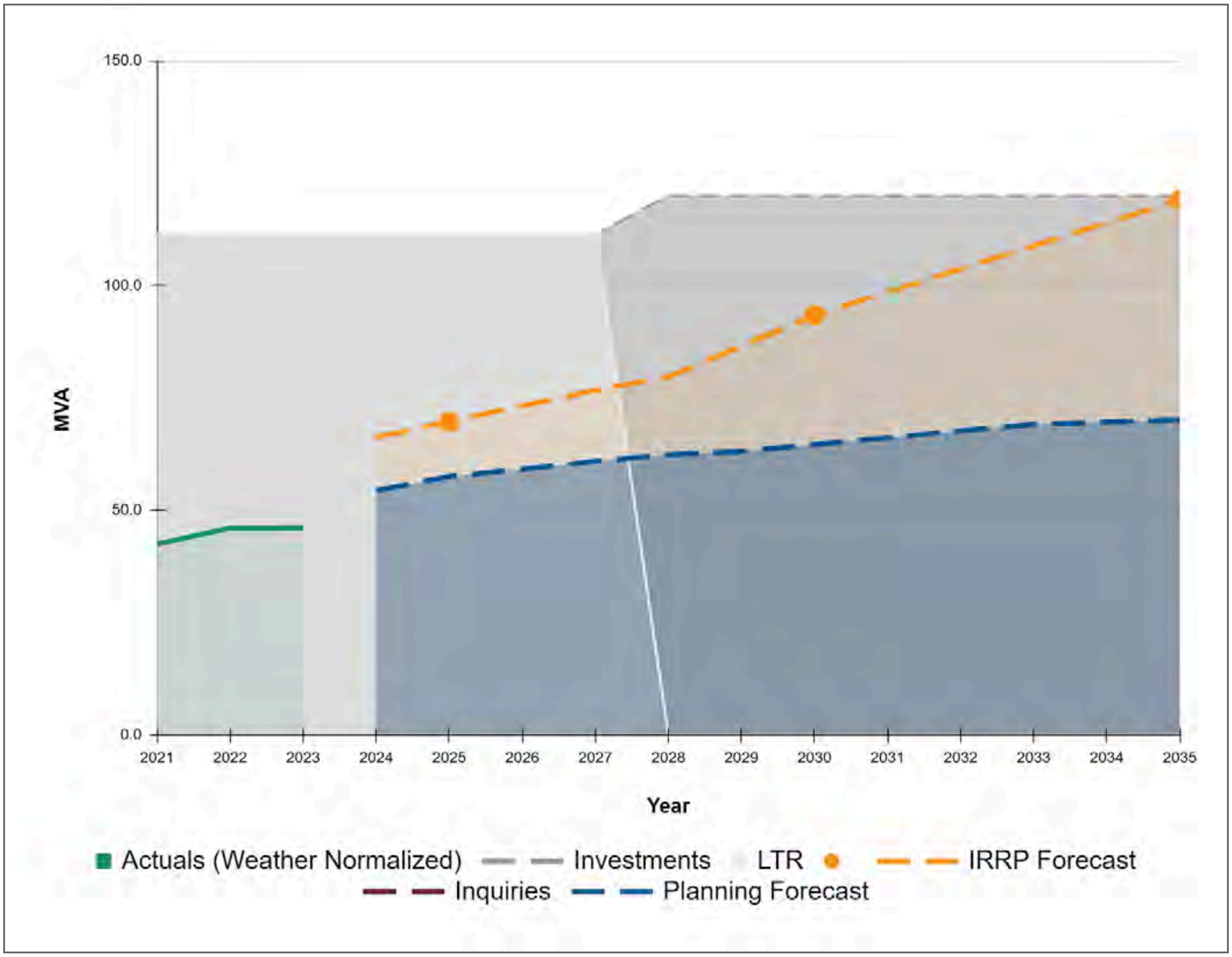


Figure 4 below presents the load forecast against planned capacity, factoring the energization of Mer Bleue MTS in 2028, which doesn't add additional capacity to the overall system (negligible addition due to Mer Bleue LTRs), due to the decommissioning of Bilberry TS, but transfers load from the constrained 115 kV to the 230 kV transmission system. The figure compares the IRRP Forecast, Planning Forecast for Bilberry TS, Orleans TS and Mer Bleue MTS.

Figure 4 - East 28 kV Forecast (Eastern region)



The issues to be resolved by this new station, namely the end of life Bilberry TS and 115 kV capacity constraints, are elaborated below.

- The previous cycle of the regional planning process led by IESO and the regional infrastructure plan report led by Hydro One in 2022 identified the need to refurbish the Bilberry TS which supplied by the 115 kV transmission system and approaching its end-of-life and to expand the station to accommodate two additional breaker positions to supply Hydro Ottawa customers.
    - This solution was based on the 2018/2019 forecast that did not include impacts due to the more recent large load requests such as the Ottawa Hospital's New Campus[2], OC Transpo's Zero Emission Buses[3], Department of National Defence Dwyer Hill Training Center Upgrade[4], new laboratory facilities for the Regulatory and Security Science Main Project[5], located at the existing Canadian Food Inspection Agency's Ottawa Laboratory, and the TerraCanada National Capital Area project located at the National Research Council of Canada facilities[6].
    - The inclusion of these load requests on top of the updated forecast led to the determination that the regional 115 kV system is constrained. All stations in the Ottawa Downtown and some suburban stations are supplied by the 115 kV system. To ease the capacity constraints on the 115 kV system, and avoid expensive transmission upgrades to introduce 230 kV into Downtown Ottawa, it was imperative that some suburban stations be transferred to a 230 kV supply.
    - The 115 kV constraints led the IRRP working group to re-evaluate the proposed Bilberry TS refurbishment along with other alternatives to meet both the end-of-life needs at

[2] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/

[3] Ottawa-Carleton Transportation, "OC Explained: Zero Emission Bus Project," https://www.octranspo.com/en/news/article/oc-explained-zero-emission-bus-project/

[4] Department of Nation Defence, "Minister Anand announces $1.4 billion investment to upgrade Dwyer Hill Training Centre infrastructure," https://www.canada.ca/en/department-national-defence/news/2023/03/

[5] Government of Canada, "Government of Canada invests in laboratories to support science in Canada." https://www.canada.ca/en/public-services-procurement/news/2024/03/

[6] Government of Canada,"Government of Canada announces milestones for new science facilities in National Capital Area" https://www.canada.ca/en/public-services-procurement/news/2024/07/government-of-canada-announces-milestones-for-new-science-facilities-in-national-capital-area.html

Bilberry Creek TS as well as addressing broader supply capacity needs on the Ottawa 115 kV System.

Construction of the Mer Bleue MTS was found to be the most optimal solution. This would result in the decommissioning of the end of life 115 kV connected Bilberry TS and transfer the loads to the new 230 kV connected Mer Bleue MTS, thus aiding with offloading the constrained 115 kV system. More details in Section 4.2 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

New Kanata North MTS

The proposed station is a new 230 kV-connected 28 kV station with 100 MVA capacity and will supply up to eight new feeders to support the West 28 kV (North) system currently supplied by Kanata MTS and Marchwood MTS as shown in Figure 5.

Figure 5 - West 28 kV (North) Region with proposed Kanata North MTS

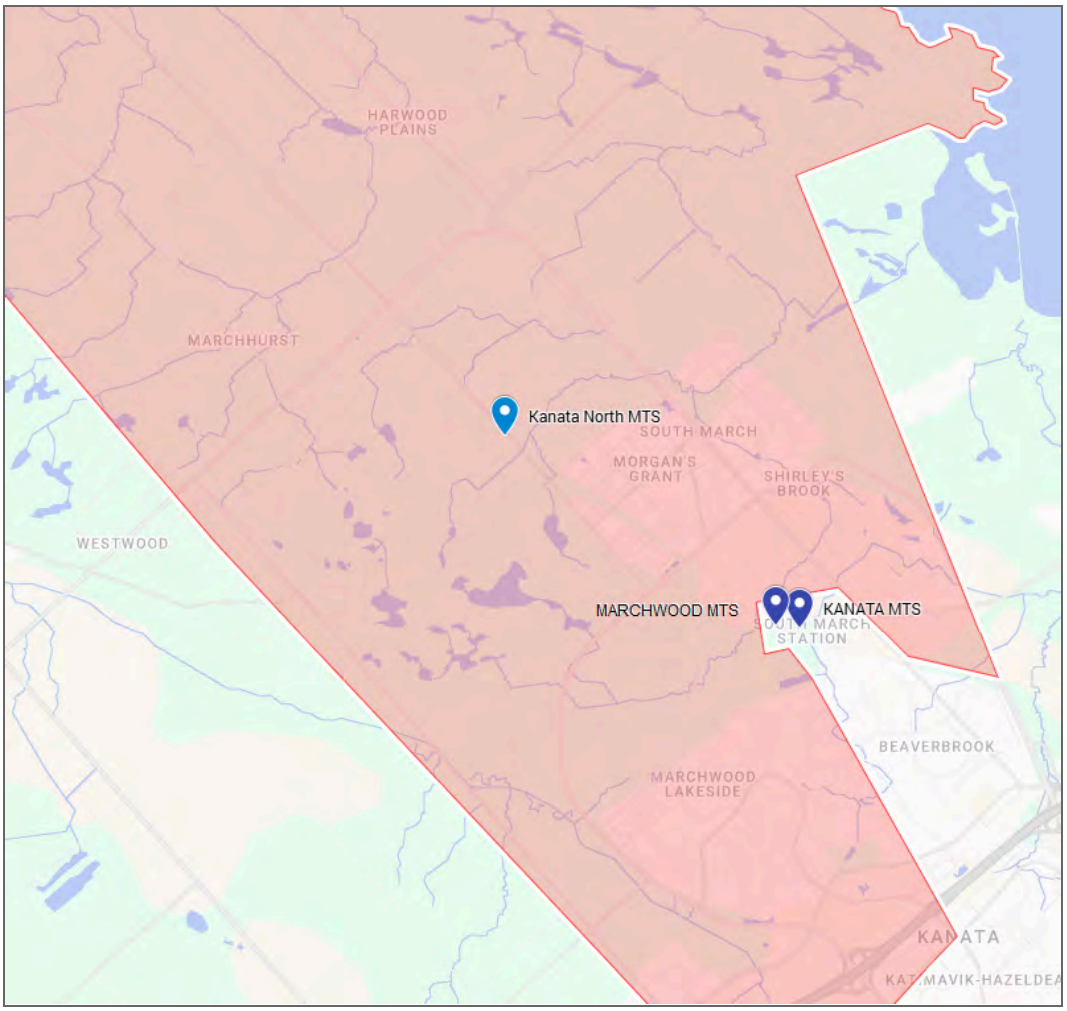


Figure 6 presents the load forecast against planned capacity (LTR), factoring the energization of Kanata North MTS in 2028, which will increase the region's capacity to 207 MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages in the West 28 kV (North) system.

Figure 6 - West 28 kV (North) Forecast with Kanata North MTS upgrade

The issues that this new station helps address are elaborated below.

- Rapid growth in Kanata North[7], particularly in the technology sector, has strained existing West 28 kV (North) stations, pushing them to their operational limits. Also, there has been a surge in large load requests in this region and data center connection inquiries.
- To facilitate the decommissioning of the end-of-life 12 kV stations and distribution infrastructure, this region will see added load due to voltage conversion from 12 kV to 28 kV.
- The new station will improve reliability by introducing new inter-station ties to balance load with Kanata MTS (currently operating at 95% of planning capacity) and Marchwood MTS (currently operating at 140% above planning capacity).

As per the forecasted demand shown in Figure 6, the need for a new station in this region is urgent and the proposed solution will ease capacity constraints and improve reliability of the West 28 kV (North) region.

Non-Wires Customer Solutions, as further detailed in Section 9.2 of Schedule 2-5-4 - Asset Management Process, are being evaluated to manage current peak capacity constraints while the new station is constructed and will continue to provide support to this region in the long term considering the IRRP forecast.

[7] Growth in Kanata North- https://ottawa.ca/en/city-hall/city-news/newsroom/kanata-north-shimmering-jewel-ottawas-business-crown

Greenbank MTS

The proposed station to be located in the Greenbank/Hunt Club area is a 230 kV-connected 28 kV station with 100 MVA capacity and will supply up to eight new feeders in support of introducing the 28 kV system in the Nepean and Barrhaven communities. Figure 7 shows the the location of the new Greenbank MTS, the Nepean 8 kV system (highlighted in green), the Barrhaven 8 kV system along with the 28 kV Fallowfield MTS and Longfield DS supply region (highlighted in yellow) and the 28 kV Cambrian supply area (highlighted in purple)

Figure 7 - South 28kV and Nepean 8kV Regions

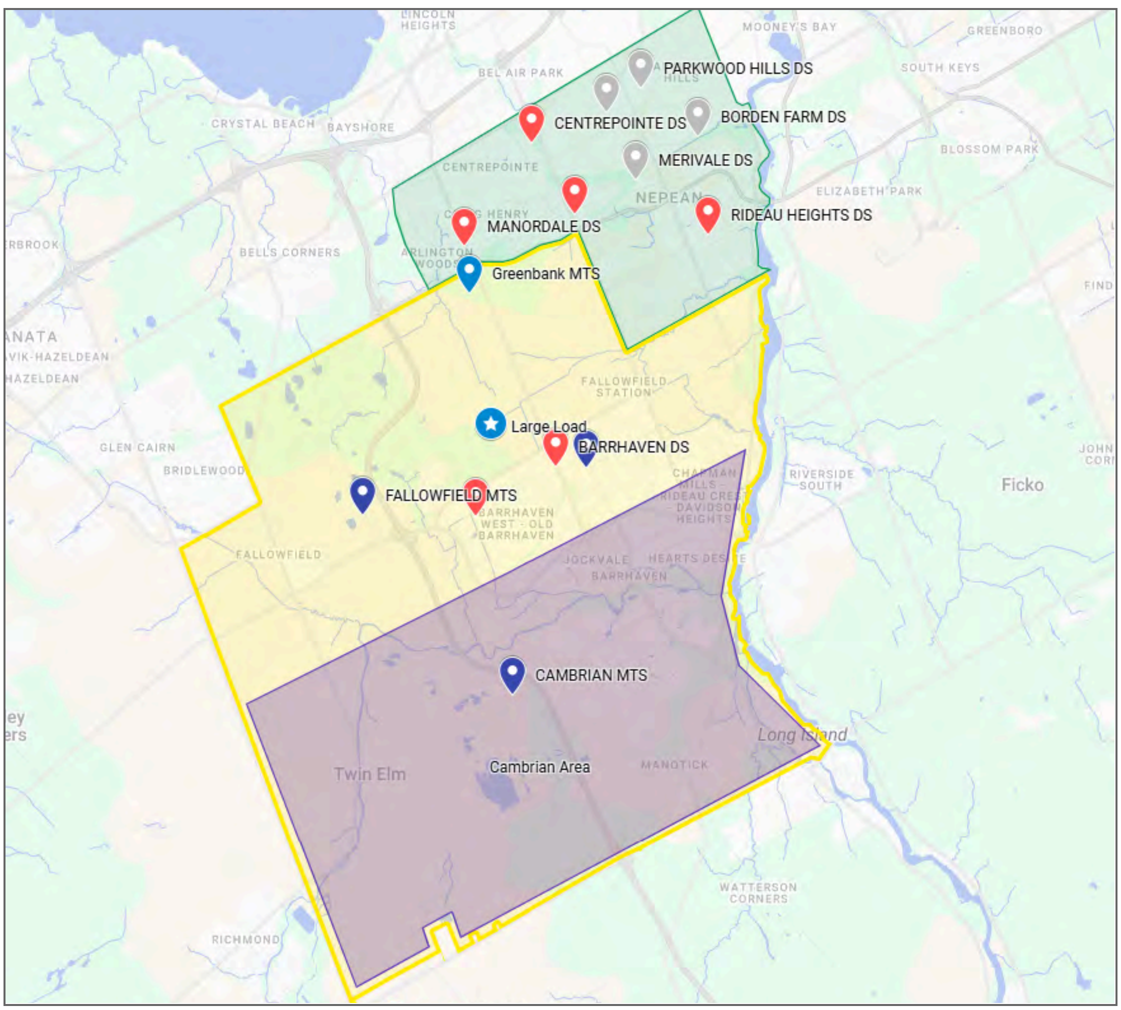
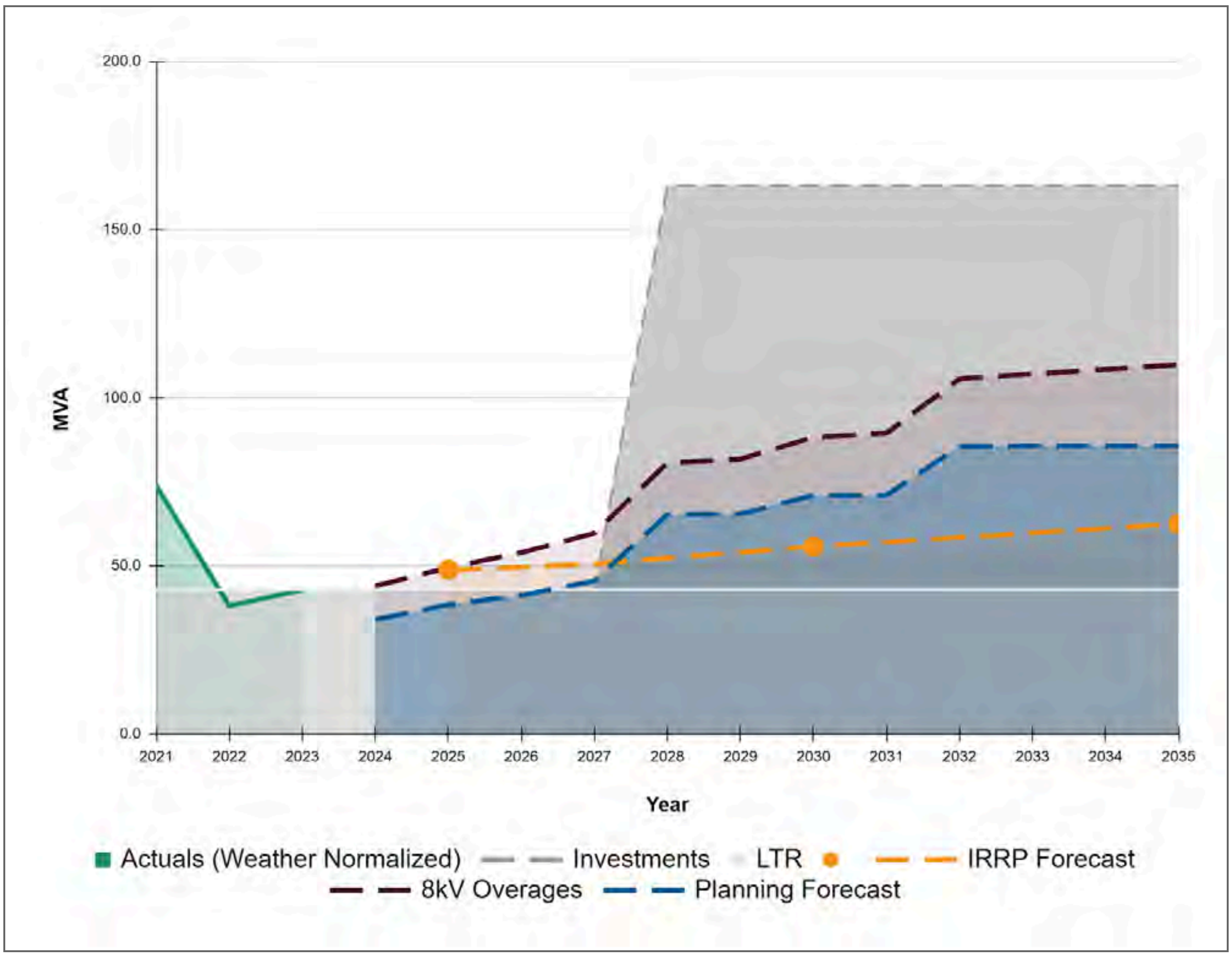


Figure 8 presents the load forecast against planned capacity, factoring the energization of Greenbank MTS in 2028, which will increase the region's LTR to 160MVA. The figure compares the IRRP Forecast, the 28 kV region Planning Forecast, and the new loads to be transferred from 8 kV overloaded stations, which represent the 28 kV Planning Forecast plus the additional capacity needed to address the overloaded 8 kV system.

Figure 8 - South 28 kV Forecast with Greenbank MTS upgrade



The current issues that the new Greenbank MTS will resolve are elaborated below:

8 kV System Limitations

- The Nepean and Barrhaven communities, as shown in Figure 7, are currently supplied by the Nepean and Barrhaven 8 kV systems. The 8 kV system presents several challenges:
  - Compared to 28 kV, 8 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 28 kV remains effective up to 15km.
  - The maximum capacity of an 8 kV feeder is 3.6MVA, versus 16.4MVA for a 28 kV feeder, significantly limiting the ability to accommodate the large load requests.
  - Heavy loading on the 8 kV stations in the Nepean and Barrhaven regions is hindering new customer connections. Seven out of the ten stations are operating above 85% of their planning capacity, with Manordale MTS and Centerpointe MTS exceeding their planning capacity.

28 kV System Limitations

- The region's 28 kV supply is strained, with Fallowfield MTS operating at 114% and Longfields DS operating at 80% of their planning capacity. This loading level limits the ability to connect new large load customers and offload the constrained 8 kV system.
- A committed large load[8], for the Regulatory and Security Science Main (RSS Main) Project's new laboratory facilities, cannot be serviced from Fallowfield MTS/Longfields DS (or the existing 8 kV system). While Cambrian MTS is the only other 28 kV station in the South 28 kV region, it cannot supply the new large load. In 2015, the IRRP identified Cambrian's necessity to address capacity deficiencies south of Strandherd Drive (highlighted in purple on Figure 7). Energized in 2022, Cambrian also enhances the reliability through feeder ties with Fallowfield MTS,

[8] Government of Canada, "Government of Canada invests in laboratories to support science in Canada." https://www.canada.ca/en/public-services-procurement/news/2024/03/

Longfields DS, and Limebank MTS. Connecting the new large load to Cambrian would create two problems:

- First, connecting the large load would require extensive feeder extensions due to the distance to site.
- Second, it would immediately necessitate the addition of a new station in South Nepean due to capacity limitations. Since this triggers the need for additional capacity, the proposed location of Greenbank MTS also provides the additional benefit of being locationally positioned to support the constrained 8 kV system and allowing Cambrian to supply further south.

Therefore, the optimal solution to address both the constrained Nepean and Barrhaven 8 kV systems and the new large load is the construction of Greenbank MTS. This station will alleviate capacity deficiencies and is strategically located to serve both the 8 kV system and the large load. As shown in Figure 7, including the 28 kV planning forecast and 8 kV overages, the addition of capacity enabled by Greenbank MTS is required to support the growth in the regions.

Cyrville MTS Upgrade

The proposed solution will upgrade the two existing Cyrville MTS transformers from 50MVA to 100MVA capacity. Figure 9 shows the East 28 kV system along with a committed large load request in this region.

Figure 9 - East 28kV Regions

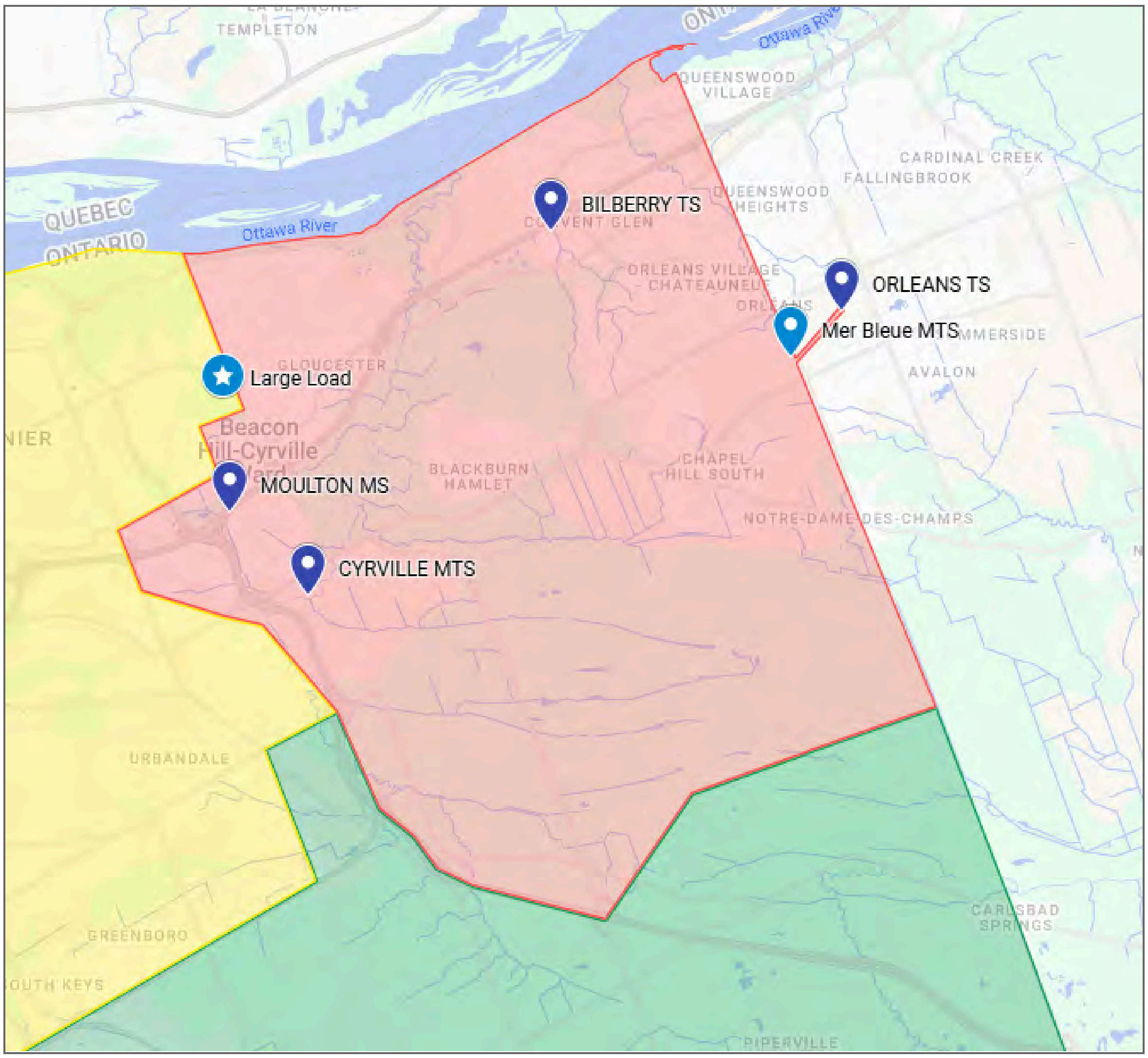
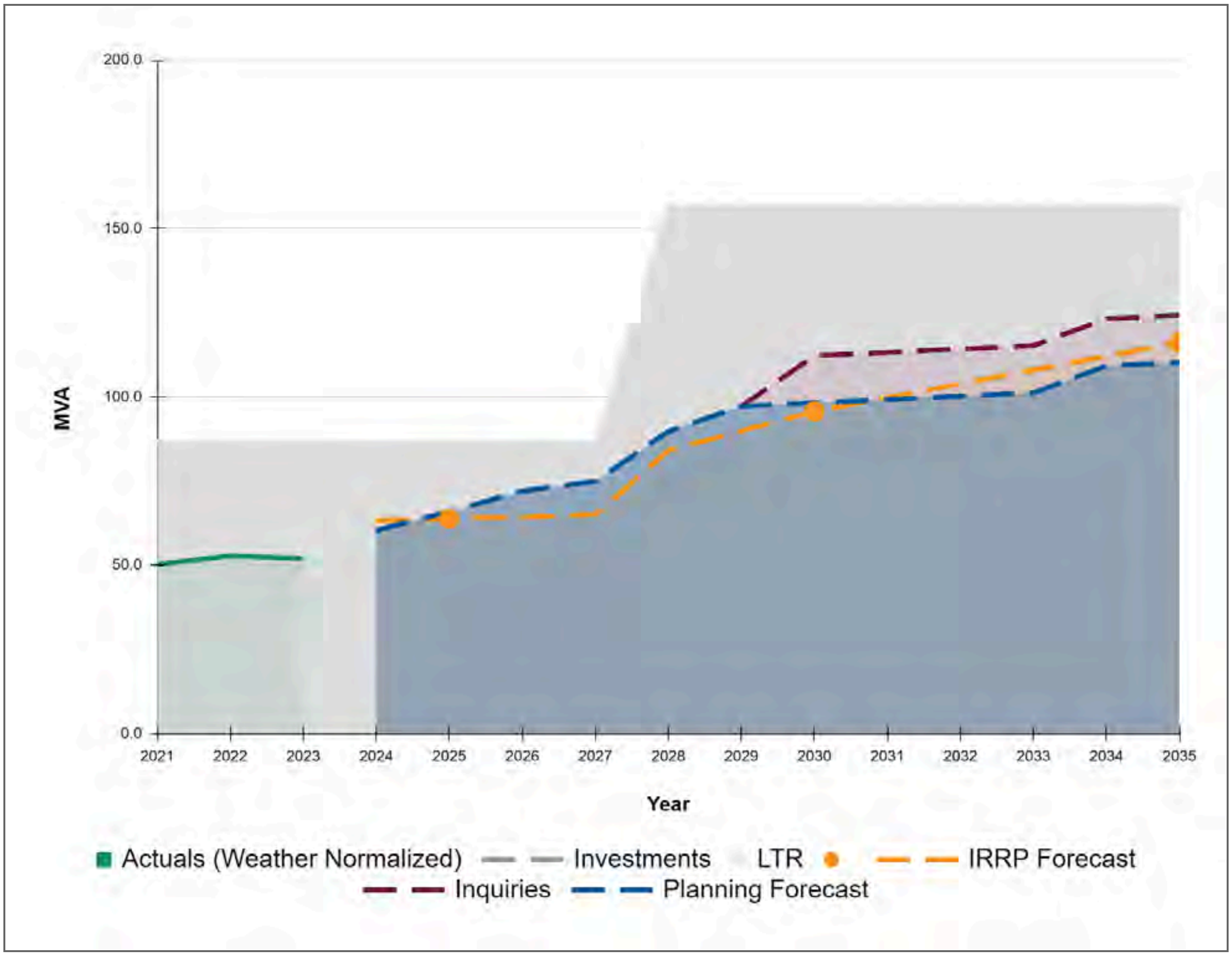


Figure 10 presents the load forecast against planned capacity, factoring the Cyrville MTS upgrade in 2028, which will increase the LTR in the region to 150 MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages for Cyrville MTS and Moulton MS.

Figure 10 - East 28 kV (Western region) Forecast with Cyrville MTS upgrade



The issues that the Cyrville MTS upgrade solution helps address are elaborated below.

- The upgrade of Cyrville MTS is primarily driven by the committed large load request for the TerraCanada National Capital Area project located at the National Research Council of Canada facilities[9] which is expected to be energized in 2028.
- Moulton MTS and Cyrville MTS were both evaluated as options to supply the load request, with Moulton MTS being preferred as it is located closest to the load site. After review, Cyrville MTS was deemed the preferred option due to the transmission line upgrade cost being approximately six times less than the Moulton upgrade option.
- The new Mer Bleue MTS was eliminated as a supply option due to the distance from the load site. This distance would require long costly distribution supply feeders and create the potential for voltage drop issues.
- As part of the transformer upgrade at Cyrville MTS it will be converted to a 230 kV supply. This means that not only will it support future demand growth but has the additional advantage of offloading the constrained 115 kV regional system. For more details, refer to Section 4.3.2 of Schedule 2-5-2 - Coordinated Planning with Third Parties
- Since the existing Cyrville MTS transformers have remaining useful life (manufactured in 2007), Hydro Ottawa plans to relocate them to Moulton MS to gain additional capacity at Moulton MS, which will increase LTR from 33MVA to 50MVA. Also, the two existing transformers at Moulton MS are fairly old (manufactured in 1987), one of them has failed and is set to be out of service for the foreseeable future.
- The proposed Cyrville upgrade will also improve reliability as it would allow for the creation of inter-station ties between Cyrville MTS, Moulton MTS and the new Mer Bleue MTS and better balance customer count and loading of the East 28 kV system.

[9] Government of Canada,"Government of Canada announces milestones for new science facilities in National Capital Area" https://www.canada.ca/en/public-services-procurement/news/2024/07/government-of-canada-announces-milestones-for-new-science-facilities-in-national-capital-area.html

- The East 13 kV system (region highlighted in yellow in Figure 9 above), situated in close vicinity to Cyrville MTS and Moulton MS, is projected to see increased demand in the next 5 years, creating capacity constraints on Overbrook TS. The additional capacity from Cyrville MTS will support new load growth which would have previously been connected to the 13 kV system.

Upgrading Cyrville MTS to cater to the committed large load in the region, support the offloading of the constrained 115 kV and manage demand growth as shown in the Figure 10 above is the most optimal solution.

Bronson DS Upgrade

The proposed solution entails conversion of the existing 4 kV Bronson DS to a 13 kV station with an incoming 115 kV transmission supply to support adjacent stations in the West and Core 13 kV regions. Figure 11 shows the existing 4 kV Bronson DS along with the adjacent 13 kV stations of Carling TM, Lisgar TL and Riverdale TR.

Figure 11 - Downtown 13.2 kV Stations surrounding Bronson DS

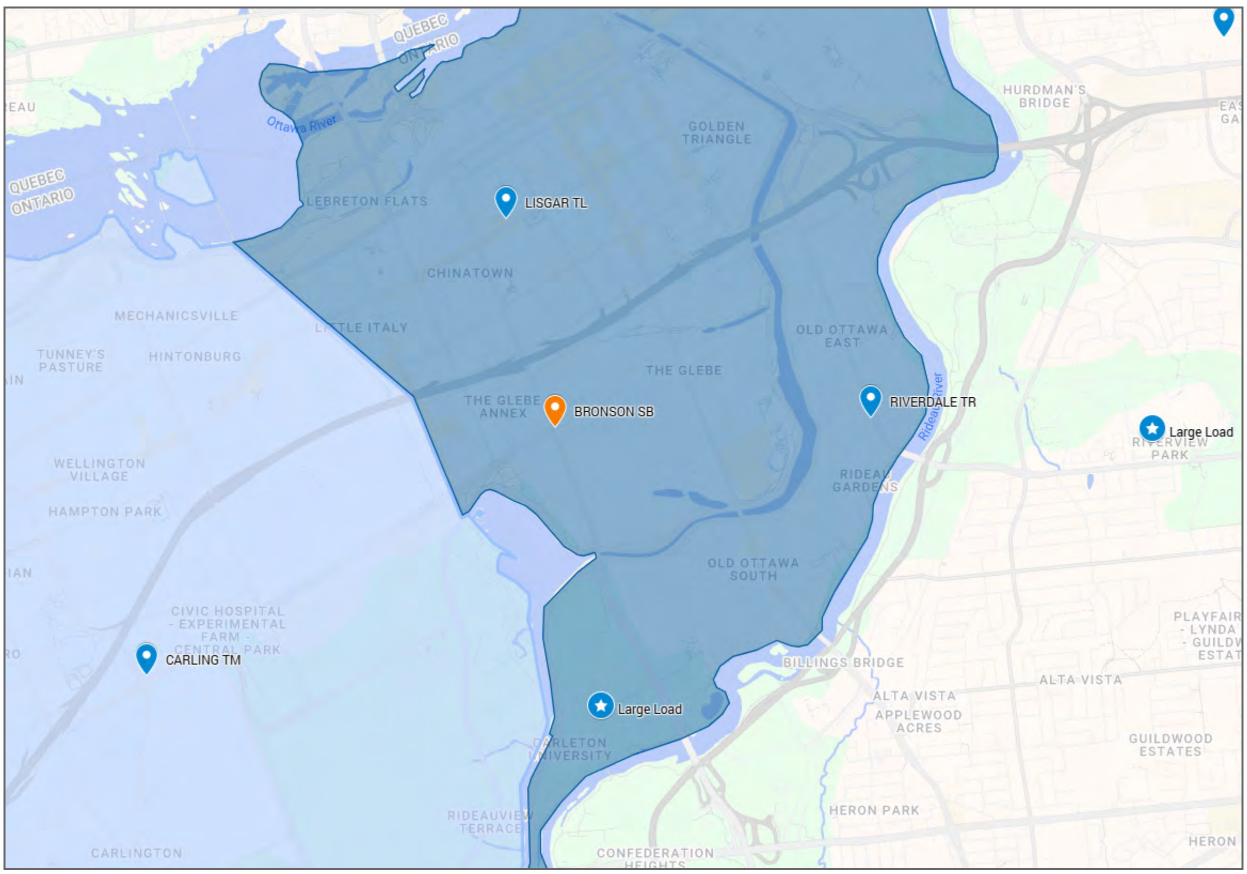
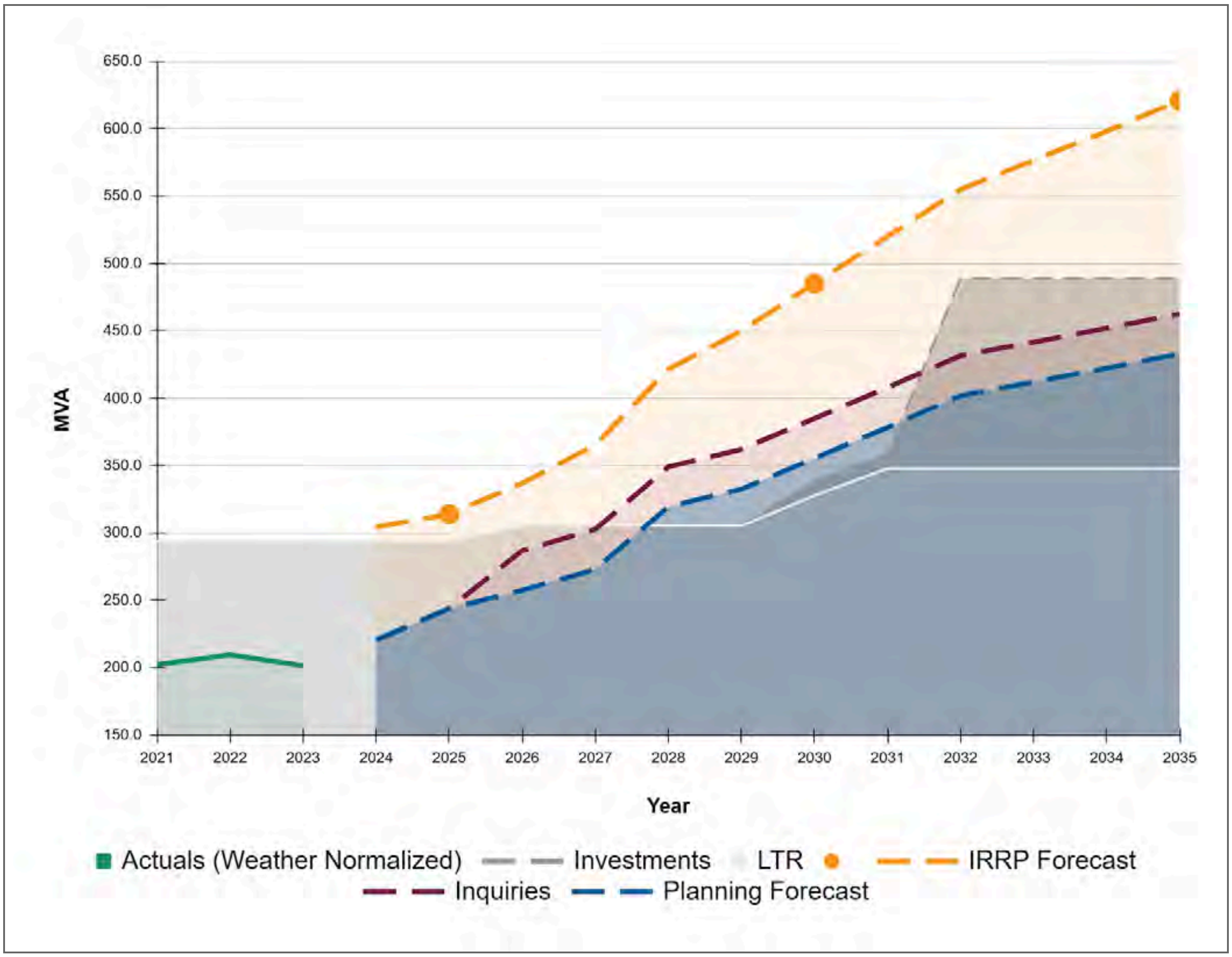


Figure 12, presents the load forecast against planned capacity (LTR), factoring two Hydro Ottawa capacity upgrade investments proposed; a NWSs (utility BESS) energizing in 2030, and the Bronson DS 13 kV upgrade, energizing in 2032 pushing the overall LTR to 500MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages.

Figure 12 - Combined Forecast of stations:
Carling TS, Lisgar TS, and Riverdale TS with Bronson DS Conversion and NWSs



The issues that the proposed capacity upgrade addresses are elaborated below.

- The Bronson upgrade aims to support the three nearby 13 kV stations through inter-station ties: Carling TS, Lisgar TS, and Riverdale TS, the combined planning forecast of which is anticipated to exceed their planning capacity by 2027 without intervention, even earlier if inquiries come to fruition.
- Addition of capacity to the 13 kV system through Bronson DS station upgrade to 13 kV will cater to the load growth in the downtown core due to intensification, transit-oriented development and committed large load customers such as universities and hospitals[10],
- The Bronson DS upgrade also supports strategic voltage conversion of the Bronson DS 4kV distribution system. This is in alignment with growing demand for intensification, transit-oriented development, EV charger-driven customer service size upgrades, which often necessitates transitioning from 4 kV to the more robust 13 kV system. This is due to the challenges presented by the 4 kV system:
    - Compared to 13 kV, 4 kV is less efficient for long-distance power distribution, leading to greater losses and voltage drop issues beyond approximately 5km, while 13 kV remains effective up to 10km.
    - The maximum capacity of a 4 kV feeder is 2.3MVA, versus 9.7MVA for 13 kV, significantly limiting the ability to accommodate the large load requests.
- Based on the above justification, upgrading the 4 kV Bronson DS station adds capacity to the constrained 13 kV system and is also strategically located to support the overloaded 13 kV stations. Capacity needs in the interim (until 2030) is fulfilled through NWSs (more details in Non-wire Program Needs below) until the Bronson 13 kV station is energized in 2032.

[10] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/

2.3.2.2. Distribution Capacity Needs

The planned investments under the Distribution Capacity Upgrades program for 2026-2030 address several issues: adding distribution capacity to leverage new station capacity; reducing demand on existing feeders to below planning ratings; enabling forecasted growth with reduced system expansion requirements for customers; and deferring more expensive alternatives, such as new station builds.

Without these investments, Hydro Ottawa's distribution system will not be able to leverage the new station capacity being built for the committed load requests and forecasted load growth, impacting system accessibility as well as failing to improve reliability of the existing system that would be achieved by offloading feeders running above planning rating. Section 9.1.4 of Schedule 2-5-4 - Asset Management Process outlines the system capacity needs by Planning Region.

The major investments proposed under this program include:

- **Feeder Integration for Piperville MTS:** This project aims to extend distribution feeders from Piperville MTS to connect new customers and establish inter-station ties with Leitrim station. Leitrim station is currently operating above its planning rating. This project will offload a portion of the Leitrim station load, helping to maintain reliability and create capacity for future growth in the community serviced by this station.
- **Feeder Integration for Mer Bleue MTS:** This project aims to extend distribution feeders from Mer Bleue MTS to connect new customers and offload Bilberry MTS, which will be decommissioned as it has reached the end of its useful life.
- **Feeder Integration for Kanata North MTS:** This project aims to extend distribution feeders from Kanata North MTS to connect new customers and create inter-station ties to Marchwood MTS and Kanata MTS. Both of these stations are currently operating above their planning rating. This project will offload a portion of the load on these stations, helping to maintain reliability and creating capacity for future growth in the communities serviced by these stations.

- **Feeder Integration for Greenbank MTS:** This project aims to extend distribution feeders from Greenbank MTS to enable introduction of 28 kV in the capacity-constrained 8 kV system in the Nepean region and connect a large load. This project will help to maintain reliability and address capacity constraints in the Nepean region.
- **Feeder Integration for Cyrville MTS Capacity Upgrade:** This project aims to extend distribution feeders from Cyrville MTS to connect new customers and create inter-station ties to adjacent stations to improve reliability.
- **Voltage Conversion for Bronson DS Upgrade:** This project enables the upgrade of Bronson DS from 4 kV to 13 kV through phased voltage conversions in the 4 kV distribution system to 13 kV to support growth in the downtown core.

2.3.2.3. Non-Wires Program Needs

Hydro Ottawa has identified NWSs as viable solutions to address a variety of challenges on the distribution system. This section describes the options and proposed solutions based on Hydro Ottawa's NWSs assessment process, for more details, see Section 9.2.1, Schedule 2-5-4 - Asset Management Process. Based on this assessment, Hydro Ottawa has proposed utility-owned battery energy storage systems (BESS) and Non-Wire Customer Solutions. Details of each solution and the issues they address are below.

West 28 kV (North)

There is no further feasible wire solution capable of addressing this region's needs prior to station energization. Due to the urgency of the capacity relief needed in the Kanata North region, Hydro Ottawa proposes to deploy Non-Wires Customer Solutions to acquire 10 to 15MW in the Kanata North region by 2030. It is important that Hydro Ottawa act quickly to engage, educate and encourage customers to participate in order to ensure the immediate system needs can be met in the near term.

More details on the justification for choosing this region is available in Section 2.3.2.1- Station Capacity Needs, Kanata North MTS.

West 28kV system

Hydro Ottawa owns one feeder (BECK-F2) supplied from Hydro One-owned Beckwith DS, in Goulbourn, as shown in Figure 13.

Figure 13 - West 28kV (Beckwith Region)

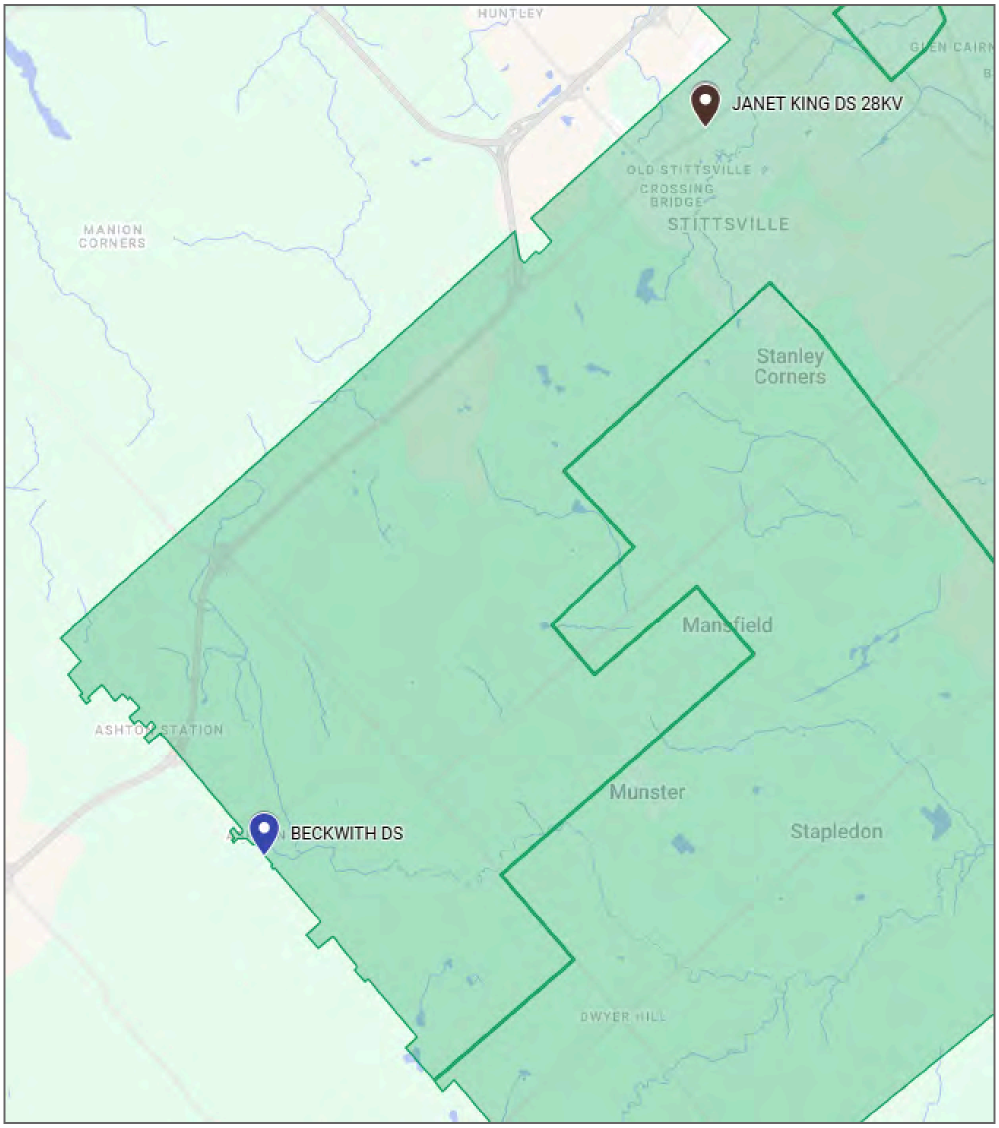
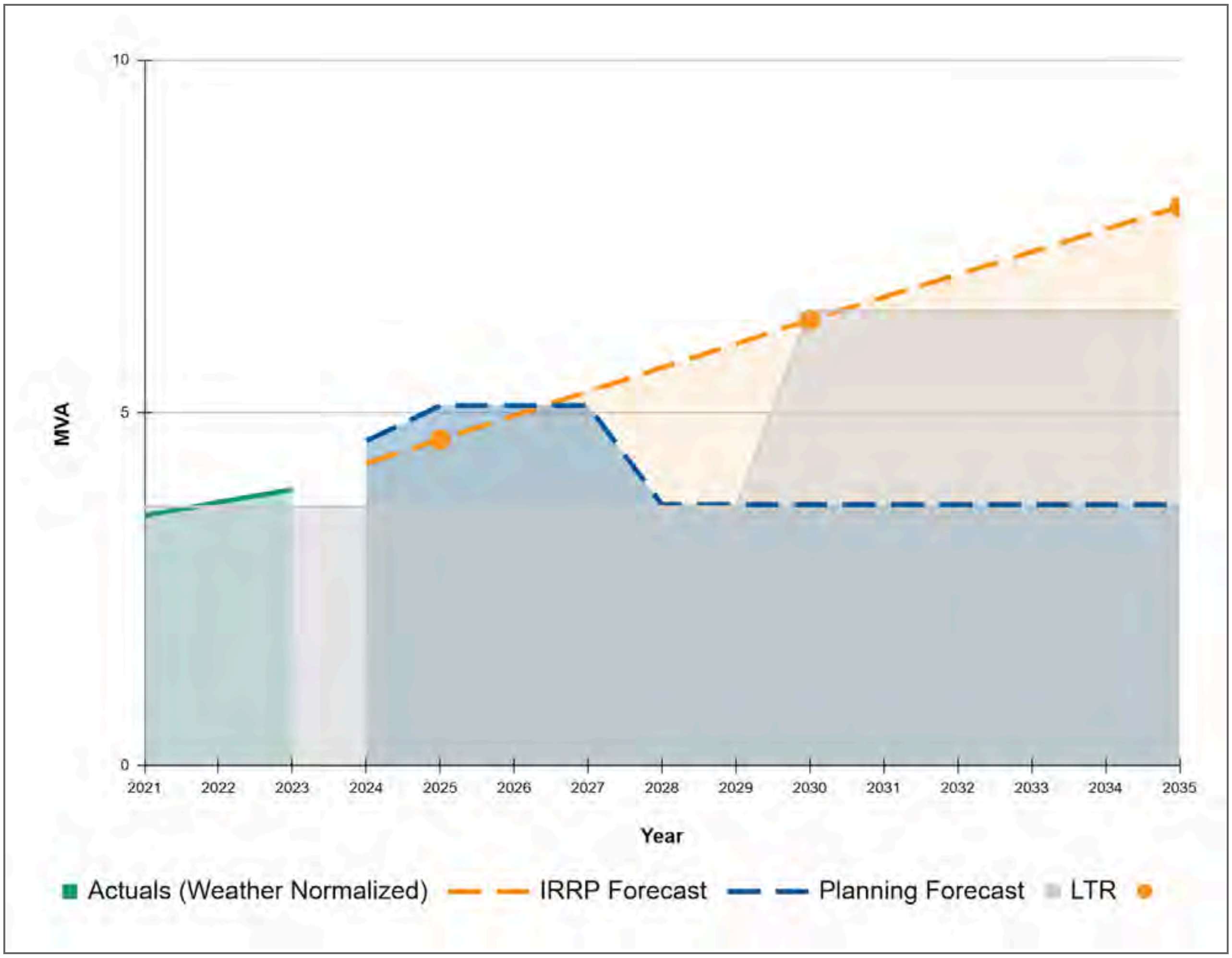


Figure 14, presents the load forecast against planned capacity (LTR) of the BECK-F2 feeder, factoring a 2.5 MW NWSs (utility BESS) energizing in 2030, pushing the overall LTR of the Beckwith region to 6.4MVA. The figure compares the IRRP Forecast and the Planning Forecast of Beckwith DS.

Figure 14 - Beckwith Forecast



The proposed NWSs in this region is to install a 2.5MW utility owned BESS. The issues that this solution addresses are elaborated below:

- **Capacity Constraints:**The BECK-F2 feeder is currently running above its planning capacity. The only ties available to the BECK-F2 feeder is from Janet King F4 feeder which is also heavily loaded (95% of planning capacity). Some load from Beckwith is planned to be moved to

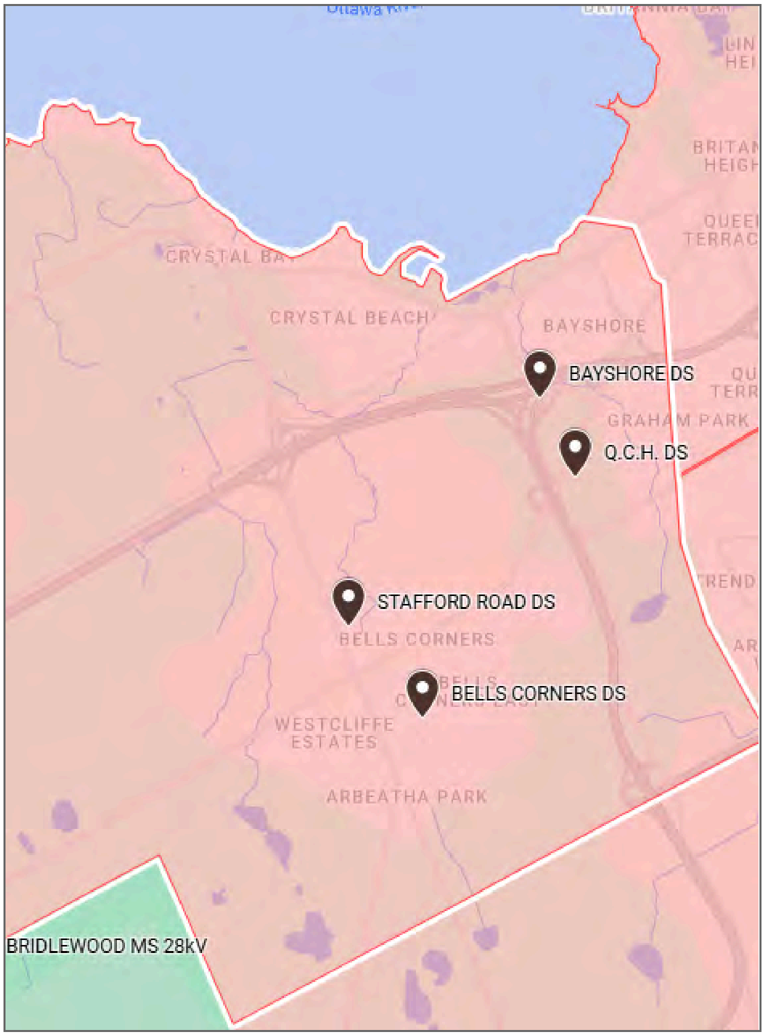
Richmond South MTS in 2028 to reduce loading to its planning capacity but that will not be enough to manage load growth considering the long term outlook (IRRP Forecast).

- **Wire Upgrades**: In consultation with Hydro One, to extend another feeder from the Beckwith DS would cost roughly $12M. Inter-station ties with adjacent Hydro Ottawa stations will not be economically viable considering the location of the station requiring long feeder extensions. In addition, adjacent stations of Janet King DS are approaching capacity limits (90% of planning rating) and Richmond South MTS will support a new large load 2027 onwards reducing its capability to support an offload from Beckwith DS. Also, with the long term outlook considering the IRRP forecast, this would likely trigger transmission upgrades.
- Hence the most optimal solution to manage the load growth in this region until 2030 and possibly beyond is to install a 2.5MW utility owned BESS which assists with peak load management considering the IRRP forecast.

Bells Corners/ Bayshore 8kV system

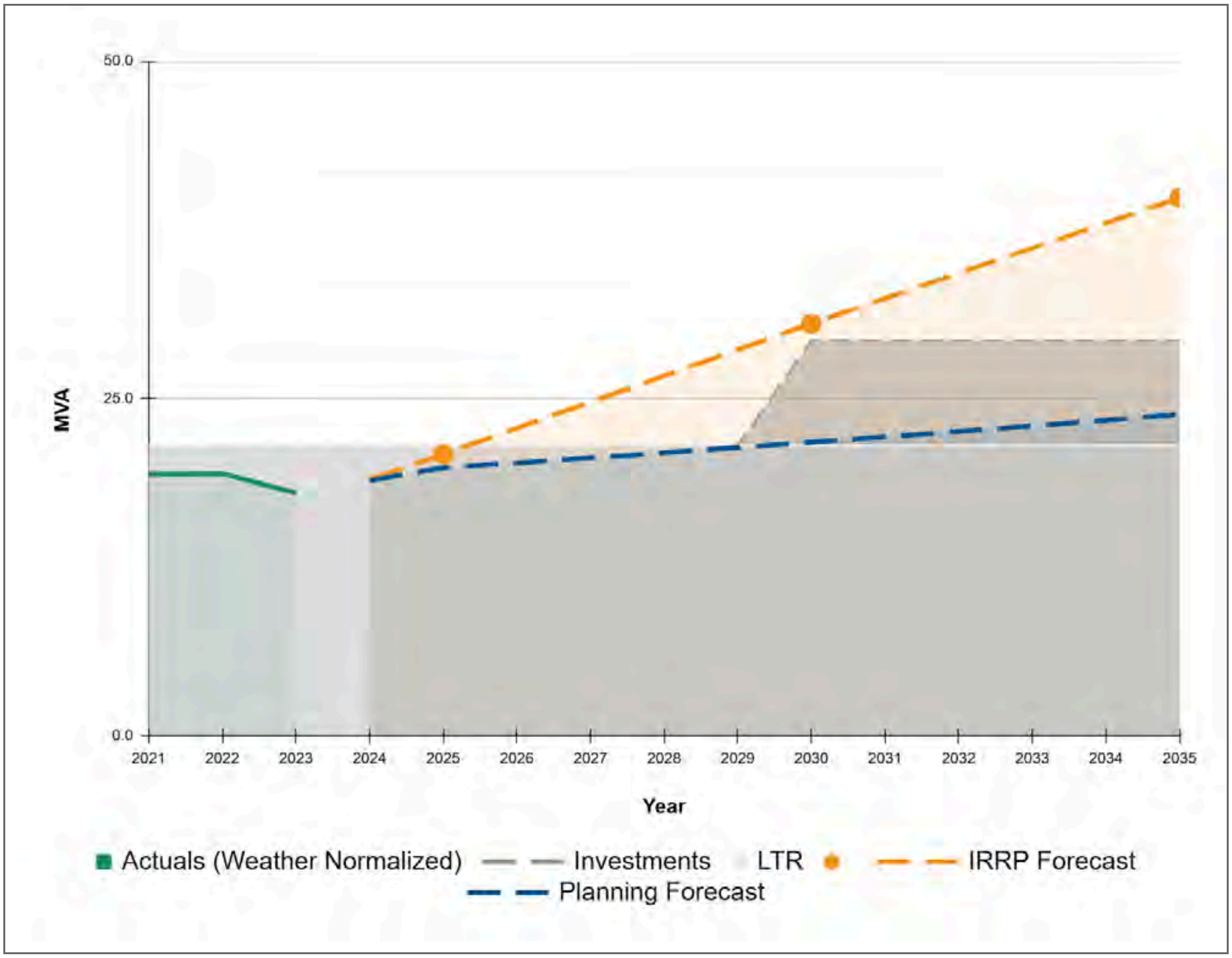
The Bells Corners/Bayshore 8kV supply region covers the northwest portion of Nepean. This region is supplied by Bayshore DS, Queensway-Carleton Hospital (Q.C.H) DS, Stafford Road DS, and Bells Corners DS as shown in Figure 15.

Figure 15 - Bells Corners/Bayshore 8kV Region



Bayshore DS and Q.C.H DS are approaching their planning limits. Figure 16, presents the load forecast against planned capacity (LTR) of Bayshore DS and Q.C.H DS factoring a 7MW NWSs (utility owned BESS) energizing in 2030. The figure compares the IRRP Forecast and Planning Forecast of both these stations.

Figure 16 - Bayshore & QCH stations 8kV Forecast



The proposed NWSs in this region is to install a 7MW utility owned BESS. The issues that this solution addresses are elaborated below.

- **Capacity Constraints**: Bayshore DS is currently at 94% of planned capacity and Q.C.H DS is at 74% of planned capacity and based on the planning forecast, capacity will be exceeded by 2030. Capacity is also insufficient considering the long term outlook (IRRP forecast).

- **Wire Upgrades**: Both these stations are currently supplied by 44kV feeders. Given the 8kV system is insufficient in dealing with large loads and service upgrades, conversion to 28kV would be optimal. However, this would require a transmission supply from the constrained 115kV system which could trigger transmission upgrades. Also, this region is isolated from the rest of the 8kV system with limited ties to Q.C.H DS. Creating new inter-station ties with Bells Corners DS will not be economically viable given it will support the entire Stafford DS load by 2026 reducing its capability to support an offload from Bayshore DS/ Q.C.H DS. Also, with the long term outlook considering the IRRP forecast, inter-station transfers will not be enough to manage the load growth.
- Hence the most optimal solution to manage the load growth in this region is to install a 7MW utility owned BESS solution which assists with peak load management.

Casselman 8kV system

The Municipality of Casselman is supplied by Casselman DS via four 8kV feeders which is illustrated in Figure 17.

Figure 17 - Casselman 8kV

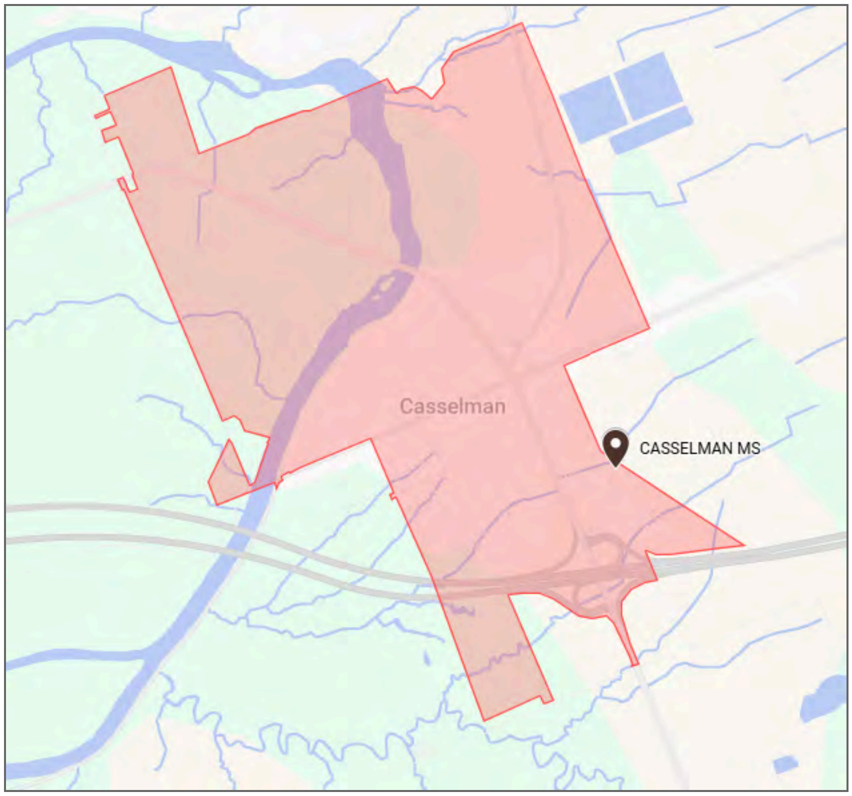
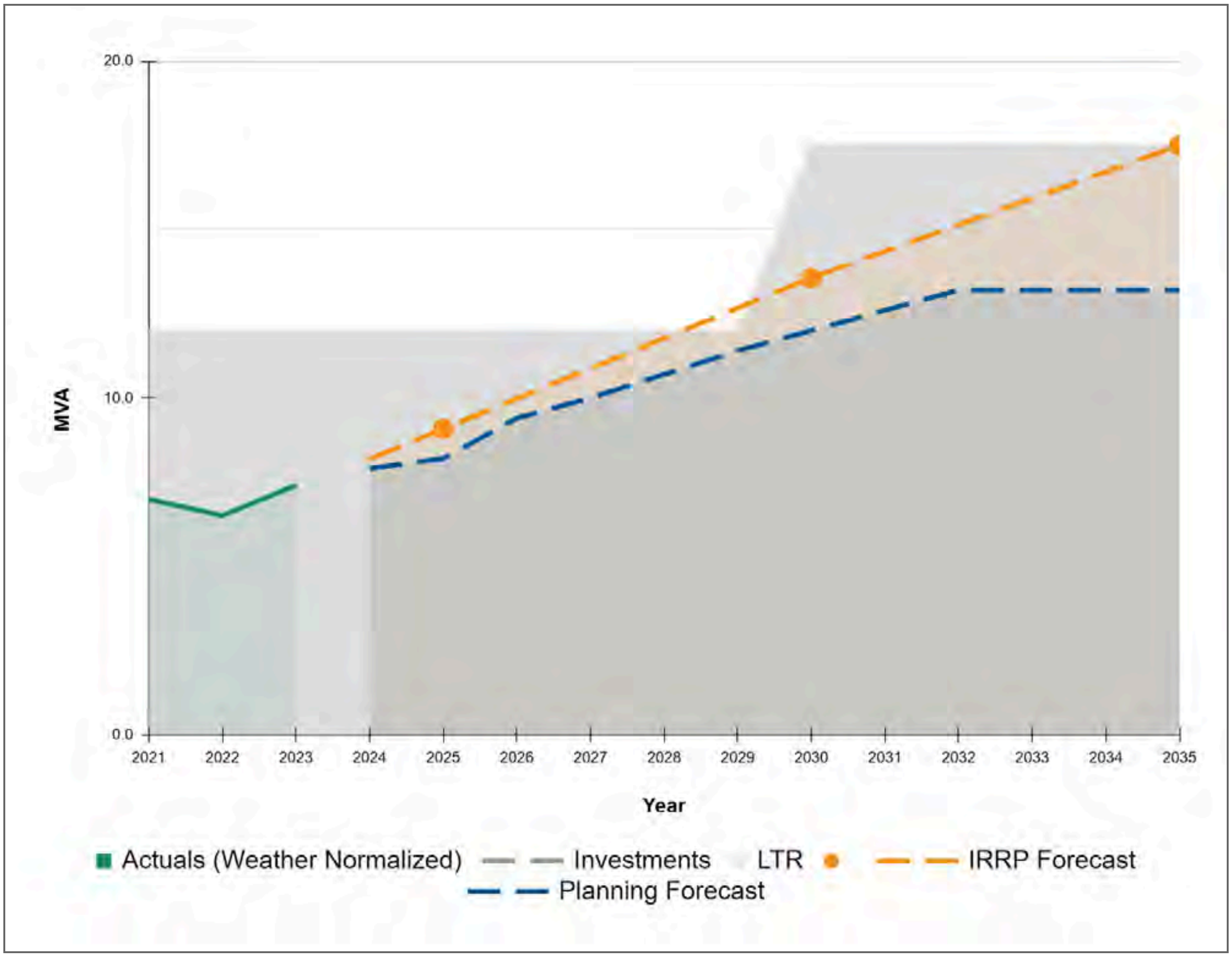


Figure 18 presents the load forecast against planned capacity (LTR) of Casselman DS factoring a 5 MW NWSs (utility BESS) energizing in 2030, pushing the overall LTR of the region to 17 MVA. The figure compares the IRRP Forecast and Planning Forecast of Casselman DS.

Figure 18 - Casselman 8kV Forecast



The proposed NWSs in this region is to install a 5MW utility owned BESS. The issues that this solution addresses are elaborated below.

- **Capacity Constraints**- Casselman DS is expected to exceed its planned capacity by 2030. Two out of the 4 feeders are currently running above planned capacity. In the short term, Hydro Ottawa has plans to balance load on all 4 feeders through feeder reconfigurations, however, that will not sufficiently address the capacity constraints out to 2030 per the planning forecast and is also insufficient considering the long term outlook per the IRRP forecast.

- **Wire Upgrades**- Increasing the station capacity at Casselman will trigger transmission upgrades as Casselman is supplied from a dual transmission supply from Hydro One owned St. Isidore TS. Also, the Casselman region is geographically isolated from the rest of Hydro Ottawa's distribution system, making load transfers an infeasible option.
- Hence the most optimal solution to manage the load growth in this region until 2030 and beyond is to install a 5MW utility owned BESS solution which assists with peak load management.

Core 13kV and West 13kV system

Figure 19 shows a sub-section of the Core 13 kV and the West 13kV system namely the 13kV stations of Carling TM, Lisgar TL and Riverdale TR along with the 4kV Bronson DS.

Figure 19 - Downtown 13.2 kV Stations surrounding Bronson DS

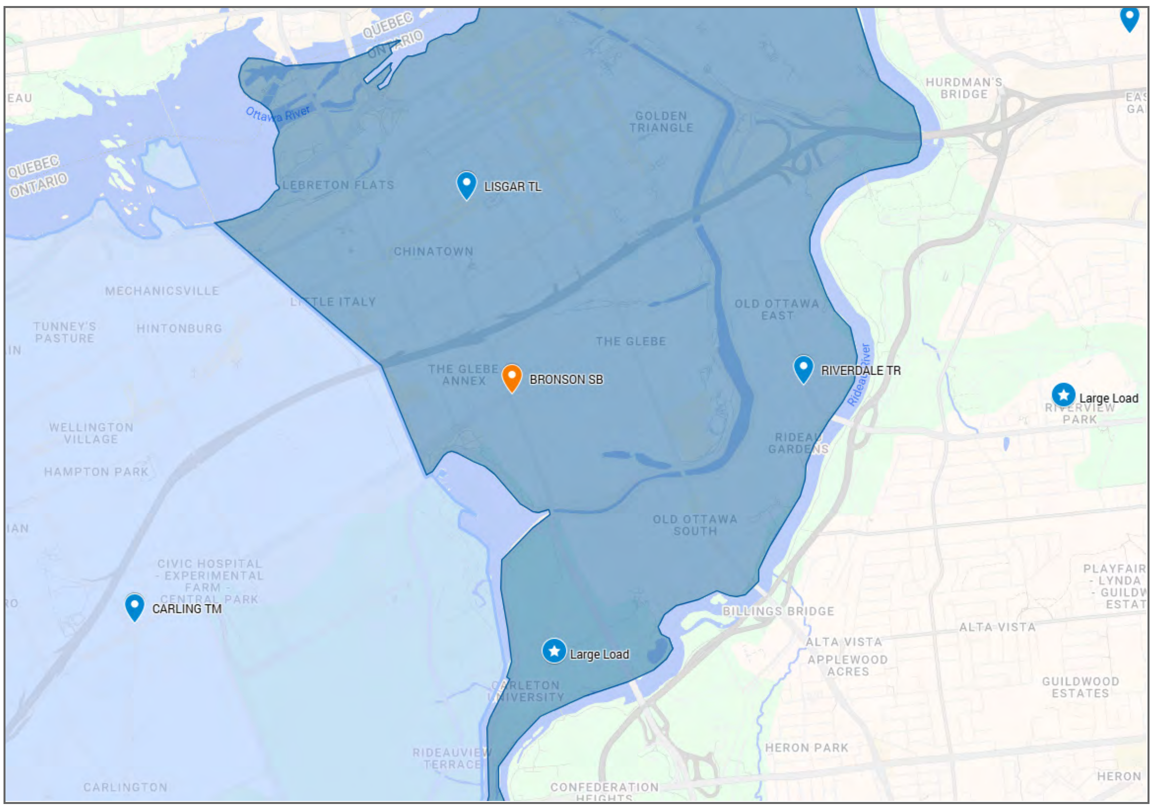
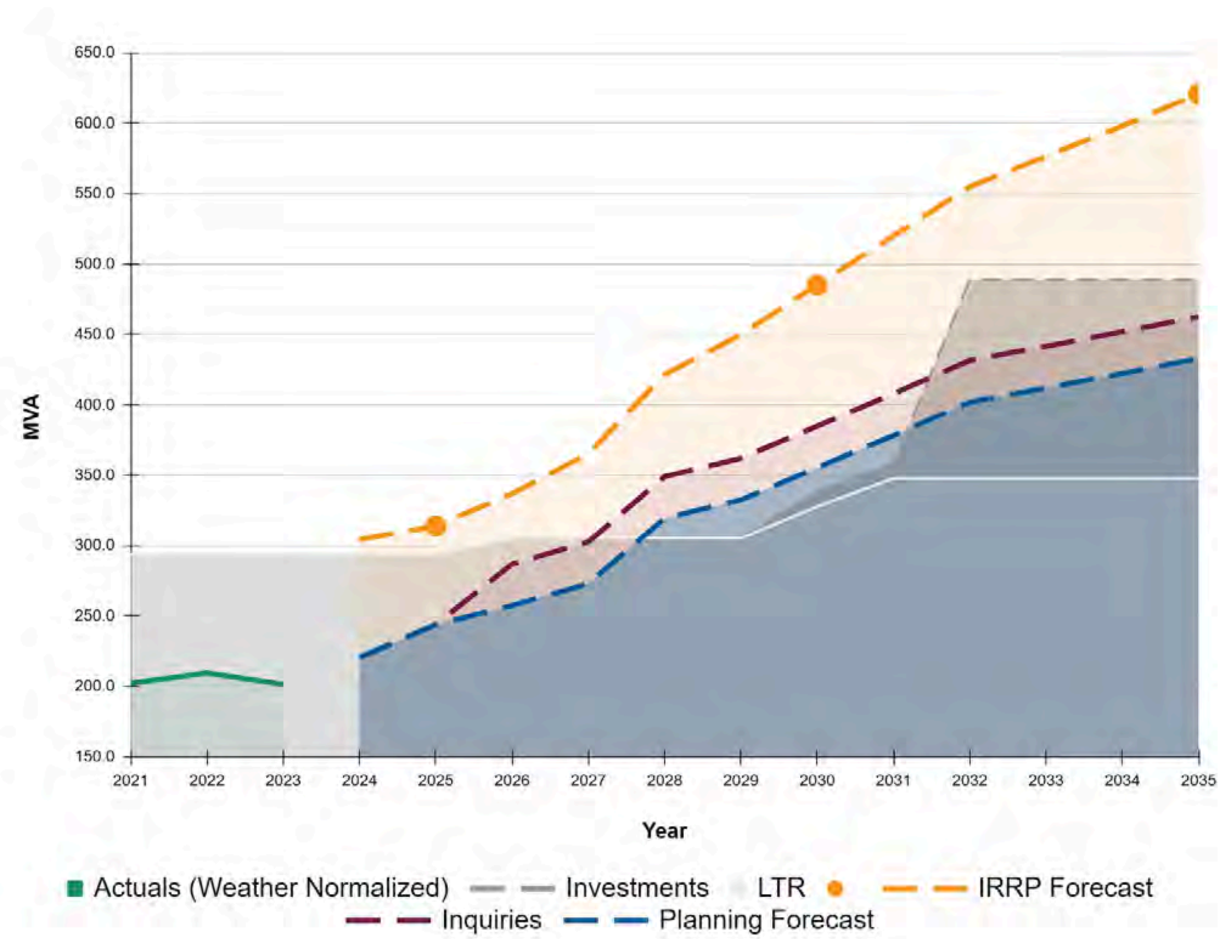


Figure 20 presents the load forecast against planned capacity (LTR), factoring two Hydro Ottawa capacity upgrade investments proposed; a 10MW NWSs (utility BESS) energizing in 2030, and the Bronson DS 13 kV upgrade, energizing in 2032 pushing the overall LTR to 500MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages.

Figure 20 - Combined Forecast of stations:

Carling TS, Lisgar TS, and Riverdale TS with Bronson DS Conversion and NWSs



The proposed NWSs in this region is to install a 10MW utility-owned BESS along with the deployment of Non-Wires Customer Solutions delivering an additional 10 to 15MW to bridge the gap between planned capacity and planning forecast. The issues that this solution addresses are elaborated below.

- **Capacity Constraints**: The planning forecast of the sub-section is anticipated to exceed the planning capacity by 2028 without intervention, even earlier if customer load inquiries come to fruition. Additionally, the transmission supply for these stations is from the constrained 115kV system.
- **Wire Upgrades**: Addition of capacity through the Bronson DS upgrade will eventually be needed to support the load growth in this region due to 4kV voltage conversions, intensification, transit-oriented development and committed large load customers such as universities and hospitals[11].
- The most optimal solution to manage the load growth in the interim until the Bronson station is energized in 2032 is to get support from NWSs. 10MW of utility owned BESS solution which assists with peak load management is proposed for this region along with Non-Wires Customer Solutions to bridge the gap between planned capacity and planning forecast. Following energization of the Bronson station, NWSs will provide support for the long term outlook considering the IRRP forecast.

2.4. PROGRAM BENEFITS

The benefits associated with the proposed Capacity Upgrade program are detailed below.

2.4.1. System Operation Efficiency and Cost Effectiveness

The proposed upgrades in capacity will satisfy upcoming load growth and increase system flexibility to restore power or offload feeders. The additional capacity will avoid cycling power outages and associated switching operations due to stranded load during transformer- or bus-related outages.

NWSs will enhance grid reliability and flexibility by accommodating the growing penetration of DERs and alleviating capacity constraints. These solutions offer peak-reducing technologies to increase system switching potential.

[11] Ottawa Hospital, "The Ottawa Hospital's New Campus," https://newcampusdevelopment.ca/

2.4.2. Customer Benefits

This program provides solutions to meet committed load requirements of large loads and the growing capacity needs in the Kanata, Downtown, Orleans and Nepean regions due to organic growth as well as evolving electrification needs. It helps align with customer expectations to prioritize reliability - the top customer need identified in Hydro Ottawa's 2026-2030 investment plan survey - while serving a growing community.

Guidance on energy consumption and technologies was listed as a top three priority by commercial and industrial customers in Hydro Ottawa's 2026-2030 investment plan survey. The various Non-Wires Customer Solutions will help strengthen Hydro Ottawa's role as a trusted advisor and energy partner. These programs will help enhance customer engagement and create the potential for electricity cost savings for customers of all classifications. Please refer to Section 2.4 of Schedule 1-4-1 - Customer Engagement Ongoing for further insight around ongoing customer engagement, specifically related to customer programming and the pursuit of NWSs.

2.4.3. Safety

This program will ensure equipment operates within safe limits, mitigating risks of equipment damage and safety hazards caused by system overload.

Microprocessor protection and control equipment will be used, where necessary, to enable proper device coordination, detailed event analysis, and faster fault detection minimizing equipment damage.

2.4.4. Coordination and Interoperability

As part of the regional planning process, IESO and Hydro One have been involved in the formulation of the capacity-build projects to ensure that there is sufficient capacity and no adverse impact on reliability of the integrated power system.

2.4.5. Economic Development

The investments under this program will help meet the growing needs in developing regions such as Kanata, Nepean and Orleans as well as add more capacity to the Downtown region to cater to the growth due to intensification, transit oriented development as well as growing electrification needs triggered by decarbonization goals.

Investments in NWSs will help promote economic growth by fostering local job creation, enhancing grid resilience and reducing energy costs.

2.4.6. Environment

Hydro Ottawa plans to use lower Global Warming Potential materials and employ innovative design, procurement and construction techniques to reduce the embodied carbon associated with new substation builds.

Where new transformers will be installed to build station capacity, transformer oil containment pits will be installed to avoid adverse environmental impacts of a potential transformer leak.

2.5. PROGRAM COSTS

Table 2 shows the historical and future spending by the underlying Budget Programs, as a part of the Capacity Upgrade program. The 2026-2030 period will see a significant increase in spending, reaching $342.6M net capital, compared to $108.2M net capital in the 2021-2025 period.

Table 2 - Historical, Bridge and Test Year Expenditures for the Capacity Upgrade Program ($'000 000s)[12]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stations Capacity Upgrades	$ 18.5	$ 1.8	$ 1.5	$ 21.3	$ 43.1	$ 56.1	$ 62.1	$ 10.9	$ 26.8	$ 40.6
Distribution Capacity Upgrades	$ 2.2	$ 5.0	$ 6.5	$ 8.5	-	$ 17.3	$ 21.6	$ 18.6	$ 16.2	$ 15.4
Non-Wire Upgrades	-	-	-	-	-	$ 4.1	$ 13.9	$ 20.2	$ 14.3	$ 8.7
Contributed Capital	-	-	-	-	-	$ (1.3)	$ (2.6)	$ (0.4)	-	-
CAPEX-TOTAL	**$ 20.7**	**$ 6.8**	**$ 7.9**	**$ 29.8**	**$ 43.1**	**$ 76.1**	**$ 95.1**	**$ 49.4**	**$ 57.2**	**$ 64.7**
Other Revenue Expense - Non-Wire Solutions	-	-	-	-	-	$ 2.0	$ 2.0	$ 2.0	$ 2.0	$ 2.0
Non-Wire Maintenance	-	-	-	-	-	$ 2.8	$ 2.6	$ 2.8	$ 2.6	$ 2.6
ANNUAL TOTAL	**$ 20.7**	**$ 6.8**	**$ 7.9**	**$ 29.8**	**$ 43.1**	**$ 80.9**	**$ 99.7**	**$ 54.1**	**$ 61.9**	**$ 69.3**
5-YEAR CAPEX					**$ 108.2**					**$ 342.6**
5-YEAR TOTAL					**$ 108.2**					**$ 365.9**

2.5.1. Station Capacity Upgrades

In the 2021-2025 period, this program was primarily focused on new station capacity at Cambrian MTS (previously named South Nepean MTS) in Nepean South and the Piperville MTS[13] (previously named New East Station) in Leitrim as well as upgrades at existing stations such as Limebank MTS, Uplands MTS and Riverdale TS[14]. The need for these additions or upgrades was identified through the System Capacity Assessment and IRRP. The spending in the 2021-2025 period under this program is $86.1M.

The planned net expenditure under this program in the 2026-2030 period is $192.2 M. The increase in funding is due to the increased requirement for station capacity (four new stations and two station

[12] EOL Voltage Conversion investments are included in Stations and Buildings Infrastructure Renewal. Further details can be found in Schedule 2-5-7 - System Renewal Investments.
[13] Piperville MTS planned energization in 2026
[14] Riverdale TS planned energization in 2027

upgrades compared to one new station and three station upgrades in the 2021-2025 period). The investments required in the 2026-2030 period are as follows:

- **Piperville MTS (Total: $42.3M, 2021-2025: $38.7M, 2026-2030: $3.6M):** This station carries forward from the last rate period with energization planned in 2026, is proposed to be 230 kV-28 kV connected with 100 MVA of capacity.
- **Riverdale Switchgear Upgrade (Total: $14M, 2021-2025: $ 13.2M, 2026-2030: $0.8M):** This upgrade project, carrying forward from the last rate period with energization planned in 2026, replaces the switchgear lineup at Riverdale TS with additional breaker positions.
- **Mer Bleue MTS (Total: $47.8M, 2021-2025: $13.8M, 2026-2030: $34M):** This station carries forward from the last rate period with energization planned in 2028, is proposed to be 230 kV-28 kV connected with 100 MVA of capacity, and supply up to eight new feeders.
- **New Kanata North station (Total: $44.8M, 2026-2030: $44.8M):** The station is proposed to be 230 kV-28 kV connected with 100 MVA of capacity and supply up to eight new feeders with a planned energization in 2028.
- **Greenbank MTS (Total: $38.5M, 2026-2030: $38.5M):** The station is proposed to be 230 kV-28 kV connected with 100 MVA of capacity and supply up to eight new feeders in the Greenbank/Hunt Club area with energization in 2028.
- **Cyrville Capacity Upgrade (Total: $35.3M, 2026-2030: $35.3M):** The Cyrville T1 and T2 transformers will be upgraded from 50MVA to 100MVA and is expected to be energized in 2028.
- **Bronson Upgrade (Total: $35.1 M, 2026-2030: $35.1M):** This project is to upgrade the existing 4 kV Bronson station to a 13 kV station with an incoming 115 kV transmission supply with energization planned beyond this rate period.

2.5.2. Distribution Capacity Upgrades

Distribution Capacity Upgrade projects in the 2021-2025 period have mostly been for station egress and feeder integration for the new stations of Cambrian TS and Piperville TS with a spending of $22.1M.

In 2026-2030, the program will build feeder egress and overall feeder integration for the new stations and will offload existing constrained feeders. Feeder integration will allow Hydro Ottawa to effectively leverage capacity of the new stations. This program will also help to eliminate undersized conductor sections in existing feeders and strategic voltage conversions to enable 13 kV conversion of the Bronson station. Eliminating undersized conductor sections will help leverage the full rating of the feeder for better utilization of existing assets. The proposed funding for this program is $89.1M. The increase in spending is predominantly due to the number of new stations requiring higher-distribution feeder extensions. The investments required in the 2026-2030 period are as follows:

- **Piperville MTS distribution upgrades ($6.0M)**: This project involves feeder line extensions, pole line upgrades, and SCADA switch installations. This is necessary to effectively integrate Piperville MTS into the South-East 28kV system and assume supply of two Leitrim MS feeders, maintaining Leitrim MS below its LTR.
- **Mer Bleue MTS distribution upgrades ($16.6M)**: This project involves extending six egress feeders out of the station as well as feeder line extensions, pole line upgrades, and SCADA switch installations. This is necessary to effectively integrate Mer Bleue into the East 28kV region and assume supply of the existing Bilberry and Orleans feeders that are being decommissioned.
- **New Kanata North distribution upgrades ($20.7M):** This project involves extending six egress feeders out of the station, upgrading pole lines and underground cabling, and integrating SCADA-enabled switches. The project is required to support load growth and high-tech industries in the area, and facilitate the conversion of remaining non-28kV systems. Moreover, this project strengthens grid reliability and contingency readiness by offloading load from overloaded substations in the West 28kV (North) and establishing critical ties between existing 28kV stations.

- **Greenbank MTS distribution upgrades ($20.0M):** This project involves extending six egress feeders out of the station, pole lines upgrades, feeder line extensions, as well as 8kV voltage conversion of several substations from the Nepean 8kV and Barrhaven 8kV systems.
- **Cyrville Capacity distribution upgrades ($4.5M):** This project involves extending two egress feeders out of the station and feeder line extensions. The project is required to support growth in the area and increase reliability by creating additional ties between Moulton MTS and the new Mer Bleue MTS
- **Bronson distribution upgrades ($15.0M):** This project involves feeder and pole line upgrades to prepare for and complete partially phased voltage conversions to 13.2kV. This project is required to meet growing demand in the area and increase capacity on the Central 13.2kV network.
- **Undersized conductors ($6.3M):** This project involves upgrading sections of conductor on ten different feeders that are currently undersized. It is necessary to meet increased growth on the feeders and provide additional feeder ties that are not hindered from ampacity constraints to increase feeder reliability.

2.5.3. Non-Wires Solutions

Non-Wires Solutions (NWSs) were evaluated based on the NWSs assessment process, please refer to Section 9.2.1 of Schedule 2-5-4 - Asset Management Process for further details. The proposed investment categories for NWSs are Utility-Owned Battery Energy Storage Solutions and Non-Wires Customer Solutions.

This is a new program being introduced for the 2026-2030 period, and therefore there is no historical spending. Hydro Ottawa is proposing to add 24.5MW of capacity through Utility-Owned Battery Energy Storage Solutions (Beckwith, Casselman, Bayshore/QCH and Core & West 13kV regions) and 20 to 30MW additional capacity from Non-Wires Customer Solutions Program (Kanata North, Core & West 13kV regions). These programs represent a capital investment of $61.2M and an additional $10M of costs included in Other Income and Deductions - Services to Third Parties, (see Schedule 6-3-5 - Other Income and Deductions) and $13.3M costs included in OM&A (see Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs) in the 2026-2030 period.

2.5.4. Cost Factors

Multi-year project considerations: Like any other multi-year project, this program will be subject to inflationary increases in both labour and equipment costs. All equipment costs are estimated and some are yet to be purchased. Equipment costs may increase before a final agreement is signed.

Transmission Cost: Due to the transmission upgrade requirements, costs would be determined through the Connection Impact Assessment (CIA) and System Impact Assessment (SIA) process, and then Hydro Ottawa and Hydro One must execute Connection Cost Recovery Agreements (CCRAs). As CCRAs are finalized for each project, there may be changes to the cost estimates considered at that time.

Regulatory and policy considerations: For NWSs, regulatory and policy work is ongoing. The OEB's cost-benefit analysis framework has a second phase in development and a related cost-sharing mechanism between LDCs and the bulk system needs to be refined through provincial directive or regulatory policy.

2.6. ALTERNATIVES EVALUATION

2.6.1. Alternatives Considered

Hydro Ottawa prioritized investments in areas with existing capacity constraints and immediate, confirmed load requirements. To ensure strategic alignment, immediate capacity investments, informed by Hydro Ottawa's planning forecast, were validated against long-term needs indicated by the IRRP forecast, considering the four to six-year lead time for station upgrades and even longer for transmission upgrades. This approach optimizes capital deployment and asset utilization. Hydro

Ottawa will continuously monitor electrification impacts to minimize disruptions and ensure new customer connections.

In order to meet the capacity needs of the system, three alternatives were considered, as outlined in Table 3.

Table 3 - 2026-2030 Capacity Upgrade Capital Investments ($’000 000s)

Program Investments	Alternative 1: Decelerated Growth Approach	Alternative 2: Accelerated Growth Approach	Alternative 3: Economical Growth Approach (Recommended)
System Capacity - Wires	360 MVA	770 MVA	550 MVA
System Capacity- NWSs	None	None	24.5MW BESS + 20-30MW NWCS
Stations overloaded by 2030 (Planning Forecast)*	23	0	0
Planning Regions overloaded by 2035 (IRRP Forecast)	55% (10/18)	0%	6% (1/18)
Supports Economic Development	Minor	Highest	Medium
Supports Environmental Sustainability	Minor	Highest	Medium
Station Capacity Upgrades	$82.4	$384.2	$192.2
Distribution Capacity Upgrades	$65.1	$121.2	$89.1
Non-Wires Capacity Upgrades	-	-	$61.2
SUBTOTAL CAPACITY UPGRADES	**$147.5**	**$505.4**	**$342.6**

*Excluding 4kV stations

Alternative 1: Decelerated Growth Approach- This alternative involves only continuing with in-progress station projects. The required investments include:

- Piperville MTS
- Mer Bleue MTS
- New Kanata North MTS

This alternative will provide:

- Continued strain on the system due to capacity lagging behind growth resulting in inability to connect all committed customer load requests.
- Station loads exceeding planning ratings, negatively impacting system accessibility, reliability and the ability to support service upgrades or new connections.
- Inability to support decarbonization goals since many planning regions will be above its planning rating considering the IRRP forecast.

Alternative 2: Accelerated Growth Approach: This alternative involves solely wire solutions to meet demand levels based on the IRRP forecast. The required investments include:

- Ongoing new stations: Piperville MTS, Mer Bleue MTS, New Kanata North MTS
- New stations: New Casselman station, Greenbank MTS, New Carling station
- Upgrades to existing stations: Cyrville (full station), Bronson (13 kV upgrade), QCH (transformer), Ellwood (transformer), King Edward (Hydro One-Sec cable), Lisgar (Hydro One-sec cable), Albion (Hydro One-transformer), Russell (Hydro One-transformer), South March (Hydro One-Transformer)
- Distribution upgrades: Voltage conversion for Bayshore transfer to 13 kV system, Beaverbrook, South March, Augusta, Bayswater, Bronson, Fisher, Slater, Florence, Gladstone, Henderson, Nepean, Shillington, Brookfield, Cahill, Church, Dagmar, Eastview, Langs Road, McCarthy, Urbandale, Vaughan, Wakley.

This alternative will provide:

- Ability to connect all committed projects.
- Station loads below planning ratings, positively impacting system accessibility and the ability to support service upgrades or new connections.
- Ability to support government decarbonization goals since all planning regions will be below its

planning rating considering the IRRP forecast.

Alternative 3: Economical Growth Approach (Recommended Alternative):
This alternative involves a more economical approach that involves building regional capacity with support from NWSs that meet the criterion defined in Section 9.2.1 of Schedule 2-5-4 - Asset Management Process. The investments required in this alternative include:

- New Stations: Piperville MTS, Mer Bleue MTS, New Kanata North MTS, Greenbank MTS
- Upgrades to existing stations: Cyrville (full station), Bronson (13 kV upgrade), King Edward (Hydro One-Secondary cable upgrade), Lisgar (Hydro One-Secondary cable upgrade), Carling (Hydro One-Secondary cable upgrade), Russell (Hydro One-transformer), South March (Hydro One-Transformer), Albion (Hydro One-transformer)
- Distribution transfers: as required to keep stations below their planning rating.
- Non-Wires Solutions: Utility-Owned Battery Storage Solutions at West 28 kV, Casselman, Core 13 kV and 8 kV systems and targeted Non-Wires Customer Solutions

This alternative will provide:
- Ability to connect all committed projects.
- Station loads at or below planning ratings by 2030, positively impacting system accessibility and the ability to support service upgrades or new connections over the next 5 years.
- Support from NWSs and grid modernization efforts for expected overloads due to decarbonization goals (as per the IRRP forecast) enhancing grid reliability, flexibility, resilience, and customer engagement.

2.6.2. Evaluation Criteria

System Accessibility

In order to meet the increasing power demands and predicted growth associated with electrification, it is crucial to focus on improving system accessibility (capacity). The preferred approach should enhance the system capacity available by ensuring robust and scalable infrastructure. This includes satisfying N-1 capacity requirements (feeders and stations that have exceeded or are approaching planning ratings) for seamless and quick load transfers as well as to accommodate future load growth.

If an alternative is required, the selected alternative should meet the needs identified through the IRRP to ensure enough reliable electricity is made available to the Hydro Ottawa service territory through the provincial grid over the long term to support the community's growth and economic development plans.

Financial

Investment cost-effectiveness is paramount when upgrading electric infrastructure to meet the immediate and long-term needs of the community and to support economic development. The evaluation criteria balance the necessity for robust infrastructure enhancements with the need to minimize impact to customer rates. Key considerations for cost-effective investments include:

- Prioritization of critical upgrades, phased implementation, advanced planning and forecasting, and Benefit-Cost Analysis completed through the capital expenditure process, refer to Section 5.3.1 of Schedule 2-5-4 - Asset Management Process;
- Leveraging existing assets through risk-based assessments done by Predictive Analytics, refer to Section 5.1.4 of Schedule 2-5-4 - Asset Management Process;
- Integration of smart technologies to modernize the grid and enable NWSs, refer to Section 3.4.2 of Schedule 2-5-4 - Asset Management Process;

System Reliability & Resiliency

Reliability remains critical to Hydro Ottawa's customers, with a focus on reducing the duration and frequency of outages while enhancing resilience against extreme weather events. It is essential to maintain reliability as electrical demand continues to increase at local, feeder-wide, and system-wide levels through continuous system optimization and the deployment of cost-effective technologies and solutions. Key strategies include implementing N-1 contingency plans, which ensure the system can handle the failure of any single major component without disrupting service. Additionally, infrastructure hardening initiatives are vital to bolster resilience against extreme weather events. The goal is to ensure a more robust and reliable electric distribution network that meets the demands of its growing communities and supports sustainable economic development.

Economic Development

The program should contribute to the City of Ottawa's growth and sustainability. This criterion evaluates the program's contribution to the economic growth and sustainability of the City of Ottawa. This includes supporting development projects, enabling business expansion, and fostering a stable and reliable electrical infrastructure that attracts investment and supports job creation. A robust and adaptable electrical grid is essential for economic development. Infrastructure relocations and upgrades can facilitate new construction, business operations, and the expansion of services, contributing to the overall economic health and vitality of the City of Ottawa.

Environmental Sustainability

The program should promote environmental sustainability by supporting electrification, renewable energy integration, and energy efficiency. This criterion examines the program's impact on environmental sustainability, including its support for electrification (transitioning to electric vehicles and heating systems), renewable energy integration (connecting solar and wind power to the grid), and energy efficiency initiatives. Hydro Ottawa has a responsibility to contribute to a cleaner environment. By considering these factors in relocation projects, the program can help reduce greenhouse gas emissions, promote the use of clean energy sources, and improve overall energy efficiency.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

2.6.3. Preferred Alternative

Hydro Ottawa assessed the three alternatives outlined in Section 2.6.1 - Alternatives Considered under the evaluation criteria provided in Section 2.6.2 - Evaluation Criteria.

Hydro Ottawa's primary strategic objective is to ensure customer affordability while significantly expanding the overall capacity of the electrical grid. This dual approach is essential to address the projected surge in energy demand by 2030 and adapt to the rapidly changing landscape of government policies and technological innovations.

To achieve these ambitious goals, Hydro Ottawa proposes a hybrid model that strategically integrates traditional wire upgrades with innovative NWSs, as presented in Alternative Three (Economical Approach). This approach encompasses the construction of new and upgraded stations and the expansion of existing and new distribution lines. These traditional wire upgrades will form the backbone of the grid, ensuring reliable and efficient power delivery. Simultaneously, the integration of NWSs, which may include technologies such as utility owned BESS and other Non-Wires Customer Solutions, will provide additional flexibility and resilience to the grid.

By implementing this comprehensive strategy, Hydro Ottawa aims to bolster economic growth and promote sustainability within the region. This will be achieved by removing existing capacity constraints, ensuring that all committed projects can be seamlessly connected to the grid, with additional capacity built in to accommodate future electrification growth through efficient capital deployment. These projects are poised to play a pivotal role in supporting development, enabling business expansion, and fostering a stable electrical infrastructure that will attract investment and stimulate job creation.

The preferred hybrid alternative strikes a delicate balance between meeting capacity needs, ensuring system reliability, and managing investment costs. This will be accomplished through the strategic deployment of traditional wire upgrades in conjunction with NWSs, thereby enhancing grid reliability, flexibility, resilience, and customer engagement. NWSs can provide customers with greater control over their energy usage and offer the choice and flexibility to actively participate in demand response programs, further enhancing grid stability and efficiency.

Hydro Ottawa's projections indicate that this hybrid approach will reduce the number of planning regions operating above planned capacity, bringing the number down from 10 to just 1. In regions that may still experience capacity constraints, NWSs will be instrumental in managing overloads. This will ensure that Hydro Ottawa can continue to connect new customers without compromising system accessibility, all while providing uninterrupted service at a lower cost. By proactively addressing capacity constraints and leveraging innovative solutions, Hydro Ottawa aims to create a sustainable and resilient electrical grid that can meet the needs of a growing population and a rapidly evolving energy landscape.

2.7. PROGRAM EXECUTION AND RISK MITIGATIONS

2.7.1. Implementation Plan

The capacity upgrades to be executed between 2026 and 2030 were assessed based on critical needs of the system. Station Capacity Upgrade projects typically span four to six years while Distribution Capacity Upgrade projects are usually completed in one to two years. Non-Wires Upgrade projects for utility owned solutions could take two to three years while Non-Wires Customer Solutions can be deployed quickly once the foundation is set, and would be an ongoing program. Table 4 shows the projects proposed for the 2026-2030 period as a part of the Capacity Upgrade program.

1 **Table 4 - Proposed Projects Under the Capacity Upgrade Program**

Year	Proposed Projects
2026	• Piperville TS energization • Riverdale Switchgear Upgrade • Mer Bleue TS, station egress and and feeder integration • New Kanata North TS, stations design, feeder integration • Greenbank TS station design • Cyrville station upgrade design • Lisgar TL secondary cable upgrade • Carling TS secondary cable upgrade • Russell TB transformer replacement • Utility Owned Battery Storage • Non-Wires Customer Solutions
2027	• Mer Bleue TS, station egress and feeder integration • New Kanata North TS, station egress and feeder integration • Greenbank TS, station egress and feeder integration • New Bronson 13 kV and associated voltage conversion • Cyrville station upgrade • Carling TS secondary cable upgrade • King Edward TK secondary cable • Russell TB transformer replacement • Utility Owned Battery Storage • Non-Wires Customer Solutions
2028	• Mer Bleue TS energization • New Kanata North TS energization • Greenbank TS energization • New Bronson 13 kV and associated voltage conversion • Cyrville station upgrade • Carling TS secondary cable upgrade • King Edward TK secondary cable • Russell TB transformer replacement • Utility Owned Battery Storage • Non-Wires Customer Solutions
2029	• New Bronson 13 kV and associated voltage conversion • Carling TS secondary cable upgrade • King Edward TKsecondary cable • Russell TB transformer replacement • Utility Owned Battery Storage • Non-Wires Customer Solutions
2030	• New Bronson 13 kV and associated voltage conversion • Carling TS secondary cable upgrade • King Edward TK secondary cable • Russell TB transformer replacement

Year	Proposed Projects
	• Utility Owned Battery Storage • Non-Wires Customer Solutions

2.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in executing the Capacity Upgrades Program, particularly the transformational landscape of decarbonization, and the evolving needs of customers, paired with the ever increasing demand for reliable electricity in the community, presents various pressures on the distribution grid. Table 5 identifies the key risks and corresponding mitigation strategies that Hydro Ottawa will undertake as needed.

1 **Table 5 - Key Risks for the Capacity Upgrades Program and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implementing solutions on a case by case basis.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.
Stakeholder Approvals	The time required to obtain approval from the OEB, Hydro One and the IESO for some of the transmission upgrades poses a risk to the program delivery schedule.	Coordinate closely with stakeholders and plan in advance with regular touchpoints with stakeholders to secure necessary approvals in a timely manner
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute	Create and where required implement contingency plans to account for

Category	Risk	Mitigation
	work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labour which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Regulatory and Compliance Risks	Rapidly changing regulations that may require changes to designs (such as how DER's are managed) pose a risk to project delivery, schedule, and budget.	Maintain compliance by integrating industry best practices and regulatory requirements into the upgrade planning process. Conduct regular audits and risk assessments to stay ahead of regulatory deadlines. Participate in regulatory committees and proactively prepare designs for compliance.
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.

2.7.3. Other Factors

Regulatory and policy work around the OEB's Benefit-Cost Analysis framework for NWSs is not yet complete. Only phase 1 has been completed and phase 2 - which outlines the calculation to include both local and bulk system benefits costs, known as the Energy System Test (EST) - is still underway. An IESO-LDC Working Group has also been established to examine approaches to cost-sharing of "Stream 2" Electricity Demand Side Management (eDSM) activities (local programs designed and administered by LDCs that will have both bulk and local system benefits). When these two initiatives are completed - during 2026 or 2027 - Hydro Ottawa will transition its NWSs work to conform to the revised model as described in Section 9.2 of Schedule 2-5-4 - Asset Management Process.

2.8. LEAVE-TO-CONSTRUCT

Assessment pertaining to Section 92 of the OEB Act, 1998 will likely be needed for the transmission lines that Hydro One will build to support Hydro Ottawa's capacity upgrade projects such as the New Kanata North station, Greenbank MTS, Cyrville upgrade and Bronson 13 kV upgrade. Hydro Ottawa's contribution to these projects will be captured under the General Plant Connection Cost Recovery Agreement, please refer to Section 7 of Schedule 2-5-9 - General Plant Investments for additional details.

3. DISTRIBUTION ENHANCEMENTS

3.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $27.5M

2026-2030: $92.8M

Budget Program: Distribution System Reliability, Distribution Enhancements, Distribution System Observability, Distribution System Resiliency.

Main Driver: Reliability

Secondary Driver: Capacity Constraints, Resilience, Observability

Outcomes: Operational Effectiveness, Customer Focus

Hydro Ottawa's investment plan for the Distribution Enhancements Capital Program (2026-2030) focuses on modernizing and strengthening the electricity distribution network, enabling it to adapt to the challenges of climate change, growing demand, reliability concerns and the increasing integration of Distributed Energy Resources (DERs). Together, these programs provide the necessary real-time data, control capabilities, and grid stability to dynamically forecast and adjust electricity consumption and generation. This allows for optimized grid performance, seamless integration of renewables, and the implementation of demand response programs. Ultimately, these investments ensure a more flexible, reliable, and responsive energy grid, crucial for Hydro Ottawa's long-term sustainability and customer satisfaction.

Hydro Ottawa's Distribution Enhancements Capital Program (2026-2030) outlines a strategic investment of $92.8M to modernize and reinforce the electricity distribution network. This represents a substantial increase compared to the historical spending of $27.5M in the 2021-2025 period. This increase is primarily driven by the imperative to enhance grid resilience against increasingly severe weather events, augment grid observability for proactive management, and modernize the grid to accommodate the growing integration of DERs. The expenditure plans detailed in this document are aligned with and in response to feedback received from customers through Hydro Ottawa's customer engagement survey, please refer to Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

This Distribution Enhancements Capital Program encompasses the following Budget Programs over the 2026-2030 period:

Distribution System Reliability

This program is designed to enhance the overall reliability of the electricity distribution system. This program encompasses a range of initiatives aimed at bolstering system performance and mitigating outages, including:

- **Feeder Optimization and Capacity Management:** Reconfiguring feeders, adding tie points, and addressing capacity constraints to optimize the electricity distribution network. This creates a more stable and responsive grid, essential for handling dynamic load adjustments and the integration of DERs.
- **Enhancing System Observability:** Deployment of advanced automation to achieve real-time distribution system observation & control, enhancing efficiency and outage response. Real-time observability is a critical component of managing DERs as it allows for immediate responses to changing load patterns and facilitates precise control of grid assets.
- **Improving Distribution Efficiency:** Mitigation of voltage imbalances and overload by implementing feeder phase balancing to improve distribution efficiency. Efficient distribution increased the grid's capabilities to handle dynamic loads, ensuring optimal performance during periods of fluctuating demand.

These initiatives are informed by a comprehensive reliability assessment process detailed in Section 5.2.2.3 of Schedule 2-5-4 - Asset Management Process.

Distribution Enhancements

The Distribution Enhancements Program is designed to modernize and enhance grid infrastructure to accommodate the growing integration of DERs and optimize system performance. This program encompasses a range of initiatives aimed at system reliability, system observability, and fostering technological innovation, including:

- **Strategic Grid Infrastructure Enhancements:** Strategically enhance grid infrastructure by extending station neutral ties and mitigating third-party pole risks, improving system stability and reliability.
- **DER Integration and Grid Optimization:** Enable DER integration and optimize load management through advanced forecasting, scheduling, and aggregation tools, supported by AMI 2.0 and federal funding, to enhance grid flexibility and resilience. This initiative directly enables Hydro Ottawa's ability to manage flexible loads by providing the tools and infrastructure necessary for real-time control and optimization of DERs. Advanced forecasting and scheduling are critical for predicting and managing load fluctuations, supported by granular data needed for precise load control and demand response.

Distribution System Resilience

The Distribution System Resilience Program is a new budget program designed to enhance the resilience of the electricity distribution network against the increasing frequency and intensity of adverse weather events. This emphasis on resilience is of paramount importance given that Ottawa has become the weather-alert capital of Canada[15], experiencing a surge in extreme weather events that place significant strain on and cause damage to the electricity grid. Recent events, such as the devastating 2022 Derecho, tornadoes, ice storms, and flooding, have underscored the vulnerability of the grid and the critical need for proactive measures to enhance its resilience. Refer to Section 4.4 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement for details on the impacts of major weather events on Hydro Ottawa's distribution system. By proactively

[15] Environment and Climate Change Canada - https://www.canada.ca/en/environment-climate-change.html

strengthening the grid against extreme weather, the Distribution System Resilience Program ensures that the grid can quickly recover and reinstate critical functions to maintain responsive control to balance electricity demand and adapt to fluctuating energy needs and optimize its performance under diverse conditions.

This program encompasses the following initiatives:

- **Strategic Undergrounding:** Strategic undergrounding of vulnerable overhead lines, to mitigate risks associated with severe weather, enhancing grid resilience.
- **Storm Hardening:** Strengthening overhead infrastructure against extreme weather by reinforcing poles, reducing spans and attachments, and utilizing composite/concrete poles in critical areas.
- **Feeder Reconfiguration:** Optimizing the configuration of electricity feeders to improve system redundancy and minimize the impact of outages.
- **Station Egress Undergrounding:** Burying existing overhead station egress points to protect critical infrastructure.
- **Line Relocation:** Relocating vulnerable power lines to less exposed areas or underground to reduce the risk of damage.

Through proactive investment in grid resilience, Hydro Ottawa aims to mitigate the reliability impacts posed by a changing climate and provide customer value by strengthening the resilience of the grid to withstand and bounce back from extreme weather events. Further details are available in Section 5.2.2.4 of Schedule 2-5-4 - Asset Management Process.

Distribution System Observability

The Distribution System Observability Program is a new budget program introduced to enhance grid reliability, flexibility, resilience, and customer engagement, while promoting sustainability. This program aligns with Hydro Ottawa's Grid Modernization Strategy. This strategy responds to the need to modernize deteriorating infrastructure, accommodate decarbonization efforts, and meet changing customer expectations.

Real-time observability is foundational for effective advanced flexible load management, providing the essential data needed to dynamically balance grid demand. Investments in advanced monitoring systems empower grid operators with the visibility to predict and respond to load fluctuations, enhancing grid stability and resilience. By enabling precise, data-driven control, observability optimizes the integration of distributed energy resources and facilitates targeted demand response programs. Observability provides the data that allows for the real-time reaction to grid conditions, a necessity to maintain grid stability while effectively managing flexible loads.

Investments under this program will focus on data-driven and technologically-advanced grid management, utilizing new assets that provide real-time condition data, loading data, and fault-detecting capabilities; remote switching capability (Smart Switches); installation of fault circuit indicators (FCIs); and monitoring and control boxes. Examples of these technologies follow in Figures 21 through 23.

Figure 21 - Example of Automated Switchgear with Control Box

Figure 22 - Example of Overhead Automated Switch with Control Box

Figure 23 - Example of Smart FCI Device on Overhead Pole Line

These investments will enable the adoption of innovative control and optimization technologies, such as Advanced Distribution Management Systems (ADMS). By enhancing system observability, Hydro Ottawa aims to support the following Grid Modernization objectives:

- **Enhanced Reliability:** Improve grid reliability through advanced monitoring, proactive failure detection, and faster fault localization.
- **Adaptive Grid Flexibility:** Enable the grid to adapt to changing energy demand and incorporate diverse energy sources, including renewables.
- **Fortified Resilience & Robust Security:** Improve the grid's ability to withstand disruptions caused by system faults or extreme weather events.
- **Strengthened Customer Engagement & Empowerment:** Engage and empower customers by providing them with real-time data and tools to manage their energy use.
- **Sustainable Decarbonization & Renewable Integration:** Reduce carbon emissions and promote sustainability by optimizing grid planning and operations to support the integration of renewable energy sources.

Further details are available in Section 5.2.2.1 of Schedule 2-5-4 - Asset Management Process.

3.2. PERFORMANCE OUTCOMES

The following outcomes are expected to be achieved through the Distribution Enhancement Capital Program:

Table 6 - Distribution Enhancement Program Performance Outcomes

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	• Improve system reliability by reducing the number of worst performing feeders. This will contribute to improving system reliability by reduced outage duration and frequency achieved through reliability and distribution enhancement investments. • Improve grid control and observability through the installation of Smart FCIs and Smart Switches, contributing to improved productivity and system performance. • Mitigating reliability risk by strengthening the grid's resilience against extreme weather. These outages can create safety risks, particularly for vulnerable populations reliant on electricity for medical devices and other essential needs.
Customer Focus	• Improve Customer Reliability by mitigating capacity and reliability risks. Reduce disruptions to businesses, schools, and other essential services, impacting productivity and economic activity.

3.3. PROGRAM DRIVERS AND NEED

3.3.1. Drivers

Primary Driver: Reliability;

This program supports Hydro Ottawa's commitment to enhancing the reliability of its electricity distribution services, as detailed in Section 5.2.2 of Schedule 2-5-4 - Asset Management Process. This commitment involves continuous assessment of system performance and implementing appropriate actions to address any identified reliability issues. The program focuses on:

- **Real-time Monitoring of Distribution Asset Performance:** This facilitates early issue detection and proactive intervention, mitigating the risk of failures and associated downtime.
- **Enhanced Grid Resilience to Adverse Weather Events:** This reduces the likelihood of weather-related outages and strengthens the overall resilience of the distribution network.

- **System Reconfiguration to Optimize Outage Management and Load Restoration:** This provides enhanced flexibility to isolate outages and restore load, thereby building redundancy, minimizing outage durations, and improving key reliability metrics (SAIFI and SAIDI). This facilitates the foundation to dynamically respond to real-time grid conditions and maintain stability during energy fluctuations or outages.

Secondary Drivers: Capacity Constraints, Resilience, Observability.

Capacity Constraints: As detailed in Schedule 2-5-4 - Asset Management Process, Hydro Ottawa regularly evaluates the capability and reliability of the distribution system to ensure a stable and dependable power supply for customers. This program will contribute to these efforts by implementing system reconfiguration and creating ties to help maintain feeders and stations at or below planning ratings, thereby reducing capacity constraints and ensuring the system can accommodate growing demand.

Resilience: Investments in undergrounding, storm hardening, and feeder reconfiguration will mitigate the consequences of failures by increasing asset resilience to extreme weather events and improving power restoration capabilities.

Observability: In line with Section 3.4.2 of Schedule 2-5-4 - Asset Management Process, investments will enhance system observability and efficiency through the adoption of innovative control and optimization technologies, integration of DERs, comprehensive sensing, and measurement strategies. This will enable advanced grid control, rapid fault detection and localization, improved overload detectability, and automated/remote system restoration, ultimately supporting both daily operations and long-term system planning. Enhanced observability allows for precise load forecasting and targeted demand response, while improved grid controllability enables the dynamic adjustment of loads to balance demand. This program is a critical step towards enabling flexible load management for optimizing grid operations, integrating renewable energy, and enhancing overall grid flexibility.

3.3.2. Current Issues

Hydro Ottawa’s Distribution Enhancements Program aims to address several challenges facing Hydro Ottawa's electricity distribution system:

- **Feeders Exceeding Planning Limits**: Feeders that operate beyond their planning capacity limit Hydro Ottawa's ability to meet customer demand. This increases the risk of overloads, equipment failure, and voltage drops, potentially leading to service disruptions and increased maintenance costs. System upgrades or load transfers are required to ensure continued service quality and system longevity. Refer to Section 8.4.2 of Schedule 2-5-4 - Asset Management Process for details on feeder capacity assessment including the calculation of the Feeder Load Index (FLI). Feeders with an FLI of 4 (≥ 100% of Planning Rating) or 5 (> 70% of Design Rating) require intervention to rectify their loading levels. In 2023 there are 12 feeders with an index of 4 and 19 with an index of 5.
- **Feeder Phase Imbalance**: Phase imbalance is the uneven electrical load distribution across a three-phase feeder, causing increased energy losses and inefficient operation of the system. Additionally, these imbalances cause higher temperatures in conductors and transformers, reducing equipment typical useful life and increasing failure risks. This program supports the optimization of the distribution of electrical load across the system to improve efficiency and mitigate these challenges.
- **Station Neutral Ties**: The absence of neutral ties in Hydro Ottawa's 13 kV delta subtransmission system presents a significant challenge to reliable and efficient service delivery. The absence of neutral ties in the 13 kV system presents a technical challenge, as it limits the effective utilization of standard pad-mounted transformers, which are designed for wye-connected systems with a neutral connection. Pad-mounted transformers rely on the neutral for providing a stable reference point for the secondary voltage - a delta system does not

inherently provide this. Specifically, the lack of a neutral path results in several key issues: it necessitates costly and complex alternative solutions for customer connections, increases the complexity of system design, operation, and maintenance (leading to longer restoration times), and contributes to higher system losses due to voltage imbalances and increased current magnitudes, ultimately causing longer restoration times, increased operational costs and potentially impacting equipment typical useful life.

- **Critical Overhead lines on poles not owned by Hydro Ottawa:** Hydro Ottawa has identified operational and reliability risks regarding some critical overhead lines situated on poles not owned or managed by Hydro Ottawa. The reliance on external infrastructure introduces several challenges, including the potential for delayed maintenance, inconsistent inspection schedules, and a lack of direct control over the condition and safety of the supporting structures. Furthermore, addressing emergent issues on these third-party poles can impede timely responses to potential hazards or necessary repairs.
- **Extreme Weather Events**: The increasing frequency and severity of extreme weather events, such as ice storms, high winds, and heavy rainfall, pose a significant threat to the electricity distribution network, particularly deteriorating overhead infrastructure. These events can cause widespread damage, leading to prolonged outages and costly repairs. This heightened vulnerability to severe weather events is further underscored by the documented increase in such events in the Ottawa region, as detailed in Section 6.4.1 of Schedule 2-5-4 - Asset Management Process.
- **System Observability**: Hydro Ottawa's current system observability presents challenges to the efficient monitoring, control, and troubleshooting of the electricity distribution network. This limitation hinders the ability to proactively identify and address potential issues, optimize grid performance, and fully leverage the benefits of DERs. Furthermore, while real-time data is available from substations and remote operable devices (leveraging Hydro Ottawa's SCADA system), this currently provides a limited view of the overall grid's operational state. To compensate for these limitations and ensure the safe and reliable operation of the grid, Hydro Ottawa currently relies primarily on labour-intensive manual monitoring and control processes.

This reliance increases response times to outages and limits the ability to respond quickly and efficiently to emerging grid events.

- **DER Integration:** The increasing prevalence of DERs presents a challenge to Hydro Ottawa's current grid infrastructure. While DERs offer potential benefits, their integration requires a modernized grid capable of handling variable and intermittent generation. The current grid infrastructure that Hydro Ottawa operates is challenged by the increased DER integrations facing operational inefficiencies, reduced grid reliability, and an inability to fully realize the benefits of DERs. This limitation hinders the ability to optimize grid operations, maintain stability, and ensure reliable power delivery as DER adoption increases.

3.4. PROGRAM BENEFITS

3.4.1. System Operation Efficiency and Cost Effectiveness

Capacity Management: This program addresses capacity constraints on feeders that exceed planning limits by reconfiguring circuits and adding feeder ties. Additionally, it provides backup supply options in contingency scenarios, contributing to overall system reliability and cost-effectiveness. This strategy optimizes asset utilization, accommodates future growth, and expedites restoration efforts during outages. By ensuring the system can meet both current and future electricity demand, this approach contributes to long-term cost management and enhanced system reliability.

Feeder Phase Balancing: This program will optimize the distribution of electrical load across the system through feeder phase balancing. This will ensure that each phase of a three-phase feeder carries a similar amount of current, minimizing power losses due to imbalances. This optimization will also reduce stress on equipment, prolonging the lifespan of grid assets and reducing the need for premature replacements.

Strategic Grid Infrastructure Enhancements: This program will implement strategic grid infrastructure enhancements to address existing inefficiencies and improve the overall performance of the electricity distribution system. This includes extending 13 kV station neutral ties to enhance system stability and reliability by providing a stable reference voltage and ensuring proper operation of protective devices. This will minimize the risk of voltage imbalances and potential equipment damage, contributing to a more reliable and resilient network. Additionally, the program will strategically transfer critical overhead lines to Hydro Ottawa-owned poles to enhance control and maintenance capabilities, improving overall system reliability and efficiency. By owning and managing these poles, Hydro Ottawa can ensure timely maintenance, implement consistent inspection schedules, and proactively address potential issues, minimizing the risk of outages and disruptions, and improving the overall efficiency of grid operations. These strategic enhancements will address existing inefficiencies and improve the long-term reliability, resilience, and efficiency of the electricity distribution system.

System Observability: This program will enhance system observability by implementing advanced monitoring and control technologies, providing Hydro Ottawa with greater visibility into the real-time operation of the electricity distribution network. Improved monitoring capabilities will also lead to faster and more accurate identification of outage locations and causes, enabling more efficient outage response and reduced outage durations. Furthermore, real-time data will provide valuable insights into grid performance, enabling Hydro Ottawa to optimize grid operations. This enhanced observability is also crucial for effectively managing the integration of DERs, such as solar panels and energy storage systems, by enabling better coordination and optimization of DERs to enhance grid stability and reliability. By investing in advanced monitoring and control technologies, Hydro Ottawa will improve its ability to efficiently monitor, control, and troubleshoot the grid, leading to more reliable service, optimized grid operations, and a more resilient and adaptable electricity distribution network.

3.4.2. Customer

Reliable and Accessible Electricity Service: The program will enhance the reliability and accessibility of electricity services, ensuring a more consistent and dependable electricity supply.

This translates to fewer outages, improved power quality, and faster restoration in the event of a disruption, ultimately providing greater convenience and peace of mind. Automated switches, additional feeder ties, and feeder reconfiguration will further enhance reliability by providing backup supply options and faster restoration times.

Improved Resilience to Extreme Weather: Customers will benefit from investments in grid resilience as extreme weather events become more frequent and severe. These investments will help to prevent prolonged and frequent power outages, reduce costs associated with emergency repairs and restoration, minimize economic disruptions, and maintain public confidence in Hydro Ottawa's ability to provide reliable service. Established maintenance programs, along with resilience measures such as strategic undergrounding and pole line reinforcement, will contribute to further improvements in overall service reliability.

Increased Customer Engagement: As a result of the efforts around DER enablement and the work within the “ODERA” project, as detailed in Section 3.6.3.1 - Preferred Alternative Details, there will be increased customer engagement by providing opportunities for customers to actively enroll their DERs and participate in demand response programming.

3.4.3. Safety

Protecting Vulnerable Customers: The program's focus on resilience measures, such as strategic undergrounding and pole line reinforcement, aims to mitigate the risks to vulnerable populations who rely on electricity for essential medical equipment and other needs. By reducing the likelihood of pole failures and power outages, the program will help ensure the safety and well-being of these customers.

Mitigating Weather-Related Hazards: Enhancing grid resilience through strategic undergrounding, line reinforcement, and other measures will reduce the risk of downed power lines and other safety hazards during extreme weather events, protecting both the public and Hydro Ottawa crews responding to these events.

System Observability: Improved system observability will enable faster response times to outages, minimizing the duration of safety hazards caused by power disruptions. This will benefit both customers and Hydro Ottawa employees who are working to restore power.

3.4.4. Cyber Security and Privacy

Enhancing Grid Resilience and Security: Projects will prioritize cyber security measures to protect grid assets from cyberattacks, unauthorized access, and data breaches.

Safeguarding Customer Data: Customer data collected through smart grid technology will be protected through strict privacy protocols, ensuring data security and compliance with regulatory standards.

3.4.5. Coordination and Interoperability

Improved System Interconnectivity: Investments in feeder ties and other reliability improvements will enhance the grid's interconnectivity, providing system operators with greater flexibility to manage load transfers during contingencies and to dynamically adjust the grid power flow. This enhanced interconnectivity supports the efficient coordination and control of distributed energy resources and load adjustments, contributing to overall grid stability and optimized energy utilization.

Streamline Decision-Making: By enhancing system observability, the program will improve communication and facilitate more informed decision-making, supporting the adoption and implementation of innovative control and optimization technologies. This includes the ability to rapidly assess grid conditions, forecast load fluctuations, and deploy targeted responses to balance demand in real-time, improving overall grid efficiency and responsiveness.

Collaboration: This program fosters proactive collaboration with key stakeholders, including customers, the transmitter (Hydro One), the IESO, and municipalities, to ensure efficient integration of program initiatives with existing infrastructure and future plans. This collaborative approach, further detailed in Schedule 2-5-2 - Coordinated Planning with Third Parties, supports Hydro Ottawa's broader grid modernization efforts and ensures seamless integration of advanced grid functions, promoting grid stability and maximizing the benefits of distributed energy resources and demand-side flexibility. This will also allow for better communication with customers who are participating in demand side programs, and allow for better data sharing.

3.4.6. Economic Development

Enabling Growth and Investment: The program facilitates economic expansion by ensuring a reliable and scalable electricity supply to connect new customers and accommodate increased demand. Through investments in reliability, resilience, and grid modernization, the program enables the connection of new businesses, residential developments, and commercial facilities, thereby attracting investment, creating employment opportunities, and stimulating economic growth.

Adapting to Evolving Energy Needs: The program proactively addresses the evolving energy requirements of the community by ensuring the electricity distribution network can accommodate increasing demand, including the growing adoption of electric vehicles and other electrification initiatives, without compromising the safety or reliability of electricity services. This adaptability is essential to foster a thriving and prosperous economy.

Supporting Existing Businesses: Recognizing that a reliable and accessible power grid is fundamental to economic development, the program prioritizes providing consistent and dependable electricity services to support the operational efficiency, expansion, and competitiveness of existing businesses. This commitment to reliability helps retain businesses within the region and contributes to sustained job creation.

3.4.7. Environment

Reducing Emissions: By enhancing operational observability, the program will reduce the need for on-site crew investigations during service interruptions. This will decrease the emissions by Hydro Ottawa vehicles, leading to a reduction in greenhouse gas emissions and contributing to improved air quality. Enhanced grid monitoring and control capabilities will allow for more dynamic and efficient energy delivery, reducing losses and minimizing the environmental impact of electricity distribution.

Support Energy Transition: This program supports the transition to electrification by ensuring sufficient grid capacity to accommodate the wider adoption of DERs and electric vehicles. This will contribute to a reduction in emissions, promoting cleaner air and a healthier environment.

Minimize Environmental Contamination: This program contributes to minimizing the risk of environmental contamination from the electricity distribution system and enhances grid sustainability. Reducing the likelihood of pole failures and potential oil spills from overhead transformers, by strategically burying overhead power lines and reinforcing existing and new overhead infrastructure. The reinforcement of new and existing overhead assets also promotes sustainability by extending the lifespan of grid assets, reducing the need for replacements and minimizing the environmental impact of manufacturing and disposal processes. The program also promotes the use of observability devices to improve monitoring of grid assets, enabling preventative maintenance and reducing the likelihood of environmental contamination through failure

3.5. PROGRAM COSTS

The annual spend for the Distribution Enhancement Capital Program is expected to total $92.8M over the 2026-2030 period which is an increase from the $27.5M spend during the 2021-2025 timeframe.

The increased expenditure in this program is driven by the creation of two new budget programs: Distribution System Observability and Distribution System Resilience. These programs were established in response to the increasing frequency of adverse weather events, the need for grid modernization, and customer feedback. Investments in these programs include strategic undergrounding of distribution assets, grid modernization technologies, and enablement of DERs to enhance grid resilience and observability. This increased investment aligns with customer priorities for improved reliability, resilience during extreme weather events, and grid modernization, as reflected in the customer engagement survey, please refer to Schedule 1-4-2 - Customer Engagement on the 2026-2030 Application.

Table 7 presents the historical and projected future expenditures by the underlying Budget Programs, as a part of the Distribution Enhancement Capital Program. The underlying Budget Programs are detailed in the subsequent sections.

Table 7 - Historical, Bridge and Test Year Distribution Enhancements Budget Program Costs ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EOL Voltage Conversion	$ 1.4	$ 0.2	$ 0.1	-	-	-	-	-	-	-
Distribution System Reliability	$ 0.4	$ 1.0	$ 1.5	$ 8.0	$ 6.0	$ 0.9	$ 2.2	$ 0.8	$ 0.9	$ 0.9
Distribution Enhancements	$ 0.6	$ 2.0	$ 1.2	$ 2.7	$ 2.3	$ 3.7	$ 3.9	$ 4.1	$ 4.2	$ 4.4
Distribution System Observability	-	-	-	-	-	$ 5.6	$ 5.8	$ 6.1	$ 6.3	$ 6.6
Distribution System Resilience	-	-	-	-	-	$ 7.2	$ 7.6	$ 7.4	$ 7.2	$ 6.9
ANNUAL TOTAL	**$ 2.4**	**$ 3.3**	**$ 2.8**	**$ 10.7**	**$ 8.3**	**$ 17.5**	**$ 19.4**	**$ 18.5**	**$ 18.6**	**$ 18.8**
5-YEAR TOTAL	**$ 27.5**					**$ 92.8**				

3.5.1. Distribution System Reliability

The spend for the Distribution System Reliability Budget Program, as a part of the Distribution Enhancement Capital Program, is expected to total $5.8M over the 2026-2030 period which is a decrease from the $16.9M spend during the 2021-2025 timeframe.

This program is designed to enhance the overall reliability of the electricity distribution system through a range of initiatives that bolster system performance and mitigate outages. This program accounts for 6% of the overall Distribution Enhancement Capital Program budget.

3.5.2. Distribution Enhancements

The spend for the Distribution Enhancements Budget Program, as a part of the Distribution Enhancement Capital Program, is expected to total $20.3M over the 2026-2030 period which is an increase from the $8.9M spend during the 2021-2025 timeframe.

The Distribution Enhancements Program is designed to modernize and enhance grid infrastructure to accommodate the growing integration of DERs and optimize system performance. This program accounts for 22% of the overall Distribution Enhancement Capital Program budget.

3.5.3. Distribution System Resilience

The spend for the Distribution System Resilience Budget Program, as a part of the Distribution Enhancement Capital Program, is expected to total $36.3M over the 2026-2030 period with investments in strategic distribution system resilience, balancing risk mitigation with program costs. Key investments include $23.4M for feeder undergrounding of vulnerable OH sections, $1.0M for line reinforcement, $1.1M for feeder reconfiguration, $8.6M for station egress undergrounding, and $2.1M for line relocation.

The Distribution System Resilience Program is a new budget program designed to enhance the resilience of the electricity distribution network against the increasing frequency and intensity of adverse weather events. This program accounts for 39% of the overall Distribution Enhancement Capital Program budget.

3.5.4. Distribution System Observability

The spend for the Distribution System Observability Budget Program, as a part of the Distribution Enhancement Capital Program, is expected to total $30.4M over the 2026-2030 period. To enable remote feeder control, the program entails installing 20 automated overhead switches and 5 automated underground switches annually. This would achieve 30% automation of existing normally-open switches on the 8kV, 28kV and 44kV systems for a total investment of $25.4M. Additionally, implementing real-time visibility requires installing 50 Fault Circuit Indicators (FCIs) annually for a total of $5.0M.

The Distribution System Observability Program is a new budget program introduced to enhance grid reliability, flexibility, resilience, and customer engagement, while promoting sustainability. This program aligns with Hydro Ottawa's Grid Modernization Strategy. This program accounts for 33% of the overall Distribution Enhancement Capital Program budget. This strategy responds to the need to modernize deteriorating infrastructure, accommodate decarbonization efforts, and meet changing customer expectations. Further details on the Grid Modernization Strategy are available in Section 5.2.2.1 of Schedule 2-5-4 - Asset Management Process.

3.5.5. Cost Factors

Infrastructure Costs: This covers the direct costs of new equipment (transformers, feeders, substations, etc.), materials, labour for installation and construction, and any necessary land acquisition or easements. The complexity and scale of the infrastructure required directly impact these costs.

Project Complexity: The complexity of a project influences engineering, design, and project management costs. Projects requiring significant system reconfiguration, upgrades in congested areas, or specialized engineering solutions will incur higher costs. For example, upgrading a substation in a densely populated area is more complex and expensive than a similar upgrade in a less congested location.

Location and Terrain: Geographic factors, such as terrain, accessibility, and proximity to existing infrastructure, can significantly affect costs. Difficult terrain may require specialized construction techniques, while remote locations can increase material transportation and labour costs. Urban environments often present challenges related to right-of-way acquisition and traffic management, adding to project expenses.

Material Costs: Fluctuations in the cost of materials, particularly copper, steel, and electrical components, can lead to higher-than-anticipated expenses due to market volatility or supply chain disruptions.

Labour Costs: Labour shortages or the need for specialized skills could drive up labour costs.

Project Scope Changes: Unexpected changes in project scope, such as the need for additional capacity or the emergence of new regulatory requirements, can lead to cost increases. The contingency provides a financial cushion to absorb these unforeseen expenses.

Technical Challenges: Unforeseen technical challenges encountered during construction or the integration of new infrastructure with existing systems may necessitate additional resources, design modifications, or specialized expertise, all of which can impact project costs.

Project Delays: Delays caused by external factors, such as adverse weather conditions, community opposition, or permitting issues, can prolong project timelines. Extended timelines often result in increased labour and material costs, which are mitigated by the contingency allocation.

Financing and External Funding: The cost of financing the program, including interest rates on any borrowed capital, is a component of the overall program cost. These costs can vary based on market conditions and Hydro Ottawa's financing strategies. To help offset costs, Hydro Ottawa has pursued external funding opportunities, such as the contribution agreement for federal funding to support the ODERA project, more details can be found in Section 3.6.3.1 - Preferred Alternative Details.

Inflation: The impact of inflation on material, labour, and other project costs is considered in long-term planning. Inflation can erode the purchasing power of budgeted funds, so appropriate escalation factors are applied to cost estimates.

3.6. ALTERNATIVES EVALUATION

Hydro Ottawa assessed the three alternatives described below in Section 3.6.1 - Alternatives Considered under the evaluation criteria of Section 3.6.2 - Evaluation Criteria. Table 8 summarizes the costs for each of the three alternatives.

Table 8 - 2026-2030 Distribution Enhancements Program ($'000 000s)

Budget Programs	Alternative 1: Historical Approach	Alternative 2: Accelerated Approach	Alternative 3: Balanced Approach (Preferred)
Distribution System Reliability	$ 5.0	$ 5.8	$ 5.8
Distribution System Enhancement	$ 16.8	$ 20.3	$ 20.3
Distribution System Observability	-	$ 166.3	$ 30.4
Distribution System Resiliency	-	$ 178.5	$ 36.3
TOTAL	**$ 21.7**	**$ 370.9**	**$ 92.8**

Alternative 1 - Historical Approach

This alternative represents a continuation of Hydro Ottawa's historical investment strategy, focusing solely on maintaining existing programs and initiatives related to the Distribution Enhancements Capital Program. This approach prioritizes the established Distribution System Reliability and Distribution System Enhancements budget programs but does not include any new initiatives to improve system resilience or observability.

Alternative 2 - Accelerated Approach

This alternative demonstrates a proactive approach to addressing emerging challenges, it proposes an aggressive acceleration of investment in Hydro Ottawa's Distribution Enhancements Capital Program. This includes significant increases in funding for the established Distribution System Reliability and Distribution System Enhancements budget programs, along with substantial investments in the Distribution System Observability Program and the Distribution System Resilience Program. Specifically, Option 2 involves the installation of more automated devices and more extensive storm hardening and undergrounding resilience projects. This option provides customers with a more immediate improvement in grid reliability, resilience, and observability. While this accelerated approach aims to expedite grid modernization initiatives and proactively address the challenges of climate change, growing demand, and DER integration, it has significant financial implications, notably resulting in higher increased rates for customers due to the substantial investments required for these upgrades and automated systems.

Alternative 3 - Balanced Approach

This alternative represents a balanced and strategic approach to enhancing Hydro Ottawa's Distribution Enhancements Capital Program. It proposes increasing investments in the established Distribution System Reliability and Distribution System Enhancements budget programs while also prioritizing targeted investments in the Distribution System Observability Program and the Distribution System Resilience Program. This approach complements the existing programs and strikes a balance between enhancing grid resilience and observability while maintaining fiscal responsibility and ensuring a reasonable overall cost.

3.6.1. Alternatives Considered

Alternative 1 - Historical Approach

This alternative represents a continuation of Hydro Ottawa's historical investment strategy, focusing on maintaining existing programs and initiatives related to the Distribution Enhancements Capital Program. This approach prioritizes the established Distribution System Reliability and Distribution System Enhancements budget programs but does not include any new initiatives to improve system resilience or observability. While this approach may address immediate operational needs, it lacks the foresight to adapt to the evolving energy landscape, including the increasing need for climate change resilience. It potentially leaves the electricity distribution network vulnerable to emerging challenges and hinders the ability to fully leverage new technologies and opportunities.

The total cost for Distribution Enhancements Capital Program would be $21.7 M which equates to an annual average spend of $4.3M over the 2026-2030 period which is a decrease from the $5.5M average annual spend during the 2021-2025 timeframe. The breakdown of these costs under this scenario is as follows:

- **Reliability**: This alternative would encompass distribution system reliability initiatives which include worst feeder betterment through feeder reconfiguration, load balancing, protection coordination, new feeder ties and animal guards. The initiative also includes phase balancing across distribution feeders, transfers and reconfiguration for feeders exceeding planning capacity, second supply for radial feeds, and ties between stations. These initiatives would total $5.0M over the five year period.
- **Enhancements**: Minor distribution enhancement initiatives encompass third party pole ownership transfers, 13 kV neutral ties between subtransmission stations. The investment required would be $16.8 M over the five year period.
- **Resilience & Flexibility**: None
- **Grid Modernization**: None

Alternative 2 - Accelerated Approach

Hydro Ottawa will continue its existing Distribution Enhancements Capital Program investments, with a reinforced commitment to bolstering resilience and observability. This will be achieved by allocating additional resources to undergrounding, reinforcing, and automating a larger proportion of the distribution system. This alternative builds upon the existing System Reliability and Distribution Enhancements programs by significantly increasing investments in resilience and grid modernization initiatives in order to complete a greater number of projects.

The investment required for the accelerated approach is estimated to be $5.8M for distribution system reliability, $20.3M for distribution enhancements, $166.3M for observability and $178.5M for resilience, for a total of $370.9M over the 2026-2030 period.

- **Reliability**: Increase in reliability investment over the decelerating scenario, with a total of $5.8M spent over five years for worst feeder betterment, phase balancing, reconfiguration, and station ties.
- **Enhancements**: Increase in system enhancement investment over the decelerating scenario, with a total of $20.3M spent over five years for third party pole ownership transfers, 13 kV

neutral ties and DER enablement initiatives. This alternative introduces flexible load dispatch enablement activities through a pilot project that will leverage Predictive Analytics and customer-owned DERs/assets with advanced integrations to predict both grid loading and available load curtailment potential. This information will facilitate granular scheduling and deployment of load curtailment to mitigate predicted equipment overload and maximize the grid capacity.

- **Resilience & Flexibility**: Investment for undergrounding and storm hardening measures to further enhance the system's ability to withstand severe weather through additional line reinforcement, line relocation, and station egress undergrounding. These investments will improve flexibility in outage response by allowing the grid to be more adaptable and responsive to outages, enabling faster power restoration. They will also allow the grid to recover more rapidly from disruptions, leading to improved overall system stability. Investment in strategic undergrounding of distribution feeders would total $115M over five years, line reinforcement would total $5M, feeder reconfiguration $5.5M, station egress undergrounding $42.5M, and line relocation $10.5M, for a total investment of $178.5M over five years for distribution system resilience.
- **Grid Modernization**: Under the new Distribution System Observability program introduces substantial investments in real-time visibility and remote control of feeders, a pilot of self-healing grid capabilities, and a centralized wireless device management system. Remote control of feeders would entail the annual installation of 92 new automated overhead switches and 45 new automated underground switches annually, resulting in 100% automation of all existing normally-open overhead and underground switches on the 8kV, 28kV and 44kV systems over the 5 year periods. The cost of the automated switch investment would be $158.8M over the five year period. Investment in real-time visibility would entail the installation of 75 FCIs on an annual basis for a total of $7.5M over the 5 years. These projects aim to improve situational awareness, reduce outage durations, enhance efficiency, and bolster cyber security for a total of $166.3M over 2026-2030.

Alternative 3 - Balanced Approach

In this alternative, in addition to the existing programs of System Reliability and Distribution Enhancements, targeted and strategic investments will be made in the System Resilience and System Observability programs.

The investment required for the recommended approach is estimated to be $5.8M for distribution system reliability, $20.3M for distribution enhancements, $30.4M for observability and $36.3M for resilience, for a total of $92.8M.

- **Reliability**: Total of $5.8M invested over five years for worst feeder betterment, phase balancing, reconfiguration, and station ties, the same proposal as under Alternative 2.
- **Enhancement**: Total of $20.3M invested over five years for third party pole ownership transfers, 13 kV neutral ties and DER enablement initiatives. This alternative introduces flexible load dispatch enablement activities through a pilot project that will leverage Predictive Analytics and customer-owned DERs/assets with advanced integrations to predict both grid loading and available load curtailment potential. This information will facilitate granular scheduling and deployment of load curtailment to mitigate predicted equipment overload and maximize the grid capacity. This is the same proposal as under Alternative 2.
- **Resilience & Flexibility**: This option will enable fewer customers affected by major storms, faster restoration efforts, increased flexibility in responding to outages, and quicker system recovery and stabilization after storms, all at a significantly lower cost compared to the accelerated approach. In this alternative, resilience investments were proposed to balance resilience risk mitigation with investment levels. Investment in strategic undergrounding of distribution feeders would total $23.4M over five years, line reinforcement would total $1.0M, feeder reconfiguration $1.1M, station egress undergrounding $8.6M, and line relocation $2.1M, for a total investment of $36.3M over five years for strategic distribution system resilience.
- **Grid Modernization**: Targeted investments in real-time visibility and remote control of feeders to enhance situational awareness and reduce outage duration. Remote control of feeders would

entail the annual installation of 20 new automated overhead switches and 5 new automated underground switches, resulting in 30% automation of all existing normally-open overhead and underground switches on the 8kV, 28kV and 44kV systems over the five year period. The cost of the automated switch investment would be a total of $25.4M over the five year period. Investment in real-time visibility would entail the installation of 50 FCI's on an annual basis for a total of $5.0M over the five year period. These projects aim to improve situational awareness, reduce outage durations, enhance efficiency, and bolster cyber security at a total cost of $30.4M over the five year period.

3.6.2. Evaluation Criteria

System Reliability

This criterion assesses the distribution system's ability to provide uninterrupted power to customers. Reliability enhancements aim to reduce the frequency and duration of outages by addressing aging infrastructure, load imbalances, early detection of equipment failures and system reconfiguration to build redundancy.

System Resilience

This criterion evaluates the distribution system's ability to withstand disruptions and recover quickly from extreme weather events or unexpected events.

Hydro Ottawa's distribution system has been significantly impacted by a recent series of severe weather events, notably the 2022 Derecho storm. The Ottawa region is also experiencing an increase in the frequency and intensity of extreme weather events, including tornados, lightning storms, ice storms and heavy snowfalls, highlighting the need for ongoing investment in grid resilience to mitigate the effects of climate change.

System Observability

System observability is critical for enhancing operational awareness and enabling informed decision-making. Increased grid visibility allows Hydro Ottawa to monitor asset health in real-time, detect faults quicker, and optimize power flow. Grid modernization projects under this criterion focus on integrating smart technologies, automated switches, and real-time data analytics. These technologies enable Hydro Ottawa to operate the grid more efficiently, minimize energy losses, improve load management, and support the integration of renewable energy sources.

System Accessibility

This criterion focuses on the ease of accessing available capacity on the distribution network to accommodate growing demand. Projects under this criterion ensure the grid can handle increasing loads without compromising service quality. This may include expanding feeder capacity, building redundancy through inter-station ties, or reinforcing key network sections to support new customer connections or growing energy needs. By improving capacity availability, Hydro Ottawa ensures a flexible system capable of supporting both current and future loads, while minimizing the risk of overloads and voltage drops.

Safety

This criterion prioritizes the protection of both the public and Hydro Ottawa's personnel from electrical hazards. This includes modernizing outdated infrastructure, ensuring proper insulation of overhead lines, increasing clearances in densely populated areas, and adhering to the latest safety codes and standards. Projects may also focus on reducing the risk of faults that could lead to fires, electrical shocks, or equipment failures. By prioritizing safety, Hydro Ottawa minimizes potential risks, enhances system reliability, and creates a safer working environment for utility crews and a more secure electrical system for customers.

Financial

This criterion assesses alternatives based on their cost-effectiveness in meeting system requirements, while simultaneously balancing improvements in distribution system resilience, reliability, automation, and real-time visibility against the goal of minimizing customer rate impacts.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

3.6.3. Preferred Alternative

While Alternative 1 - the Historical Approach offers lower initial costs, it fails to address critical reliability and resilience needs. Maintaining the status quo would leave Hydro Ottawa vulnerable to increasingly severe weather events, resulting in more frequent and prolonged outages, escalating repair costs, and missed opportunities for grid modernization and the enablement of DER integration. Specifically, this approach neglects essential investments in resilience improvements, real-time grid visibility, and remote control capabilities hindering progress towards a modern, reliable, and resilient grid.

The "Do Nothing" approach of Alternative One fails to address the growing challenges facing the distribution system. It prioritizes short-term cost savings over long-term reliability and adaptability, potentially leading to increased costs and service disruptions in the future.

Alternative Two - Accelerated Approach, offers significant enhancements to grid resilience, flexibility, and outage response. However, the high cost and resource requirements associated with its implementation renders it less favourable. The substantial financial investment required does not justify the incremental benefits of completing a larger number of initiatives.

Alternative Three - Balanced Approach, is preferred due to its strategic combination of existing programs with targeted investments in resilience and grid modernization. This approach achieves a balance between enhancing grid reliability and observability while maintaining cost-effectiveness. By prioritizing targeted investments, it provides a strong and adaptable foundation for improving grid performance and enabling advanced flexible load management in a staged approach, allowing for future optimization as technology and the grid needs evolve.

3.6.3.1. Preferred Alternative Details

Distribution System Reliability

This program is designed to enhance the overall reliability of the electricity distribution system through a range of initiatives that bolster system performance and mitigate outages. The initiatives include optimizing feeder configurations, proactively addressing capacity constraints, enhancing system observability through advanced technologies, and improving distribution efficiency.

This program encompasses the following initiatives:

- **Worst Feeder Betterment:** Improving the performance of the most problematic feeders by installing sectionalizing devices (e.g. reclosers and automated switches), upgrading distribution protection, adding animal guards, and reconfiguring feeders. Prioritization for worst feeder betterment is determined through the annual poor performing feeder evaluation and report.
- **Distribution Phase Balancing:** Optimizing the balance of electrical load across feeders to improve efficiency and reduce losses. This is achieved through a combination of strategies, including switching operations and new switch installations, to ensure a more efficient, reliable, and cost-effective power supply for all customers.
- **Feeder Loading Limits:** Addressing overloaded feeders by transferring load through switching operations and installing new switches. These switches provide flexibility for managing load during peak demand periods, enabling system operators to distribute electricity effectively and prevent overloads. Feeder loading limits are assessed and prioritized based on annual peak loading analysis.

- **Feeder Ties:** Enhancing redundancy by extending feeders to provide alternative supply paths, thereby reducing the impact of outages on customers. This involves establishing new connections between existing feeders, allowing for faster restoration of service by isolating faulted sections and rerouting power through alternative pathways.

These initiatives are informed by the reliability assessment process which is further detailed in Section 5.2.2.3 of Schedule 2-5-4 - Asset Management Process.

Distribution Enhancements

The Distribution Enhancements Program is designed to modernize and enhance grid infrastructure to accommodate the growing integration of DERs and optimize system performance. This program encompasses a range of initiatives aimed at improving system reliability, system observability, and fostering technological innovation to enhance grid flexibility and resilience.

This program encompasses the following initiatives:

- **Extending 13 kV Neutral Ties:** This project will establish 13 kV station neutral ties to extend the system neutral between subtransmission stations, along with other minor enhancements. Specifically, this work will be performed on the existing 13 kV distribution system, entailing the installation of approximately 6,700 meters of neutral conductor per year. This will be accomplished by pulling neutral cable through existing ducts of the 13 kV sub-transmission network. Establishing 13 kV station neutral ties will enhance system stability and reliability by providing a stable reference voltage and ensuring proper operation of protective devices. This will minimize the risk of voltage imbalances and potential equipment damage, contributing to a more reliable and resilient network. Annual system studies will inform the prioritization and scheduling of these initiatives.
- **Transferring Critical Lines:** The program will strategically transfer critical overhead lines to Hydro Ottawa-owned poles to enhance control and maintenance capabilities, improving overall

system reliability and efficiency. By owning and managing these poles, Hydro Ottawa can ensure timely maintenance, implement consistent inspection schedules, and proactively address potential issues, minimizing the risk of outages and disruptions, and improving the overall efficiency of grid operations.

- **DER Enablement Initiatives:** This includes pursuing projects that explore DER enablement through renewable energy integration, grid modernization, energy storage, and system integrations that will leverage demand-side resources. Hydro Ottawa is preparing to launch The Ottawa DER Accelerator (ODERA) Project. In March 2025, Hydro Ottawa executed a contribution agreement to access federal funding towards this project, in addition to the investment requested in this program allowing Hydro Ottawa to execute work sooner while not burdening the ratepayer with the associated cost. This innovative pilot project will leverage Predictive Analytics and customer-owned DERs/assets with advanced integrations to predict both grid loading and available load curtailment potential. This information will facilitate granular scheduling and deployment of load curtailment to mitigate predicted equipment overload and maximize the grid capacity.

ODERA Project

The ODERA project is a pilot initiative in the Kanata North region designed to enhance grid reliability and efficiency by optimizing asset utilization, mitigating capacity constraints, and improving long-term asset planning through the strategic deployment of demand-side resources. This approach empowers customers to actively participate in the evolving energy landscape by leveraging their distributed energy resources (DERs). The Kanata North region was selected for this pilot as it has capacity constraints and a higher-than-average history of equipment-related outages, providing an opportunity to test and validate this NWSs while addressing real grid needs.

Planning for the ODERA project commenced in Q4 2024, with the project planned to begin in Q1 2025 and continue through 2028. When complete, Hydro Ottawa will evaluate the feasibility of scaling the technology for use across its distribution territory.

This innovative project will utilize Predictive Analytics and advanced integration of customer-owned DERs/assets to forecast grid loading and assess available load curtailment potential. This information will enable granular scheduling and deployment of load curtailment to mitigate predicted equipment overload and optimizing grid capacity. In this project customers will be incentivized to enroll their devices.

The ODERA project is expected to enhance grid flexibility through the implementation of NWSs and reduce overloading of distribution assets in capacity constrained Kanata North. With sufficient customer participation, this project can effectively manage electricity demand peaks, alleviating capacity constraints and deferring or eliminating the need for costly infrastructure upgrades. Furthermore, it will mitigate equipment overloads, extending asset useful life and reducing premature equipment replacement.

This project aligns with Hydro Ottawa's Grid Modernization roadmap, showcasing the effective integration and management of DERs to address grid capacity challenges.

Distribution System Resilience

The Distribution System Resilience Program is a new budget program designed to enhance the resilience of the electricity distribution network against the increasing frequency and intensity of adverse weather events.

This emphasis on resilience is of paramount importance given that Ottawa has become the weather-alert capital of Canada, experiencing a surge in extreme weather events that place significant strain on and cause damage to the electricity grid. Recent events, such as the devastating 2022 Derecho, tornadoes, ice storms, and flooding, have underscored the vulnerability of the grid and the critical need for proactive measures to enhance its resilience.

This program encompasses the following initiatives:

- **Strategic Undergrounding:** The strategic burying of vulnerable overhead power lines to reduce exposure to weather-related damage. Unlike broad overhead system renewal, strategic undergrounding targets specific vulnerabilities to improve distribution system resilience. This involves undergrounding feeders with the highest benefit-to-cost ratio, focusing on: increasing resilience for critical infrastructure (hospitals, emergency services), addressing wind-related vulnerabilities in open areas with north-south pole lines, and targeting high-impact pole lines to reduce the number of overhead circuits. The identification and prioritization for strategic undergrounding is detailed in Hydro Ottawa's resilience assessment in Section 5.2.2.4 of Schedule 2-5-4 - Asset Management Process.
- **Storm Hardening:** This initiative aims to strengthen existing and new overhead infrastructure against extreme weather by replacing vulnerable wooden poles at critical locations like railway and highway crossings with stronger concrete and composite poles, and by implementing more robust construction standards for lines carrying more than two circuits. To increase loading capability and prevent cascading failures, additional guying and anchoring will be installed on approximately every fifth pole along north-south lines. Stress on poles will be further reduced by shortening span lengths or installing mid-span poles. Prioritization of these reinforcements will be based on pole line orientation and exposure to predominant wind patterns, with north-south lines and areas prone to severe weather receiving immediate attention.

- **Feeder Reconfiguration:** This initiative will optimize the configuration of electricity feeders to improve system redundancy and minimize the impact of outages. This includes reducing the number of customers served by each primary supply segment, implementing ties and distributed automation for looped supplies, and strategic segmentation. Feeder reconfiguration is prioritized based on customer count and the number of laterals.
- **Station Egress Undergrounding:** This initiative will enhance the protection of critical station infrastructure by burying station egress points with more than two circuits.
- **Line Relocation:** This initiative will relocate vulnerable power lines to less exposed areas to reduce the risk of damage. This includes relocating lines from areas that are difficult to access,

with prioritization based on surrounding vegetation and insights from Hydro Ottawa inspections. These inspections consider factors such as the age and condition of the lines, the terrain, proximity to trees, and the history of outages and repairs. This allows for prioritizing line relocations that will have the greatest impact on reducing the risk of damage and improving the reliability of electricity supply.

Distribution System Observability

The Distribution System Observability Program is a new budget program introduced to enhance grid reliability, flexibility, resilience, and customer engagement, while promoting sustainability. This program aligns with Hydro Ottawa's Grid Modernization Strategy.

This program encompasses the following initiatives:

- **Remote Operable Switches:** Remote control of feeders through automated overhead and underground switches on the distribution system. Prioritization of locations based on normally-open tie-points, peak feeder loading, and respective customer count. Hydro Ottawa has set a target to improve Controllability & Observability to provide remote operability to 30% of all normally-open overhead and underground switches by 2030. Refer to Section 6 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement.
- **Smart Fault Circuit Indicators:** Real-time telemetry visibility of distribution feeders at strategic locations on the distribution network. Prioritization of locations based on history of frequent faults, long feeders, major intersections, and worst performing feeders.

These initiatives are critical to provide real time data to enable the adoption and implementation of innovative control and optimization technologies. Hydro Ottawa's Grid Modernization Strategy, as described in Section 3.4.2 of Schedule 2-5-4 - Asset Management Process, serves as the foundation for the Grid Modernization Roadmap. This Roadmap will guide the prioritization and execution of initiatives to modernize the grid and achieve corporate objectives.

The planned initiatives as guided by the Grid Modernization Roadmap will be executed within the 2026-2030 timeframe. Annual studies will inform the prioritization and scheduling of these initiatives.

If any projects require expedited action due to higher urgency, adjustments may be made, including, switching, deferring, adding, adjusting or removing projects as needed.

3.7. PROGRAM EXECUTION AND RISK MITIGATIONS

3.7.1. Implementation Plan

All initiatives under the Distribution Enhancements Program will be implemented throughout the 2026-2030 period, as shown in Table 9. Annual system studies will inform the program prioritization, and if any projects under this category require expedited action, adjustments may be made, including switching, deferring, adding, altering or removing projects as necessary.

Table 9 - Proposed Projects Under the Distribution Enhancement Program

Year	Proposed Projects
2026-2030	• Worst Feeder Betterment • Distribution Phase Balancing • Feeder Loading Limits • DER Enablement - ODERA Project • 13 kV Neutral Ties • Distribution System Resiliency- Strategic Undergrounding and other Storm Hardening Measures • Distribution System Observability- Switch Automation, Installation of Fault Circuit Indicators, Monitoring and Control Boxes

3.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Distribution Enhancements Program; Table 10 identifies the key risks and corresponding mitigation strategies.

1 **Table 10 - Key Risks for the Distribution Enhancement Program and Mitigation Strategies**

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors, will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Public Opposition to Projects	As with many construction projects, opposition from some members of the community are always expected which pose a risk to program delivery schedule and cost.	Ensure public consultation well in advance of project execution and include contingency budget to mitigate public concerns.
Regulatory and Compliance Risks	Rapidly changing regulations may require changes to designs (such as how DER's are managed) pose a risk to project delivery, schedule, and budget.	Maintain compliance by integrating industry best practices and regulatory requirements into the upgrade planning process. Conduct regular audits and risk assessments to stay ahead of regulatory deadlines.Participate in regulatory committees and proactively prepare designs for compliance.
Customer Participation and Engagement	Programs involving DER's are reliant on customer participation (such as the ODERA project). Insufficient customer participation in DER programs pose a risk to program delivery and schedule.	Review best practices around customer engagement for DER programming from neighbouring utilities already utilizing similar DERs with programs. Building on those learnings, a pilot program in a targeted area allows Hydro Ottawa to learn about the technological capabilities while gaining a better understanding of the value and experience customers require to participate.
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks

Category	Risk	Mitigation
	risk to program delivery cost, schedule, and scope.	early and implementing on a case by case basis.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labour which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.

4. STATIONS ENHANCEMENTS

4.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $2.6M

2026-2030: $3.0M

Budget Program: Station Cyber Security, Station Temp Sensors

Main Driver: Asset Controllability & Observability

Secondary Driver: System Reliability

Outcomes: Operational Effectiveness

The expenditures under the Station Enhancements Program are aimed at increasing visibility into the station assets and improving reliability and operability through increasing remote operability and reporting/alarms. Additionally, this program includes station investments driven by the Station Cyber Security initiative to ensure Hydro Ottawa is able to identify, protect and detect cyber threats on these critical systems. The prioritized projects under the Station Enhancements Program include modifications to existing stations that are made to improve system operating characteristics.

Hydro Ottawa plans to invest $3.0M to address needs under the following categories over the 2026-2030 rate period:

Station Temp Sensors: This initiative's focus is to continue to deploy online monitoring solutions to support the real-time temperature and dissolved gas monitoring of station transformers.

Station Cyber Security: This program's focus is to continue to deploy OT Cyber Security devices in the remaining Hydro Ottawa substations as a network traffic anomaly detection monitoring tool.

4.2. PERFORMANCE OUTCOMES

The implementation of the Station Enhancements Program is expected to lead to improvements in the outcomes detailed in Table 11.

Table 11 - Performance Targets for the Station Enhancement Program

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	Online station transformer monitoring shall help contribute to the proactive management of station transformers and improve observability in terms of available real-time condition information.

4.3. PROGRAM DRIVERS AND NEED

4.3.1. Main and Secondary Drivers

The main and secondary drivers for this program are as follows:

Primary Driver: Asset Controllability & Observability;
Online monitoring solutions are vital in proactively identifying transformers with developing faults. Once a transformer is identified as having a developing fault (electrical or thermal), it can be planned to be removed from service for maintenance, and corrective actions can be proactively implemented. The use of online monitoring helps improve the observability of Hydro Ottawa's station transformers and their relevant proactive management. Asset controllability is also met by implementing station transformer online monitoring systems, based on the control upgrade and automation implementation.

Secondary Driver: System Reliability;
Station transformers have a direct impact on system reliability, as all customers connected would experience a power outage in the event of a failure. Online monitoring solutions will decrease the likelihood of an unexpected transformer failure due to an electrical/thermal fault.

4.3.2. Current Issues

Station Transformer Monitoring

Over half (53%) of Hydro Ottawa's 170 station transformers have reached, or are within 10 years of reaching, their typical useful life. In order to better manage its station transformer fleet, Hydro Ottawa needs to continue to invest in transformer monitoring technologies. Winding temperature and dissolved gas data are necessary to evaluate the health of station transformers and to determine if there are any growing internal defects. However, such online monitoring solutions are not available at many stations. With electrification and growing power demands, the number of station transformers exceeding their planning capacity rating has increased, thereby having electrical or thermal implications on the transformer's remaining useful life.

At several of these stations, transformers can be retrofitted with magnetic-mount Resistance Temperature Detectors (RTDs) and temperature monitoring units to capture, store, and communicate thermal data. Transformers can also benefit from the use of Online Dissolved Gas Analyzers (ODGAs). ODGAs periodically draw samples of oil from the transformer's tank and determine the concentration of various fault gases within the oil. This data is useful for identifying potential electrical and thermal faults as the transformer's condition worsens, but before an actual fault occurs. This allows Hydro Ottawa to remove the transformer from service and plan maintenance strategies accordingly. Existing transformers can be retrofitted with ODGAs to monitor the concentration of combustible gases. Only transformers connected to transmission or sub-transmission systems (44 kV and higher) will be fitted with ODGA units to balance cost vs. benefit.

Station Cyber Security

Remaining substations that don't have the OT Cyber Security sensors represent critical vulnerabilities in the security infrastructure, refer to Section 4.4.4 - Cyber Security and Privacy. These gaps create blind spots in network visibility, hindering real-time threat detection and response capabilities. This leaves these substations susceptible to cyberattacks that can disrupt operations, compromise grid stability, and potentially lead to power outages. Additionally, the lack of comprehensive monitoring across all substations makes it difficult to identify and respond to anomalies, potentially delaying mitigation efforts and increasing the impact of security incidents. This fragmented security posture increases the overall risk profile of the utility company and jeopardizes its ability to maintain reliable and secure power delivery.

4.4. PROGRAM BENEFITS

Key benefits that will be achieved by implementing the Station Enhancements Program are summarized in the section below.

4.4.1. System Operation Efficiency and Cost Effectiveness

The proposed station enhancements will increase observability on the system by providing live monitoring data, enable more efficient response to station transformer issues and allow for proactive management. Online monitoring solutions provide real-time data for condition assessment and help prevent a potential catastrophic transformer failure and related emergency replacement costs.

4.4.2. Customer

This program improves reliability for customers by enabling proactive management of station transformers reducing the risk of failures from electrical or thermal faults. Additionally, these investments enable Hydro Ottawa to respond more efficiently to station outages, minimizing disruptions and upholding public confidence in Hydro Ottawa's ability to provide reliable service.

4.4.3. Safety

Installing temperature and ODGA monitoring systems reduces the risk of thermal and electrical faults, as well as hot oil being expelled from the pressure release valve. Installing ODGA units reduces the risk of internal faults, as they can be detected in a proactive manner. The program's focus - to mitigate the risks by reducing the likelihood of station transformer failures - enhances the safety of Hydro Ottawa station employees, in particular.

4.4.4. Cyber Security and Privacy

Continuing the deployment of OT Cyber Security sensors in its substations significantly enhances cyber security and privacy. By continuously monitoring network traffic and device behavior, these sensors provide real-time visibility into potential threats, enabling proactive identification and mitigation of cyberattacks. This strengthens the security posture of the substation, reducing the risk of disruptions to critical operations and protecting sensitive data from unauthorized access. With improved anomaly detection and threat intelligence, OT Cyber Security sensors help safeguard grid stability and ensure the reliable delivery of electricity while maintaining the privacy of sensitive operational data.

4.4.5. Coordination and Interoperability

Enhancing system observability through station transformer monitoring will facilitate informed decision-making and support the proactive management of station transformers. Real-time information from ODGA units (specifically on combustible gases) and temperature monitors help detect developing internal faults and plan the next course of action. For example a partial discharge (PD) issue caused by elevated hydrogen gassing would require transformer detanking and an internal inspection to fix the PD source. Potential carbonization of insulating paper in addition to elevated winding temperatures would require transformer offloading and a removal of moisture in paper. By reviewing real-time dissolved gas/temperature data, Hydro Ottawa performs additional analyses to decide on the potential maintenance/refurbishment activity, to avoid a catastrophic transformer failure.

4.4.6. Economic Development

Investing in station transformer monitoring solutions allows for improving the reliability of Hydro Ottawa's distribution system (at its substations). A reliable and accessible power grid is a fundamental requirement for economic development, and this program ensures that Hydro Ottawa can meet the evolving energy needs of the community, fostering a thriving and prosperous economy.

4.4.7. Environment

Implementing station transformer online monitoring systems will reduce the risk of environmental oil contamination caused by failure and oil expulsion.

4.5. PROGRAM COSTS

In the 2021-2025 rate period, a total of $2.6M was invested in station enhancements/improvements through the installation of temperature and ODGA units. In the upcoming 2026-2030 rate period, a planned expenditure of $3.0M will be allocated to the Stations Enhancements Program. This increased level of expenditure will support additional investments for Hydro Ottawa's cyber security program and continue to leverage the installation of station transformer online monitoring systems.

Table 12 summarizes the historical and proposed future spending for the Stations Enhancements Program.

Table 12 - Historical, Bridge and Test Year Stations Enhancement Budget Program Costs ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Stations Enhancements	$ 0.1	$ 1.2	$ 0.2	$ 0.7	$ 0.4	$ 0.5	$ 0.6	$ 0.6	$ 0.7	$ 0.7
ANNUAL TOTAL	**$ 0.1**	**$ 1.2**	**$ 0.2**	**$ 0.7**	**$ 0.4**	**$ 0.5**	**$ 0.6**	**$ 0.6**	**$ 0.7**	**$ 0.7**
5-YEAR TOTAL					**$ 2.6**					**$ 3.0**

4.5.1. Station Enhancements

The scope of the Stations Enhancements Program encompasses proposed investments in station transformer online monitors and continuing to enhance station cyber security. Currently, 55 (approximately 32%) of Hydro Ottawas' station transformers have an ODGA monitor installed, while 27 units (approximately 16%) have an online temperature monitor.

Through the station enhancements program, Hydro Ottawa will install temperature monitoring systems on a select fleet of station transformers that currently do not have the ability to monitor winding temperature. The candidate transformers chosen would be based on stations that are close to or exceeding the planning capacity rating, alongside signs of other insulation aging factors such as high insulation moisture content and the presence of dissolved gases.

Hydro Ottawa would also install ODGA units on a select population of station transformers connected to a transmission or sub-transmission system (44 kV and over) without any existing monitoring available. The candidate transformers chosen would be based on the presence of dissolved gases with the potential to result in thermal or electrical faults.

The scope of the station enhancements program through 2026-2030 involves:

- Retrofitting 22 transformers with temperature monitoring systems, which will increase the overall proportion of transformers with a temperature monitor from 16% in 2024 to 28% by 2030
- Retrofitting 10 transformers with ODGA units, which will increase the overall proportion of transformers with an ODGA monitor from 32% in 2024 to 38% by 2030

4.5.2. Cyber Security

The Station Enhancements Program involves a continuation of Hydro Ottawa's cyber security initiatives. It is to continue deploying OT Cyber Security sensors in the 45 remaining substations as a network traffic anomaly detection monitoring medium.

4.5.3. Cost Factors

The cost of initiatives under the Stations Enhancements Program could be influenced by factors such as resource constraints, which may require outsourcing work to third parties, and potential increases in material costs. To mitigate this risk, a dedicated Project Manager shall be assigned to oversee the station enhancement initiatives, alongside planning resourcing for the relevant implementation on-site.

4.6. ALTERNATIVES EVALUATION

4.6.1. Alternatives Considered

To achieve the objectives of the Stations Enhancement program, two alternatives were considered:

Alternative 1: Do nothing; This alternative involves no investments or plans to implement the initiatives of the Stations Enhancements Program.

Alternative 2: Implement the Program as described above; This alternative involves implementing the ODGA and winding temperature monitoring solutions at select station transformers, as determined by analyzing the extent of utilization, loading profile, insulation condition and extent of dissolved gases present.

4.6.2. Evaluation Criteria

Safety

Hydro Ottawa puts the safety of its employees and the public at the center of its decision-making process. By reducing the risk of thermal, electrical, and internal faults, the installation of temperature and ODGA monitoring systems enhances the safety of Hydro Ottawa station employees and the safety of a public reliant on electricity by mitigating the likelihood of station transformer failures.

System Reliability and Observability

This criterion assesses the distribution system's ability to provide uninterrupted power to customers. Station enhancements aim to reduce the frequency and duration of outages by addressing deteriorating station transformer infrastructure and helping with their proactive management. The preferred alternative shall also enhance the ability to monitor or diagnose the state of the station transformers, in line with Hydro Ottawa's grid modernization initiatives/efforts, and reduce the probability of potential failures, leading to improved reliability, fewer outages, and cost savings.

Financial

The preferred alternative is one that leads to relevant planned renewal projects (through proactive monitoring of station transformer condition), where appropriate staffing resources can be allocated, rather than unplanned renewal projects that would lead to costly transformer renewal and take resources away from other work.

Environmental

The chosen alternative shall help mitigate potential environmental risks/concerns around station transformer leaks due to unplanned failures.

Resources

The preferred alternative shall result in fewer unplanned or reactive renewal projects. Advanced planning and visibility into actual station transformer condition will result in greater optimization and allocation of internal and external project resources.

Cyber Security

Deploying OT Cyber Security sensors across all remaining substations strengthens Hydro Ottawa's security posture by eliminating blind spots, enabling proactive threat detection and response, and ensuring the reliable and secure delivery of electricity across the entire grid.

Resource & Material Procurement Efficacy

Ability to achieve successful and timely execution of the capital investment plan by demonstrating optimized resource management (internal and external) and ensuring the reliable procurement of required quantities of materials within planned timelines and budgets.

4.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 4.6.1 - Alternatives Considered under the evaluation criteria of Section 4.6.2 - Evaluation Criteria.

If the Stations Enhancements Program is not executed in the 2026-2030 period (Alternative 1), then station transformers will pose an increased risk to safety and reliability due to an imminent failure risk. Transformers would continue to be unmonitored and new monitoring systems would have to be implemented over a longer timeline alongside new transformer installations.

Failure to implement the Stations Enhancement Program will result in a backlog of end-of-life transformers with unknown operational and condition status. Without online monitoring to detect thermal and electrical faults, the risk of catastrophic transformer failures increases, leading to substantial financial loss. Additionally, long lead times for new station transformer procurement will strain the existing fleet, further elevating failure risk and potentially necessitating additional spending for emergency transformer relocation from other stations.

Failing to deploy OT Cyber Security sensors in all remaining substations leaves Hydro Ottawa vulnerable to cyberattacks and operational disruptions. These unprotected substations become weak points in the grid, susceptible to breaches that could compromise critical systems, disrupt power distribution, and potentially lead to cascading failures across the network. This lack of comprehensive security monitoring hinders timely threat detection and response, increasing the risk of prolonged outages and financial losses. Additionally, it leaves the utility with an incomplete picture of its overall security posture, making it difficult to identify vulnerabilities and implement effective mitigation strategies.

4.7. PROGRAM EXECUTION AND RISK MITIGATIONS

4.7.1. Implementation Plan

Table 13 shows the timeline of proposed projects for the 2026-2030 period.

Table 13 - Proposed Projects under the Stations Enhancements Program

Year	Proposed Projects
2026	Winding Temperature Sensor Installation: • Terry Fox MTS (T1 and T2) • Cyrville MTS (T1 and T2) • South March DS (T2) ODGA Sensor Installation: • Parkwood Hills DS (T1 and T2) Deploy OT Cyber Security sensors: • 15 Substations
2027	Winding Temperature Sensor Installation: • Limebank MS (T1, T2 and T4) • Beaverbrook MS (T1 and T2) ODGA Sensor Installation: • Beaverbrook MS (T1 and T2) Deploy OT Cyber Security sensors: • 15 Substations
2028	Winding Temperature Sensor Installation: • Richmond North DS (T1) • Parkwood Hills DS (T1 and T2) ODGA Sensor Installation: • Rideau Heights DS (T1 and T2) Deploy OT Cyber Security sensors: • 15 Substations
2029	Winding Temperature Sensor Installation: • Janet King DS (T2) • Longfields DS (T1) • Woodroffe DS (T1) • Centrepointe DS (T1 and T2) ODGA Sensor Installation: • Centrepointe DS (T1 and T2)

Year	Proposed Projects
2030	Winding Temperature Sensor Installation: ● Jockvale DS (T1) ● Bayshore DS (T1) ● Moulton MS (T1 and T2) ODGA Sensor Installation: ● Bayshore DS (T1) ● Jockvale DS (T1)

4.7.2. Risks to Completion and Risks Mitigation Strategies

Hydro Ottawa faces several risks in managing its Stations Enhancements Program; Table 14 outlines the key risks and corresponding mitigation strategies.

Table 14 - Key Risks to Stations Enhancements Program and Mitigation Strategies

Category	Risk	Mitigation
Project Planning & Execution	Adjustments to third-party energization schedules, required distribution system upgrades, and potential logistical challenges (equipment delivery delays) can complicate project planning, posing a risk to program delivery cost, and schedule.	Hydro Ottawa will prioritize flexible project designs and budgets, proactive communication with third-party requesters, and robust resource planning. Long-term infrastructure plans will be developed, and resources will be allocated efficiently. Close coordination with suppliers and contractors will ensure timely execution. Additional details related to 3rd party coordination are provided in Section 6 of Schedule 2-5-2 - Coordinated Planning with Third Parties
Project Unknowns	The unknowns associated with technology and construction projects pose a risk to program delivery schedule, cost, and scope.	Develop detailed budgets with contingencies and monitor financial and schedule performance closely throughout the project lifecycle. Additionally, Hydro Ottawa's comprehensive risk management framework will help to mitigate unknowns associated with technology and construction projects.
Regulatory Approvals & Permits	Increases in work volumes across the industry have led to long turnaround times for review and approval of permits and other regulatory reviews; this poses a risk to the program delivery schedule.	It is standard practice to engage early and communicate plans for future work with the City of Ottawa and other external approval bodies.

Category	Risk	Mitigation
Supply Chain	Supply chain pressures due to shortages, tariffs, and other factors may lead to equipment/material cost increases, and delays which pose a risk to program delivery cost, schedule, and scope.	Continue to coordinate closely with suppliers and contractors to ensure timely equipment/material delivery and installation, while identifying specific supply chain risks early and implement mitigation strategies on a case by case basis.
Weather and Environment	Adverse weather and environmental conditions, as well as severe weather events impact the ability to execute work and in some cases requires reprioritization of resources to address damages to plant. These scenarios pose a risk to program delivery schedule and cost.	Create and where required implement contingency plans to account for weather-related delays and environmental factors.
Resource Availability	The demand for skilled personnel across many industries may lead to a shortage in skilled labour which poses a risk to program delivery schedule, and cost.	Plan resource needs well in advance and maintain strong relationships with contractors to secure reliable access to contract resources. Additionally, continued training programs and partnerships with post secondary institutes help to maintain a pipeline of skilled personnel.
Safety	Safety incidents during the connection process or construction pose a risk to program delivery schedule and cost.	Continue to enforce strict safety protocols, offer comprehensive training, and conduct regular audits and inspections to ensure safe work practices.

5. GRID TECHNOLOGIES

5.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $20.8M

2026-2030: $6.4M

Budget Program: SCADA Upgrades

Main Driver: System Efficiency

Secondary Driver: Reliability and Security

Outcomes: Operational Effectiveness

The Grid Technologies Program implements robust technical solutions that enhance observability and controllability by combining data acquisition, monitoring and control capabilities to actively manage electricity distribution grid operations. This program focuses on the Advanced Distribution Management System (ADMS) and supports the automation of grid troubleshooting and asset monitoring. This includes the collection of data that supports adjacent programs such as the Enterprise Asset Management system, Data and Systems Integration as well as the complimentary Grid Technology program under the General Plant investment category. The data and adjacent programs are used for preventative, condition-based, and predictive maintenance through data-driven decision-making. These initiatives are key components of the Hydro Ottawa Grid Modernization Strategy, refer to Section 3.4.2 of Schedule 2-5-4 - Asset Management Process.

In total, Hydro Ottawa plans to invest an estimated $6.4M through the Grid Technology program in the 2026-2030 rate period compared to a historical spending of $20.8M in the 2021-2025 rate period. The 2021-2025 rate period was a time of growth and evolution in this program and Hydro Ottawa proactively invested in a consolidated ADMS, which drove a majority of the budget spend. In the 2026-2030 rate period, this program will focus on maintaining the ADMS system through regular platform upgrades and minor enhancements. Implementing a regular cadence of system upgrades is a key practice recommended by the Canadian Center for Cyber Security[16] to reduce vulnerabilities in critical infrastructure.

This program will also integrate a real-time Operational Historian directly into the ADMS platform. While Hydro Ottawa currently uses a Data Historian, as described in Section 6 of Schedule 2-5-9 - General Plant Investments, for long-term planning, analysis, and strategic decisions, this new Operational Historian will focus on real-time operations, process monitoring, and immediate decision support for the control room. It will provide real-time trends and operational insights to enable data-driven decisions.

5.2. PERFORMANCE OBJECTIVES AND TARGETS

The implementation of the Grid Technologies program is expected to maintain outcomes as detailed in Table 15.

Table 15 - Performance Outcomes for Grid Technologies

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	Hydro Ottawa's Operational Effectiveness objectives are supported by: ● The performance target for Hydro Ottawa's Class A Systems is 99.9% availability. This target is defined as a maximum allowable downtime of 4 hours and a maximum allowable data loss of 24 hours.

[16]Canadian Center for Cyber Security, Cyber threat to operational technology https://www.cyber.gc.ca/en/guidance/cyber-threat-bulletin-cyber-threat-operational-technology

5.3. PROGRAM DRIVERS AND NEED

5.3.1. Main and Secondary Drivers

Primary Driver: System Efficiency

- **Unified Platform:** Upgrading the ADMS modules and implementing an Operational Historian creates a single, cohesive platform. This simplifies data management, reduces potential points of failure, and streamlines system configuration and maintenance.
- **Seamless Data Exchange:** The Operational Historian is built to work directly within the ADMS ecosystem. This eliminates the need for complex interfaces and allows for smooth, efficient data transfer between the upgraded ADMS modules and the Historian. This reduces latency and ensures data integrity.
- **Optimized Data Handling:** The proposed solutions are designed to handle the increasing volume and velocity of data generated by modern grid operations. This allows the ADMS system to scale to meet future demands without compromising performance. It also prevents the ADMS from being cluttered with data needed for long term planning and analysis.
- **Faster Processing and Analysis:** Upgrading the ADMS modules unlocks performance enhancements for data processing and analysis. Combined with the Operational Historian's efficient data storage and retrieval, this leads to faster response times for critical applications and improved overall system responsiveness.

Secondary Driver: Enhanced Reliability and Adaptive Grid Flexibility. The proposed solution will provide the control room with a reliable, resilient platform that supports effective decision-making based on real-time conditions and immediate trends, reducing time for error identification and correction.

5.3.2. Current Issues

The Grid Technology program aims to address the following challenges:

- **Missed Opportunities for Optimization:** Simplification of systems used by the control room and specialization of systems to support operational trends and analysis supporting corrective or preventative actions.
- **Increased Cyber Security Risks:** Older ADMS modules might have known vulnerabilities, increasing the risk of cyberattacks.

5.4. PROGRAM BENEFITS

The benefits of this program are as follows:

Unified Platform: This streamlines data flow, enhances interoperability between applications, and simplifies system management.

- **Enhanced Performance:** Upgrading the ADMS modules unlocks performance improvements in data processing, analysis, and visualization. Combined with the Operational Historian's optimized data handling capabilities, this results in faster response times, improved grid awareness, and enhanced decision-making.
- **Advanced Analytics:** An upgraded ADMS platform, coupled with the Operational Historian, enables advanced analytics and reporting functionalities. This allows Hydro Ottawa to gain deeper insights into grid performance, identify trends, optimize operations, and proactively address potential issues.

5.5. PROGRAM COSTS

The historical period represents the purchase and installation of the ADMS platform which extended functionality beyond the pre-existing SCADA system. This was a period of significant growth in functionality and resulted in a temporary increase in program expenditure. Details on the increase over initial cost expectations are explained in Section 5.3.2 of Schedule 2-5-5 - Capital Expenditure Plan.

Hydro Ottawa notes that the ADMS program is currently undergoing a comprehensive review. Therefore, specific details of the Grid Technology budget program, including the capital budget, are subject to significant change. Updated information and supporting documentation related to the program will be filed no later than with responses to interrogatories. Hydro Ottawa believes this approach will still allow stakeholders to assess the program within the context of the rate application process.

The future costs are to maintain this platform, adopt incremental enhancements, improve performance as the vendor releases new updates, and ensure the system is running on suitable and reliable hardware. Hydro Ottawa has minimized the controllable costs with this program as it is replacing multiple standalone operational tools with the ADMS platform.
It is also important to note that Communications Infrastructure has been removed from this program and is now represented in Section 6 - Field Area Network.

Table 16 - Grid Technology Historical, Bridge and Test Year Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SCADA Upgrades	$ 0.2	$ 2.6	$ 5.6	$ 5.7	$ 6.8	-	-	-	-	-
ADMS Upgrades & Enhancements	-	-	-	-	-	-	$ 1.0	$ 0.1	$ 5.0	$ 0.3
TOTAL	**$ 0.2**	**$ 2.6**	**$ 5.6**	**$ 5.7**	**$ 6.8**	**-**	**$ 1.0**	**$ 0.1**	**$ 5.0**	**$ 0.3**
5-YEAR TOTAL	**$ 20.8**					**$ 6.4**				

5.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations from established partners to inform the expected costs of the Grid Technology program. Special attention has also been spent on improving forecasting models to reflect a unified software implementation approach that does not just look at technical implementation costs but considers a more comprehensive approach inclusive of internal labour. Forecasted costs included the following factors:

- Software licenses
- Professional services
- Internal and external labour
- Annual support fees as included in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs

Like any other multi-year project, this program will be subject to inflationary increases in labour costs. All equipment costs are estimated and many are yet to be purchased. Software and professional service costs may increase before a final agreement is signed.

5.6. ALTERNATIVES EVALUATION

5.6.1. Alternatives Considered

In order to meet the objectives of the Grid Technology program, three alternatives were considered:

Alternative One: Run to Failure; Do not upgrade, or enhance the systems. This alternative can result in a cascade of negative outcomes that impact various aspects of the business, including:

- Inability to meet service level agreements: outdated software and hardware are error-prone and system availability will not meet operational needs.
- Increased security risks: Outdated software is more vulnerable to cyberattacks, risking outages, equipment damage, data breaches, and safety hazards. This risk grows exponentially as systems age and vulnerabilities are discovered.
- Inefficient grid operations: This leads to slower outage response, higher energy losses, difficulty integrating renewable energy sources, and challenges in meeting growing demand, ultimately impacting customer satisfaction and grid reliability.
- Compliance challenges: Using outdated software may make it difficult to comply with evolving regulatory requirements for grid reliability, cyber security, and data protection, leading to penalties.
- Missed opportunities: Neglecting upgrades means missing out on new features, functionalities,

and improvements that could enhance efficiency, optimize the grid, and support innovation.

- Increased technical debt: Delaying upgrades makes future modernization efforts more complex and costly.

Alternative Two: Maintain; Upgrade the system when it reaches end-of-life, do not deploy new modules or enhance ADMS. This alternative will provide:

- Enhanced security: Upgrading to the latest versions ensures Hydro Ottawa core software has the latest security patches, minimizing vulnerabilities and strengthening defenses against cyberattacks.
- Improved system performance and stability: Newer versions often come with performance enhancements, bug fixes, and new features, improving the efficiency and reliability of individual systems.

Alternative Three: Upgrade and Enhance (Recommended); Upgrade the system and enhance capabilities with an Operational Historian. This will provide all the benefits of Alternative Two plus:

- Better data accessibility and analysis: Consolidating the Operational Historian into the ADMS platform will enable better analysis, informed decision-making, and optimized grid operations.
- Streamlined workflows: Consolidating software and moving functionalities to existing systems reduces complexity, eliminates redundancies, and streamlines workflows, which improves productivity and reduces manual effort.
- Improved innovation and agility: A modernized and integrated software environment allows for better data analysis, supporting innovation and faster adaptation to changing business needs.
- New functionalities: The fully-integrated Operational Historian offers built-in features and functionalities that are not available from a Planning Historian.

5.6.2. Evaluation Criteria

Reliability & Resilience

This criterion assesses the ability to meet service level agreements and provide uninterrupted connectivity to grid assets to enable observability and control during any adverse conditions. System upgrades aim to improve the network resilience and security. Resilience focuses on the system's ability to quickly recover from physical damage, as well as cyber attacks.

Operational Efficiency

This criterion considers the ability to position Hydro Ottawa to “do more, more quickly” in response to increasingly complex demands. Incorporating automation reduces manual effort, which improves efficiency. Facilitating data analysis and visualization enables informed decision-making and grid optimization.

Enabling Grid Modernization

This criterion evaluates how effectively the alternative can handle the need to monitor and control an increasing number of field devices. This capability is crucial for Hydro Ottawa to ensure safe supply of electricity for customers. The ideal solution should integrate seamlessly with AMI, DERs, and remote sensors.

5.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 5.6.1 - Alternatives Considered under the evaluation criteria of Section 5.6.2 - Evaluation Criteria.

The recommended approach, Alternative Three, involves implementing the Operational Historian within the ADMS platform and committing to ongoing upgrades. This approach creates a centralized hub for all grid data, empowering comprehensive analysis and informed decision-making through advanced analytics and reporting tools. By having access to both historical and real-time data, operators can identify trends, predict potential failures, and optimize grid operations for enhanced efficiency and stability. Furthermore, staying current with the latest ADMS version unlocks access to cutting-edge features, security enhancements, and improved performance, while ensuring ongoing vendor support and performance of this mission-critical tool.

This strategy also positions Hydro Ottawa to respond to Grid Modernization requirements such as integrating new technologies (e.g. DERs), and adapting to the evolving energy landscape with agility and resilience. Ultimately, this investment translates to improved reliability, reduced downtime and faster outage restoration, leading to increased customer satisfaction and a more robust and sustainable grid.

5.7. PROGRAM EXECUTION AND RISK MITIGATION

5.7.1. Implementation Plan

The Grid Technology Program projects are planned to be executed over the 2026-2030 rate period. Each project has a different duration, can be divided into phases, and can overlap with other projects depending on the resources and systems involved. Table 17 shows the projects proposed for the 2026-2030 rate period.

Table 17 - Proposed Projects under the Grid Technologies Program

Year	Proposed Projects
2026-2027	• ADMS Platform Upgrade Phase 1: Upgrade all software modules
2029-2030	• ADMS Platform Upgrade Phase 2: Upgrade all modules and supporting hardware • Operational Historian module deployment

5.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Grid Technologies Program. The key risks and corresponding mitigation strategies are detailed in Table 18.

Table 18 - Key Risks of the Grid Technologies Program and Mitigation Strategies

Category	Risk	Mitigation
Business Requirements and schedule	Changing business requirements or schedules can complicate project planning and increase costs.	Regularly engage with business to anticipate and adjust for changing business needs due to the evolution of electrification. Follow the larger IT project intake process for annual planning, ensuring resource availability and mitigating delays.
Financial Impact	Cost overruns or budget shortfalls may occur due to unexpected expenses.	Develop detailed budgets with contingencies and monitor financial performance closely throughout the project lifecycle.
Project Management	Poor project management could lead to delays or inefficiencies.	Utilize skilled Project Managers to ensure adequate management and oversight.
Resource Availability	Shortages in skilled labour may hinder project progress.	Plan resource needs well in advance and maintain strong relationships with suppliers and contractors to secure reliable access to critical resources.
User adoption and training challenges	Resistance to change or inadequate training could lead to low user adoption and hinder the realization of project benefits.	Involve users in the planning and implementation process. Provide comprehensive training programs and support materials. Communicate the benefits of the new system clearly. Encourage user feedback and address any concerns.
Vendor dependence	Over-reliance on a single vendor for the ADMS platform and historian could lead to limited flexibility and potential lock-in.	Negotiate favorable contract terms and service level agreements. Ensure close follow-up on items and tasks.

5.8. RENEWABLE ENERGY GENERATION

By renewing the ADMS platform, Hydro Ottawa is better prepared to add additional products for renewable energy generation like a DERMS module. This module is part of the Control and Optimization Program discussed in Section 7 - Control and Optimization. It will provide visibility to operators and other relative departments for system loading and data captures for renewable energy generation.

6. FIELD AREA NETWORK

6.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $1.9M

2026-2030: $20.8M

Budget Program: OTN Fiber Network Resilience, Wireless Communication, Reliability & Remote Testing, Intelligent Electronic Device Management (IEDM), OTN Cyber Security

Main Driver: System Efficiency

Secondary Driver: Enhanced Reliability

Outcomes: Operational Effectiveness

The Field Area Network (FAN) Program is key to Hydro Ottawa's Digital Strategy detailed in Attachment 1-3-4(B) - Digital Strategy and Grid Modernization Strategy described in Section 3.4.2 of Schedule 2-5-4 - Asset Management Process, enabling grid automation and modernization initiatives.

This program is composed of initiatives that ensure robust, reliable communication infrastructure to handle Hydro Ottawa's most sensitive, mission-critical information. This infrastructure connects grid-edge devices with central monitoring and control systems such as ADMS and is a key enabling technology for Grid Modernization. This builds on Hydro Ottawa's Telecommunications Master Plan investment from 2016-2020 which created a fiber optic ring connecting Hydro Ottawa offices and substations. This plan also builds on pivotal decisions made by the Canadian Radio-television and Telecommunications Commission (CRTC)[17] and Innovation, Science and Economic Development

[17] CRTC, Telecom Decision CRTC2022-181 https://crtc.gc.ca/eng/archive/2022/2022-181.htm

Canada (ISED)[18] during the 2021-2025 rate period which creates opportunity for critical infrastructure to leverage the flexibility of a low cost, reliable Long-Term Evolution (LTE) network.

The Field Area Network Program is comprised of the following initiatives over the 2026-2030 rate period:

Optical Transport Network (OTN) Fiber Network Resilience: Expand and upgrade network infrastructure through the installation of diverse network paths, modernize the optical transport network with higher-capacity technology, and implement remote optical time-domain reflectometry (OTDR) capabilities for proactive and faster fault detection. This will create a more efficient and resilient communication network.

Wireless Communication: This is a continuation of the wireless communication initiative deferred from the 2021 to 2025 rate period. Wireless communication is increasing in application and importance with the expansion of Internet of Things (IoT) devices. Utilities are now facing decisions on whether to continue with public LTE or to explore more tailored, reliable, private LTE (PLTE) networks to meet enhanced security, reliability, and resilience requirements of wireless communication. In the 2021-2025 rate period, Hydro Ottawa engaged Black & Veatch to perform an assessment of wireless technologies. This study detailed in Attachment 2-5-8(A) - Wireless Technology Study assessed Hydro Ottawa's objectives and technical requirements against various solutions. Based upon the study findings, Hydro Ottawa has elected to adopt a cautious but future-focused approach and will pilot wireless technologies to advance learning in this space. The pilot will consist of deploying a PLTE pilot site and an Evolved Packet Core which is responsible for ensuring secure and reliable data transmission and maintaining quality of service for various components. The results of the pilot will be used for the 2031-2035 Wireless Network Strategy.

[18] ISED, Technical Requirements for Non-Competitive Local Licensed Services, Including Fixed and/or Mobile Systems, and Flexible Use Broadband Systems, in the Band 3900-3980 MHz. https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/devices-and-equipment/standard-radio-system-plans/srsp-521

Intelligent Electronic Device Management (IEDM): The convergence of IT and OT has been the focus of much discussion across the industry. A recent Global Cyber Security Alliance post[19] noted that one aspect of this convergence is the need to use IT tools and practices to manage intelligently connected OT solutions. The IEDM initiative will deploy a central configuration management solution to provide a real-time device inventory for connected Remote Terminal Units (RTU's), including installed patches and firmware versions. This solution will also provide a repository for security patches as well as patch deployment capabilities to reduce vulnerabilities.

This solution will also enable the collection of oscillographic data and sequence of event (SOE) data providing a centralized, easily accessible repository of information to begin troubleshooting a disturbance or fault. Additional efficiency will be realized through this solution by reducing the need for on-site service visits.

OTN Cyber Security: This initiative will implement necessary cyber security improvements in the FAN to protect critical infrastructure, ensure grid stability, and safeguard data integrity.

6.2. PERFORMANCE OBJECTIVES AND TARGETS

The implementation of the Field Area Network Program is expected to lead to improvements in the outcomes detailed in Table 19.

[19] Global Cybersecurity Alliance, The Top 7 Operational Technology Patch Management Best Practices https://gca.isa.org/blog/the-top-7-operational-technology-patch-management-best-practices

Table 19 - Performance Outcomes for Field Area Network Program

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	Hydro Ottawa's Operational Effectiveness objectives are supported by: ● Reducing network outages and minimizing downtime through improving network diversity, proactive fiber network fault detection and faster restoration. Service Level Agreement for Class A systems is maximum allowable downtime of 4 hours and a maximum allowable data loss of 24 hours. ● Centralizing the management of 60% of eligible RTUs within the 2026-2030 rate period. ● Piloting different technologies to define the optimal technology or combination of technologies for the future wireless communication infrastructure required for Hydro Ottawa's communication with distribution automation devices, metering devices, land mobile radio, field crew, etc.
Customer Focus and Financial Performance	Hydro Ottawa's Customer Focus and Financial Performance objectives are supported by: ● Contributing to improved asset controllability and system observability through the provision of physical fiber and wireless network connectivity. ● Mitigating escalating telecommunications costs by pro-actively assessing alternatives.

6.3. PROGRAM DRIVERS AND NEED

6.3.1. Main and Secondary Drivers

Primary Driver: System Efficiency; Expansion of intelligent grid-edge devices and the resulting data streams drive grid modernization, creating a flexible system capable of adapting to changing demands and integrating diverse energy resources. Enabling real-time data sharing coupled with remote management and security, optimizes grid performance and avoids costly physical site visits. Essentially, by enabling data sharing and automation, this program minimizes waste, maximizes resource utilization, and enhances grid flexibility.

Secondary Driver: Enhanced reliability; in order to effectively and quickly respond to outage events, the Hydro Ottawa control room must have the ability to view real-time information from sensors and meters as well as to remotely operate switches or other devices (either manually or through advanced software systems such as the ADMS platforms) so that any service interruptions are minimized in both duration and the number of customers affected. Implementing diverse fiber optic cable paths will minimize the impact of disruptions such as rodent damage, construction accidents or natural disasters. Data from the IEDM will enhance the scheduling of maintenance of the equipment and avoiding unplanned downtime. Management of the expanding population of intelligent grid-edge devices is also paramount to ensure Hydro Ottawa's cyber security posture.

6.3.2. Current Issues

The proposed FAN investments are aimed at addressing the following challenges:

Reliability & Resilience: The OTN is designed to be highly available, with most of it featuring both logical and physical redundancy. However, some substations and facilities currently rely solely on logical redundancy. In the event the fiber optic cable serving these locations is damaged, communication outages could last for several days. Implementing physically-diverse fiber connections will minimize the risk of lengthy communication outages.

Number of Grid Devices: Grid Modernization is driving the exponential increase in intelligent grid-edge devices. As more smart meters, sensors and other connected devices are added, the volume of data can lead to network congestion, making it difficult to transmit real-time data. Using a technically-relevant Multiprotocol Label Switching (MPLS) network is paramount to managing the influx of data.

Reliable Final-Mile Connectivity: Connecting intelligent grid-edge devices via a robust, reliable communication channel is a challenge. Using physical fiber to connect major hubs of connected devices, like in a substation, is cost-effective and reliable. However, the exponential increase in grid-edge devices dispersed through Hydro Ottawa's service territory is impossible to connect with physical fiber in a cost-effective manner. Using public carrier networks for hundreds, if not thousands, of devices will be prohibitively expensive and these networks struggle to meet reliability objectives during major events, when situational awareness is paramount.

Lack of Commercially Available Solutions for Critical Infrastructure

Current wireless technologies do not provide the reliability, security, capacity for data-intensive applications, or the resilience in emergencies, needed for utility wireless networks. Grid Modernization and the increased reliance on real-time data from the field emphasize this gap in commercially available solutions.

Technology: Hydro Ottawa faces technology advancement challenges with its communication network as modern smart field devices shift toward next generation communication mediums. The effectiveness of grid operations will heavily depend on seamless communication between these devices and the central controller. Adapting communication infrastructure to meet these requirements will be essential for enhancing the reliability and performance of the grid.

Cyber Security: Hydro Ottawa faces cyber security challenges that can be dangerous, not just to the operations, but also to public safety if the cyberattacks cause outages. To address these challenges, implementing platforms that monitor the grid network devices in real time and refreshing the network in accordance with useful life to ensure the latest security measures are put in place are crucial steps.

6.4. PROGRAM BENEFITS

6.4.1. Support Observability and Advanced Applications

The proposed OTN Fiber Network Resilience initiative will extend Hydro Ottawa's fiber optic network and add targeted diversity for resilience. This initiative will also ensure a stable, supportable MPLS network critical for transporting grid data in real-time. Finally, it will also lead to faster restoration times, improved situational awareness and decision-making.

Hydro Ottawa's enhanced communication network will enable better integration and management of DERs, such as solar and wind power. This improved network allows for greater flexibility and control in managing the variability of these renewable energy sources. This network will also provide access to real-time data required for advanced grid management applications inherent in Grid Modernization.

6.4.2. Increased Efficiency

The proposed initiatives bring several mechanisms of increased efficiency. Robust, reliable communication infrastructure enables remote monitoring and control of grid assets, reducing the need for costly and time-consuming site visits. Facilitating the collection and analysis of real-time data will enable Hydro Ottawa to perform preventative maintenance, reducing the occurrence of unplanned outages as well as their duration.

6.4.3. Flexibility

The proposed OTN Fiber Network Resilience initiative will ensure Hydro Ottawa's communication backbone is flexible enough to handle both high data volumes and diverse applications across substations and control centers, while also prioritizing critical functions. The variety of data will continue to expand and the MPLS network will be essential in routing traffic based on Quality of Service (QoS) parameters, allowing the network to adapt to changing demands and prioritize the most urgent communications to maintain grid reliability.

6.4.4. Carbon Reduction Through Digitization

Connecting additional grid devices and supplying increased remote capabilities will contribute to cost savings as well as carbon reduction by avoiding unnecessary crew deployment.

6.4.5. Innovation

The proposed wireless pilot will trial two potential wireless spectrums that may be used for critical infrastructure. This work will complement Public Safety Canada's efforts to establish a public safety broadband network[20] as well as Electricity Canada's efforts to advance spectrum innovation through the Operating Technology & Telecommunications Committee[21].

6.4.6. Cyber Security

As the grid continues to evolve, cyber security must be incorporated at the ground level. All of the proposed initiatives contribute to this benefit in the following ways:

- OTN Fiber Network Resilience will update the MPLS infrastructure to meet compliance with the latest cyber security standards.
- The IEDM initiative will help maintain cyber security compliance by utilizing a managed platform for centrally deploying firmware patches and upgrades to field devices.
- The OTN Cyber Security initiative will aid in early threat protection, detection, response and recovery.

[20] Public Safety Canada, A Public Safety Broadband Network (PSBN) for Canada https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/2021-psbn/index-en.aspx

[21] Canadian Electricity Association, https://www.electricity.ca/news/electricity-canada-hosts-successful-ottc-workshop-in-ottawa-to-advance-utility-innovation-and-spectrum-strategy/

6.5. PROGRAM COSTS

Table 20 provides proposed future spending for FAN programs.

Table 20 - Historical, Bridge, and Test Year Field Area Network Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
OTN Fiber Network Resilience	$ 0.6	-	-	$ 0.3	$ 1.1	$ 1.1	$ 1.4	$ 5.8	$ 3.6	$ 1.6
Wireless Communication	-	-	-	-	-	$ 0.5	$ 2.7	$ 1.0	$ 0.3	$ 0.4
Intelligent Electronic Device Management	-	-	-	-	-	$ 0.7	$ 0.2	$ 0.1	$ 0.1	$ 0.1
OTN Cybersecurity	-	-	-	-	-	$ 0.6	$ 0.6	-	-	-
TOTAL	**$ 0.6**	**-**	**-**	**$ 0.3**	**$ 1.1**	**$ 3.0**	**$ 4.8**	**$ 6.9**	**$ 4.0**	**$ 2.1**
5-YEAR TOTAL					**$ 2.0**					**$ 20.8**

6.5.1. Cost Factors

Hydro Ottawa has received quotations from established partners to inform the expected costs of the Field Area Network program. Forecasted costs for new fiber segments are based on an average cost per kilometer observed in prior fiber installation projects as well as the following other factors:

- Software licenses and hardware
- Professional services
- Internal and external labour
- Annual support fees (included in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs)

Like any other multi-year project, this program may be subject to inflationary increases in labour and equipment costs.

6.6. ALTERNATIVES EVALUATION

6.6.1. Alternatives Considered

Alternative One: Resilience & Security; This option is characterized by a maintain and protect approach. It includes an upgrade of the MPLS to maintain supportability and cyber security compliance and minimal additional fiber footprint to address critical areas of network diversity. Hydro Ottawa's ability to modernize its electric grid, realize operational efficiencies and meet increased demands of intelligent grid devices will be significantly impeded in this scenario.

Alternative Two: Balanced; This option includes a judicious focus on all portions on the Field Area Network Program. It will address physical fiber diversity and grow the fiber footprint to new, operationally meaningful, substations; upgrade the MPLS; and implement remote troubleshooting capabilities to reduce fault location time.

This alternative will also conduct pilots of two non-public wireless spectrums to gain a better understanding of the feasibility and application for utility-specific private LTE. The 700 MHz spectrum, also known as B14, provides dedicated coverage for critical infrastructure that ensures uninterrupted communication during emergencies or periods of high network congestion. This spectrum is well established in the United States for public safety and critical infrastructure but has not yet been widely implemented across Canada due to the pending award of licensing and infrastructure[22]. Until licensing is formally awarded, this spectrum is available for pilot licensing to critical infrastructure. This spectrum is attractive as multiple device manufacturers are already B14-ready.

The N77 (3.9 GHz) spectrum will also be assessed for its ability to support distribution and substation automation. This spectrum has a good balance of capacity and coverage but would have

[22] Innovation, Science and Economic Development Canada. June 2017. Decisions on Policy, Technical and Licensing Framework for Use of the Public Safety Broadband Spectrum https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/learn-more/key-documents/consultations/decisions-policy-technical-and-licensing-framework-use-public-safety-broadband-spectrum-758-763-mhz#sec5.2.

more targeted applications due to its limited range compared with lower bands. This spectrum is already widely recognized by multiple device manufacturers and deployed globally.
The results of these pilots will inform Hydro Ottawa's decision on how best to support and meet the growing need for wireless communication in the modern grid.

This option will also implement an IEDM solution to monitor and collect device performance data to a central location. This platform will allow remote access to information such as switch opening and exchange and oscillographic events to assist in troubleshooting. Access to this information today requires an on-site visit, which is time consuming, inefficient and contributes to carbon emissions. The proposed solution would enable a central inventory updated in real time with immediate "anywhere, anytime" access to error logs. It will also bolster Hydro Ottawa's cyber security stance by ensuring firmware upgrades occur.

This alternative also includes special focus on improving the fiber network cyber security to improve Hydro Ottawa's detect, protect, respond and recover capabilities in its most mission-critical network.

Alternative Three: Accelerated; This option goes beyond Alternative 2 by advocating for a full-fledged deployment of a dedicated communication network. Instead of simply testing wireless spectrum, it proposes a significant investment in infrastructure, including building new towers, acquiring spectrum, and deploying compatible devices. This comprehensive approach would enable Hydro Ottawa to establish a robust and secure network capable of supporting AMI and other smart grid technologies, ultimately enhancing grid reliability and efficiency.

This option also includes additional physical fiber footprint and selection and deployment of additional solutions to centrally manage intelligent, connected grid devices.

6.6.2. Evaluation Criteria

Reliability & Resilience

This criterion assesses the ability to meet service level agreements and provide uninterrupted connectivity to grid assets that will enable observability and control during any adverse conditions. System upgrades aim to improve the network resilience and security. Resilience focuses on the system's ability to quickly recover from physical damage, as well as cyber attack.

Operational Efficiency

This criterion considers the ability to position Hydro Ottawa to "do more, more quickly" in response to increasingly complex demands. Incorporating automation reduces manual effort and improves efficiency. Facilitating data analysis and visualization enables informed decision-making and grid optimization.

Enabling Grid Modernization

This criterion assesses the ability to address the anticipated rise in field intelligence needed to ensure Hydro Ottawa can optimize capacity to meet growing demands due to electrification. The network's ability to support current communication needs as well as AMI, DERs and remote sensors supplying observability must be considered to respond to the IoT evolution.

Technical Feasibility

This criterion assesses a solution's commercial availability, interoperability, and long-term availability. This is particularly material to the FAN given the evolving nature of wireless solutions and the rapid evolution of IoT.

Cost Effectiveness

This criterion analyses the impact of each alternative and looks to identify the most cost-effective means of meeting requirements.

6.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 6.6.1 - Alternatives Considered under the evaluation criteria of Section 6.6.2 - Evaluation Criteria.

The preferred alternative is Alternative 2. Initiatives such as network security, IEDM and remote testing are critical for the continued stability, reliability and operational efficiency of the communication network. Observations from the wireless pilot will help Hydro Ottawa make informed decisions about the future of PLTE networks. Operational needs for widespread wireless communication will continue to be satisfied through a variety of means including public carrier LTE networks (e.g. Rogers, Bell, Telus), point-to-point microwave, and 900 MHz radio. While Hydro Ottawa is conducting pilots in specific wireless bands it will also continue to participate and support Electricity Canada and fellow utilities in pursuing alternate solutions.

This option reflects a judicious investment in reusable assets such as towers and represents a balanced approach to explore wireless options in the evolving Canadian telecommunication industry.

6.7. PROGRAM EXECUTION AND RISK MITIGATION

6.7.1. Implementation Plan

All initiatives under the Field Area Network Program will be implemented in the 2026-2030 rate period as outlined in Table 21. Regular initiative review will inform the program prioritization, and if any projects under this category require expedited action, adjustments may be made, including switching, deferring, adding, altering or removing projects as necessary.

Table 21 - Proposed Projects for the Field Area Network Program

Year	Proposed Projects
2026	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● Wireless pilot design ● Implement the IEDM solution ● Begin cyber security enhancement implementation
2027	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● MPLS refresh design ● Wireless Pilot - purchase and install EPC Core and Base Stations ● Complete IEDM solution implementation ● Complete cyber security enhancement implementation
2028	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● Begin MPLS refresh ● Wireless pilot execution ● Continued onboarding of IEDM devices
2029	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● Complete the MPLS refresh ● Wireless pilot execution ● Continued onboarding of IEDM devices
2030	● Address highest-priority fiber optic cable segment to improve network diversity and coverage ● Implement remote OTDR Testing ● Wireless pilot execution ● Continued onboarding of IEDM devices

6.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Field Area Network Program, particularly as technology evolves to offer greater advanced application capabilities and customer expectations shift with electricity transformation. Table 22 identifies the key risks and corresponding mitigation strategies.

Table 22 - Key Risks for the Field Area Network Program and Mitigation Strategies

Category	Risk	Mitigation
Rapidly evolving technology landscape	The technology sector is characterized by constant innovation. New, more efficient, and cost-effective technologies emerge frequently and the expectations and needs of Grid Modernization will continue to evolve. There is a risk that solutions could be superseded by a superior standard or become incompatible with newer systems relatively quickly.	**Flexible architecture:** Designing solutions with a degree of flexibility and modularity can enable easier upgrades and integration with new technologies as they emerge. **Phased implementation:** Instead of a large-scale rollout, a phased approach allows the utility to test the technology, assess its performance, and make adjustments as needed while minimizing initial investment. **Collaboration and partnerships:** Partnering with technology providers and research institutions can provide access to expertise and insights on the evolving technological landscape.
Changing business needs driven by Grid Modernization	Grid Modernization is rapidly evolving and may drive a shift in priorities or core functionality that has not been anticipated.	Continued monitoring of Grid Modernization to ensure Hydro Ottawa's roadmap continues to align with required capabilities. Use a data-driven approach for the Field Area Network annual planning.
Sudden significant shifts in product, or implementation costs	This program includes both physical assets as well as software costs. There is a risk that one or both of these may see a significant rise in costs.	Continued evaluation of technology and negotiation of contracts to maintain the lowest cost increase possible. Well defined projects will continue to favour a fixed price model to minimize the impacts of rapid inflation or other market pressures. Where cost increases are unavoidable, the scope will be adjusted.
Regulatory decisions in the telecommunications industry	With the use of LTE technology and licensed spectrum, there are a number of organizations that could alter regulations that could have an impact on the planned FAN wireless communication pilot.	The mitigation strategy for this is to engage with other utilities making similar investments in forums such as the Utility Telecommunications Council and the Canadian Electricity Association.

7. CONTROL AND OPTIMIZATION

7.1. PROGRAM SUMMARY

Investment Category: System Service

Capital Program Costs:

2021-2025: $0

2026-2030: $3.6M

Budget Program: Control and Optimization

Main Driver: Observability

Secondary Driver: System Efficiency, Enhanced Reliability, and Adaptive Grid Flexibility

Outcomes: Operational Effectiveness

The Control and Optimization Program is a key component of Grid Modernization. This program builds on the foundation of the ADMS with new capabilities such as DER management, optimization and automation of grid operations. The primary focus in the 2026-2030 rate period is the implementation of the Distributed Energy Resource Management System (DERMS). The DERMS module will enable Hydro Ottawa to manage and optimize the growing complexity of DERs, thereby enhancing grid stability, reliability, efficiency, and resilience in a cost-effective manner. Smaller modules like DMS Switch Order Manager (SOM), DMS Volt/VAR (VVO) and Feeder Reconfiguration (FR) could be deployed to help improve Hydro Ottawa's efficiency and outage restoration performance in real-time.

In total, Hydro Ottawa plans to invest an estimated $3.6M through the Control and Optimization program in the 2026-2030 rate period compared to no investment in the 2021-2025 rate period.

7.2. PERFORMANCE OBJECTIVES AND TARGETS

The implementation of the Control and Optimization Program is expected to lead to improvements in the outcomes detailed in Table 23.

Table 23 - Performance Outcomes for Control and Optimization Program

OEB Performance Outcomes	Outcome Description
Operational Effectiveness	Implementation of a DERMS will: ● Improve visibility and control of DERs (e.g. solar panels, wind turbines, BESS) by gaining real-time insights into their operation . ● Effectively manage and coordinate DERs to ensure grid stability, minimize voltage fluctuations, and minimize instances of voltage exceeding or falling below acceptable limits. ● Accommodate a higher percentage of DERs and leverage them for grid services like voltage support, peak demand reduction, and ancillary services. ● Improve grid efficiency by utilizing DERs to improve the grid's ability to handle fluctuations in demand and supply and respond to outages. ● Facilitate customer engagement in DER programs and grid services.
Customer Focus	The Distributed Energy Resource Management system supports Hydro Ottawa's Customer Focus objectives by: ● Facilitating the adoption of DERs ● Contributing the improved flexibility of the electricity grid to meet customer needs for reliable electricity.
Public Policy Responsiveness	Hydro Ottawa's Public Policy Responsiveness objectives by: ● Enabling electrification by investing in operational flexibility

7.3. PROGRAM DRIVERS AND NEED

7.3.1. Main and Secondary Drivers

Primary Driver: Observability; Effectively manage the complexities introduced by DERs and grid modernization efforts. DERMS, SOM, Volt/VAR, and feeder reconfiguration modules generate a massive amount of data about grid conditions, DER activity, and switching actions. Enhanced observability through the ADMS platform allows the utility to collect, analyze, and visualize this data in real-time, providing valuable insights into grid behavior and enabling proactive decision-making for optimized performance, improved reliability, and increased safety.

Secondary Driver: System Efficiency, Enhanced Reliability, Adaptive Grid Flexibility. The DERMS module will allow system operators a consolidated platform to view and control DERs. The number of DERs connected to Hydro Ottawa's system increased by nearly 50% between 2018 and 2023. This customer trend is expected to continue and be further augmented through the adoption of Non-Wires Solutions described in Section 2.1 - Capacity Upgrade. Implementing a central monitoring and control platform for distributed energy resources will enable grid flexibility and reliability.

This program will continue to enhance Grid Operations through digital transformation to support sustainable business practices. Through additional modules such as SOM, VVO, and FR, the program will reduce process time and errors and employ new capabilities to automate functions, thereby reducing system losses and improving performance.

7.3.2. Current Issues

The Control and Optimization program aims to address the following challenges:

Adapting To Rising Numbers of DERs

The availability of DERs and their popularity caused by the energy transition has introduced unique challenges for local distribution companies including:

- DERs, especially renewable energy sources like solar and wind, can introduce variability and unpredictability into the distribution grid. This makes it more difficult for LDCs to balance supply and demand, maintain voltage levels, and ensure grid stability.
- DERs can inject power back into the grid, creating two-way flows. This requires LDCs to upgrade their infrastructure and systems to manage these flows effectively.
- DERs can complicate the protection of the grid against faults and other disturbances.
- The integration of DERs makes it more challenging for LDCs to plan for future grid needs and forecast electricity demand. They need to develop new tools and methods to account for the impact of DERs on their networks.

Inefficient Paper-Based Processes

Current paper-based switch order processes present a variety of challenges for Hydro Ottawa, impacting efficiency, cost, and customer satisfaction. Digitizing this process via the SOM module will address:

- Slow Processing Times: Manual data entry, physical transfer of documents, and potential for errors all contribute to significant delays in completing switch orders. This can lead to missed deadlines and frustrated customers.
- Lack of Transparency and Tracking: It is difficult to track the status of a switch order in a paper-based system. This lack of visibility can cause confusion and make it challenging to identify and resolve bottlenecks.
- Potential for Errors: Manual data entry increases the risk of errors, which can lead to incorrect billing, service disruptions, and regulatory compliance issues.
- Security Risks: Physical documents are vulnerable to loss, theft, or damage. Sensitive customer information may be exposed without proper security measures.

Managing Voltage Levels Across the Grid

The Voltage Optimization module addresses several key grid challenges. Primarily, it maintains optimal voltage levels across the network, minimizing losses and improving energy efficiency. This is especially critical with the rise of DERs, which can cause voltage fluctuations. By dynamically adjusting voltage setpoints, the module will contribute to grid stability and power quality, reducing instances of over- or under-voltage that can damage equipment or disrupt customer service. Voltage optimization can also contribute to conservation efforts by lowering overall energy consumption.

Managing the Efficiency and Reliability of the Distribution Network

The Feeder Reconfiguration module addresses critical challenges in managing Hydro Ottawa distribution networks. It helps minimize power losses, improve voltage profiles, and enhance overall network reliability. By intelligently altering the network topology through switchgear operations, the module can reduce wasted energy, ensure adequate voltage levels for consumers, and quickly restore power in case of outages.

7.4. PROGRAM BENEFITS

The Control and Optimization Program will serve to improve several areas of Hydro Ottawa operations, including efficiency and outage restoration. Adding DERMS, SOM and other modules to an ADMS platform allows these modules to work together to modernize grid operations, optimize resource utilization, and improve overall grid performance.

7.4.1. Enhanced Grid Reliability and Resilience

This program enhances grid reliability and resilience by supplying tools for predictive analysis, automating response to failures and integrating DERs to help balance supply and demand.

7.4.2. Optimized Grid Operations

Smart grid technologies like VVO and FR help utilities to reduce wasted energy and work more efficiently. By automatically adjusting how electricity flows through the grid, these technologies minimize losses and deliver power more effectively. The automation reduces the need for manual adjustments, allowing operators to focus on more important tasks and ultimately saving time and resources.

7.4.3. Increased DER Penetration and Utilization

DERMS offers a comprehensive solution for integrating and optimizing DERs like solar panels, batteries and wind turbines. It ensures the safe and efficient integration of large amounts of DERs and actively manages DER output for voltage support and peak demand reduction, further enhancing grid stability.

7.4.4. Improved Safety

Automating switching procedures minimizes the potential for human error, protecting field crews and reducing the risk of outages.

7.4.5. Improved Customer Satisfaction

Enabling faster outage restoration and improving overall grid reliability will minimize service disruptions and enhance customer satisfaction. Simultaneously, VVO features within the ADMS provide better power quality by minimizing voltage fluctuations. This results in a more stable and reliable power supply, further improving the customer experience and building trust in the utility.

7.4.6. Enhanced Grid Visibility and Control

Advanced analytics and optimization tools support informed decision-making for grid operations and planning. By implementing these modules and realizing these benefits, Hydro Ottawa can create a more modern, efficient, reliable, and sustainable grid that is well-equipped to handle the challenges of increasing DER penetration and evolving customer demands.

7.5. PROGRAM COSTS

The costs for this program will include both third-party software and services and internal labour. The timing of these investments is dependent on the progress made by Hydro Ottawa on the deployment of each module, which will be rolled out sequentially. The program costs are included in Table 24.

Table 24 - Historical, Bridge and Test Year Control and Optimization Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Control and Optimization	-	-	-	-	-	$ 0.7	$ 1.8	$ 0.4	$ 0.4	$ 0.4
TOTAL	**-**	**-**	**-**	**-**	**-**	**$ 0.7**	**$ 1.8**	**$ 0.4**	**$ 0.4**	**$ 0.4**
5-YEAR TOTAL					**-**					**$ 3.6**

7.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations from established partners to inform the expected costs of the Optimization and Control program. Special attention has also been spent on improving forecasting models to reflect a unified software implementation approach that does not just look at technical implementation costs but considers a more comprehensive approach inclusive of internal labour. Forecasted costs include the following factors:

- Software Licenses
- Professional Services
- Internal and External Labour
- Annual support fees (included in Schedule 4-1-2 - Operations, Maintenance and Administration Program Costs)

7.6. ALTERNATIVES EVALUATION

7.6.1. Alternatives Considered

To achieve the objectives of the Control and Optimization program, three alternatives were considered:

Alternative One: Do nothing - Not investing in new ADMS modules presents the following considerations:

- Limited DER integration: Difficulty accommodating growing DER penetration, leading to constraints on DER interconnection and potential grid instability.
- Reduced grid efficiency: Inability to optimize voltage/VAR control and feeder configurations, resulting in greater energy losses and higher operational costs.
- Increased outage risks and durations: Manual switching processes are slower and more prone to errors, potentially leading to longer outages and safety risks.
- Decreased grid visibility: Lack of real-time data and analytics hinders proactive grid management and informed decision-making.
- Missed opportunities for cost savings: Inability to leverage DERs for grid services and optimize grid operations may result in missed cost savings opportunities.
- Lower upfront costs: Avoiding the project will save on immediate investment in software, implementation, and training.
- Reduced complexity: Maintaining existing systems is simpler in the short-term than integrating new modules and functionalities.
- Less disruption: Implementation of new software can be disruptive to existing workflows and require adjustments from personnel.

Alternative Two: DERMS only; Implementing only the DERMS module is an option that presents the following considerations:

- Focused approach: Concentrates resources on the immediate challenge of DER integration and management, simplifying the project scope and timeline.

- Faster DER value realization: Quickly gain the ability to monitor, control, and optimize DERs to improve grid stability, increase hosting capacity, and potentially leverage DERs for grid services.
- Reduced initial investment: Lower upfront costs compared to implementing all modules simultaneously.
- Scalability: Provides a foundation for future expansion by adding other modules (SOM, VVO, FR) as needs and budget allow.
- Improved grid awareness for DER impacts: Gain valuable insights into how DERs are impacting the grid, enabling proactive mitigation of potential issues.
- Limited scope of benefits: Misses out on the full potential of a comprehensive ADMS upgrade, including optimized voltage control, automated switching, and improved outage management.
- Potential for suboptimal DER utilization: Without VVO and FR, the ability to fully optimize DERs for grid support may be limited.
- Missed synergies: The modules work best together and Hydro Ottawa will not realize the full benefit by adding DERMS alone.
- Increased future integration complexity: Integrating other modules later may be more complex and costly compared to a unified implementation.
- Potential for "siloed" approach: Focusing solely on DERMS may lead to a fragmented approach to grid management rather than a holistic one.

Alternative Three: Full implementation (Recommended); This option includes adding DERMS, SOM, VVO, and FR modules to Hydro Ottawa's ADMS platform, to achieve the full benefits available from this technology:

- Comprehensive Grid Modernization: Addresses multiple aspects of grid management simultaneously, leading to a more holistic and integrated approach to grid optimization.
- Enhanced DER Integration and Utilization: DERMS enables seamless integration of DERs, while VVO and FR optimize their use for grid support and increased hosting capacity.
- Improved Grid Efficiency and Reliability: VVO and FR minimize losses and improve voltage

profiles, while SOM enhances outage management and grid resilience.

- Increased Automation and Efficiency: Automated switching, voltage control, and feeder reconfiguration will streamline operations, reduce manual intervention, and improve workforce productivity.
- Enhanced Safety: SOM reduces switching errors and improves safety for field crews, while the overall ADMS platform enhances situational awareness and supports proactive decision-making.
- Cost Savings: Reduced energy losses, improved operational efficiency, and extended equipment life contribute to significant cost savings over time.
- Improved Customer Satisfaction: Increased reliability, reduced outages, and better power quality enhance customer satisfaction.
- Future-Ready Grid: Prepares the grid for future challenges and opportunities by providing a robust platform for managing increasing DER penetration and evolving grid requirements.
- Data-Driven Insights: The ADMS platform provides comprehensive data and analytics for informed decision-making and improved grid planning.
- High Upfront Investment: Implementing all modules simultaneously requires a significant initial investment in software, hardware, implementation, and training.
- Potential for Disruption: Implementation may disrupt existing workflows and require adjustments for personnel, potentially impacting operations during the transition.
- Resource Intensive: Requires dedicated resources and expertise for successful implementation and ongoing management of the ADMS platform.

7.6.2. Evaluation Criteria

Enabling The Energy Transition

This criterion assesses the ability to address the anticipated rise in electrification within the community, including the adoption of electric vehicles, heat pumps, renewables, and light rail transit. Increased densification and other demands on the electricity grid requires efficient data-driven decisions.

System Reliability

This criterion assesses Hydro Ottawa's ability to supply reliable electricity to customers in a dynamic evolving energy landscape.

7.6.3. Preferred Alternative

Hydro Ottawa assessed the alternatives described in Section 7.6.1 - Alternatives Considered under the evaluation criteria of Section 7.6.2 - Evaluation Criteria.

The preferred alternative, the Recommended Approach, of incorporating DERMS, SOM, VVO, and FR ADMS modules was chosen over alternative approaches because it offers a comprehensive future-proof solution to the challenges and opportunities facing Hydro Ottawa's distribution network. While other options, such as standalone DERMS or piecemeal upgrades, might address immediate needs, they fall short in providing the integrated functionalities and long-term benefits this program delivers.

This comprehensive approach not only tackles the pressing need for effective DER integration but also optimizes grid operations, enhances reliability and resilience, improves safety, and unlocks cost savings through reduced losses and increased efficiency. By modernizing its grid with this integrated ADMS platform, Hydro Ottawa ensures it is well-equipped to handle increasing DER penetration, evolving customer demands, and the pursuit of a more sustainable and resilient energy future, ultimately maximizing the value of its grid assets and improving service for its customers.

7.7. PROGRAM EXECUTION AND RISK MITIGATION

7.7.1. Implementation Plan

The Control and Optimization Program is planned to be executed across the 2026-2030 rate period. Each module will be implemented in a phased approach, will have a different duration, and can overlap with other modules' implementation depending on the resources and systems involved. Table 25 shows the projects proposed for the 2026-2030 period under this program.

Table 25 - Proposed Projects under the Control and Optimization Program

Year	Proposed Projects
2026	• SOM ADMS Module
2027	• SOM ADMS Module • DERMS ADMS Module
2028	• DERMS ADMS Module
2029	• VVO ADMS Module • FR ADMS Module
2030	• VVO ADMS Module • FR ADMS Module

7.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Control and Optimization Program. Table 26 itemizes the key risks and corresponding mitigation strategies:

Table 26 - Key Risks of Control and Optimization Program and Mitigation Strategies

Category	Risk	Mitigation
Business Requirements and schedule	Changing business requirements or schedules can complicate project planning and increase costs.	Maintain flexibility in project designs and budgets. Regularly engage with business to anticipate and adjust for changes, ensuring resource availability and mitigating delays.
Financial Impact	Cost overruns or budget shortfalls may occur due to unexpected expenses.	Develop detailed budgets with contingencies and monitor financial performance closely throughout the project lifecycle.
Project Management	Poor project management could lead to delays or inefficiencies.	Utilize advanced project management tools to track progress, manage resources, and maintain timelines.
Resource Availability	Shortages in skilled labour may hinder project progress.	Plan resource needs well in advance and maintain strong relationships with suppliers and contractors to secure reliable access to critical resources.
User adoption and training challenges	Resistance to change or inadequate training could lead to low user adoption and hinder the realization of project benefits.	Involve users in the planning and implementation process. Provide comprehensive training programs and support materials. Communicate the benefits of the new system clearly. Encourage user feedback and address any concerns.
Vendor dependence	Over-reliance on a single vendor for the ADMS platform and historian could lead to limited flexibility and potential lock-in.	Negotiate favorable contract terms and service level agreements. Ensure close follow-up on items and tasks.

FIELD AREA NETWORK ASSESSMENT

BLACK & VEATCH PROJECT NO. 418910
BLACK & VEATCH FILE NO. 40.003

PREPARED FOR

Hydro Ottawa

11 JULY 2024

BLACK & VEATCH

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1.0 Project Background

Hydro Ottawa Holding Company (HOL), owned by the City of Ottawa, owns and operates four primary subsidiary companies: Hydro Ottawa Limited, Portage Power, Envari, and Hiboo Networks. HOL requested support from Black & Veatch to investigate Field Area Network (FAN) options. A Scope of Work was agreed to, and this document is the final deliverable for that original Scope of Work. This document will focus on the objectives and technical requirements for a FAN to support HOL field operations with use cases described below. Various FAN options will be described in this document. This document will make various FAN solution recommendations based on perceived HOL priorities, requirements, and budget. The recommended options will include potential public and private broadband networks. The goal of this effort is to capture an option for future HOL use that will fit within an appropriate budget. It is recognized that there is a specific focus on providing a FAN solution to support HOL's 2024 rate case submission. The ultimate decision may be based on additional information obtained in future design iterations and vendor negotiations.

1.1 Field Area Network (FAN) Report Scope

The HOL service territory to be covered is approximately 1110 km^2 in the Ottawa area and 5.4 km^2 in Casselman area. The main Ottawa service territory and Casselman service territory are physically separated by ~26 km on Highway 417.

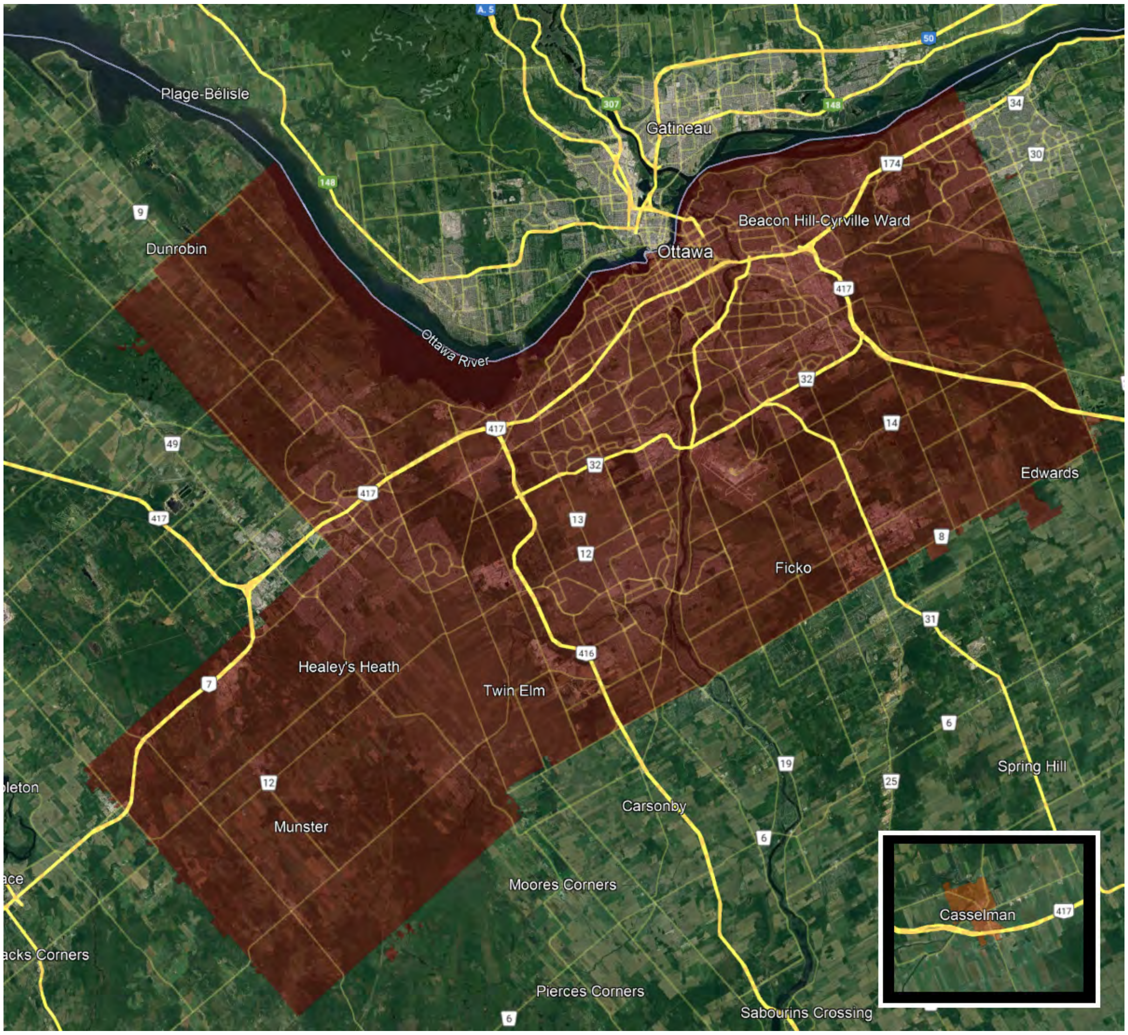

Figure 1 – Hydro Ottawa Service Territory (Casselman inset)

HOL has developed a reliable fibre infrastructure for a Wide Area Network (WAN) to provide secure, high availability, and bidirectional communications between the core grid, distribution control applications, substations, and control centres. The next step is to implement a FAN to enable reliable communications to grid devices not directly connected to HOL's fibre infrastructure to support current and future applications including but not limited to Smart Grid, Distributed Energy Resources, and next generation AMI. The FAN should also be able to support capacity growth for the long term needs of the proposed use cases.

The objective of the FAN is to provide broadband coverage across the entire service territory to enable high speed, low latency, reliable communication between HOL field assets and the two control centres. The existing assets include approximately 300 distributed automation devices and legacy AMI IP meters. The long term objectives include upgrade to almost 400k AMI 2.0 meters, future distributed energy and battery assets, and the supporting wireless communication network.

1.2 Field Area Network (FAN) Report Process

As a part of this process, Black & Veatch engaged HOL professionals in a series of stakeholder meetings including representation from Stations/Control, IT/Cybersecurity, AMI, and Assets/DSI teams. These stakeholder meetings were designed to facilitate a dialog with the project team to better align the objectives of HOL and the ultimate deliverables in support of the overarching analysis. Information gathered from the sessions feeds into the planning and assessment as a part of the gap analysis and rough order of magnitude (ROM) estimates. Additionally, the Black & Veatch project team leveraged experience from the HOL Telecom Master Plan, fibre network designs previously provided, and current involvement with the Advanced Distribution Management System.

2.0 Current State System Overview

2.1 Existing field devices

2.1.1 DA Assets

The HOL DA inventory was delivered to Black & Veatch via a layered KML inventory file which illustrated the 6 device types and counts in Table 1. Towers, future sites, and decommissioned sites included in the inventory were omitted for clarity. Local, non-communicating FCI's were also omitted. DA traffic to and from the field is distributed and collected by narrowband GE MDS radios (SD9). The models and software are at end of life or are discontinued. The northeast corner of the main service area was recently updated with newer GE MDS radios. The device prefixes in Table 1 come from the KML categories provided by HOL.

Table 1 – DA Device Summary

Device	Count
FC - Smart FCI	15
CS - Siemens Vector	2
CS - Scadamates	116
RX - Reclosers	35
SC - Automated Switchgear	32
44kv_switches	46
radio_towers	20
Sum	**266**

2.1.2 AMI Assets

Black & Veatch was also provided an inventory of AMI meters, of which approximately 360k are in use. The existing AMI meter inventory is overwhelmingly mesh backhaul, with some LTE backhaul IP meters and legacy POTs units. All of them are currently used exclusively for billing functions. 99.4% of the AMI meters are backhauled over the unlicensed 900MHz mesh network. There are small quantities (~0.6%) of IP meters and POTs meters combined. The IP devices (cellular modems) are backhauled via a Bell APN. The POTs meters (0.1%) were not discussed as they are also legacy devices. The backhaul methods and AMI meter types are summarized in Table 2.

Table 2 – AMI Device Summary

AMI Device	Count
900Mhz	356570
Cellular	1552
POTs	587
Total	358709

Meter Type	Comm Type	Count
A3 Collector	POTS	587
A3 Collector	IP (wireless)	1534
A3_ILN	900 Mhz (Mesh)	16714
REX	900 Mhz (Mesh)	273192
REX-D	900 Mhz (Mesh)	48647
REXU-EA	900 Mhz (Mesh)	17
	Total	358709

2.1.3 Fibre Assets

HOL has a modern, Nokia based, 10Gbps linked network which is broken up into four redundant quadrants with multiple links to the core loop. This network is built to be reliable and fault tolerant. Based on a GIS evaluation, Black & Veatch determined that the area contained within 1.6km of the existing fibre path makes up 43% of the main service territory. The Casselman service territory is not connected via HOL owned fibre.

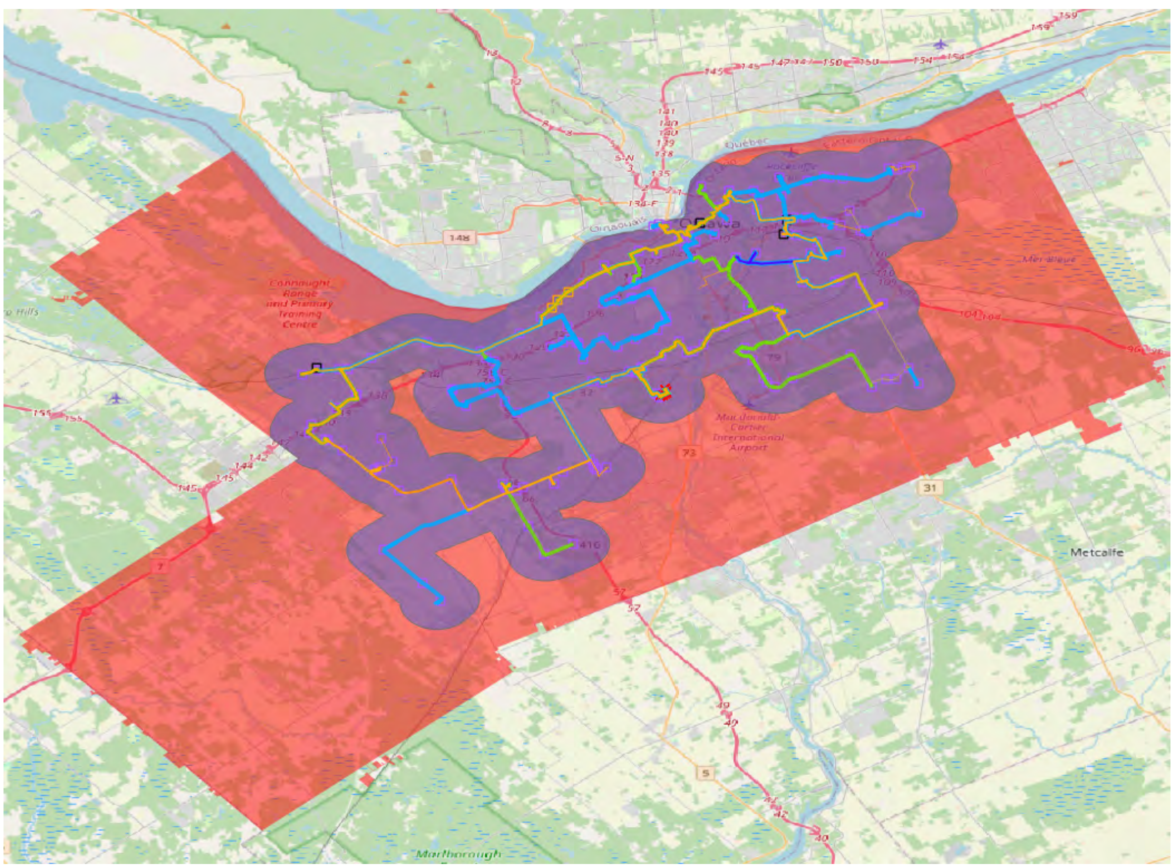

Figure 2 – HOL Fibre Extent + 1 mile buffer

2.1.4 RF Spectrum (ISED) Records and Public Cellular Utilization

Based on a survey of the ISED Spectrum database, HOL has eight licensed 900 MHz frequencies in service, four at 952MHz and four additional at 928MHz. A complete inventory is attached as an appendix. In addition, the fixed ISED database reveals that HOL has licensed 1.8125 GHz Ruggedcom Wi-Max radios at 10 locations in the HOL service territory but has never built the network. HOL does not own nor are there any existing plans or timeline to acquire 3GPP compatible LTE spectrum.

Public cellular is utilized for three applications in the HOL architecture; two are for data communications and one for voice communications. The dominant portion of devices are dedicated to AMI IP meters. Those ~1550 IP meters contain Bell SIMS which communicate with the Bell cellular network and are consolidated and delivered back to HOL over an APN. It is currently unknown if the APN is diverse across control centres. There are also ~40 active DA devices that are served by public cellular. It is our understanding that these devices have individual IP sec tunnels associated with them. The last public cellular category utilized by HOL is voice communications. HOL utilizes cell phones for field technical staff that are served by the Rogers Cellular network. The Stations stakeholder meeting indicated a preference for the Rogers Cellular network versus Bell due to its perceived superior coverage area.

2.1.5 Tower Assets

HOL has 19 towers documented in the KML drawings. Some of the centre lines have been correlated via the ISED database. There are a variety of transmitters on telephone poles which are not suitable as LTE base stations and thus are excluded from this summary. The tower assets Black & Veatch has identified are those that are suitable as LTE base stations for private use. A filtered inventory of the structures is attached as an appendix.

2.2 Existing Performance management

2.2.1 DA performance management

Some limited DA KPI's were provided by HOL via a "Previous Day RTU Stats Summary". Total DNP scans to successful scans ratio as well as ratios of uplink and downlink data volume rates for DA narrowband device were examined. Roughly 20% of the DA narrowband sites exhibit polling success rates at 95% or below, some as low as 30%. This is a single day and is therefore an insufficient data set with which to make long term assessments. Furthermore, these measurements were taken on a "sunny day" scenario. Inclement weather may erode these ratios.

For the cellular modem DA backhaul, there are available API methods via the Jasper portal for collecting and trending APN modem performance; however, these are not currently utilized by HOL. This inhibits a comparison of overall narrowband to cellular performance. Based on a Google Earth street level survey, it does not appear that external antennas are utilized for cellular links. This may inhibit higher level of performance and resiliency under adverse conditions. It may be that the photography is old and out of date, but if this practice of no external antennas is the standard, HOL is suffering much lower performance than is possible via public cellular networks.

2.2.2 AMI performance management

AMI polling metrics for the 900Mhz unlicensed network were not available and therefore not evaluated. It also does not appear that the cellular AMI backhaul success or latency is consistently measured or evaluated. There are methods to collect and assess this information via the cellular service provider such as via Jasper or Cisco Control centre. This depends on the current provider and contracted services as part of the APN.

AMI performance management, as it applies to 900 MHz and cellular backhaul, appears to be exclusively reactive in nature. Based on the selected vendor, a transition from mesh to cellular backhaul can be 1,500 meters or 60,000. Backhaul requirements would be impacted based on the topology selected. At the mesh level the performance is more based on endpoints and hop counts. With quantities of meters being smaller when meters hop from one to the other, bandwidth is less of an issue with a handful of meters.

There are two levels of performance management on an AMI network. At the meter reading level there is hop count, meter success rates, interactive command delay (like a real time disconnect command). At the backhaul level the performance factors are different. Packet delay, retry rates, speed are measurement factors considered to examine overall network performance.

2.2.3 General performance management practices

Polling success rates can be evaluated from the SCADA platform, which does provide end to end visibility but does not decompose the backhaul path into its constituent wired and wireless components. Wired networks are far more reliable for a variety of reasons and are likely carefully collected and monitored by the HOL IT team via SNMP. Performance management, as it applies to the RAN, is a process where the wireless aspect of a communication link is accounted for and evaluated on a device-by-device basis. This management process allows for high levels of visibility and helps the teams reliant in the incoming information to be proactive in terms of maintenance. The airlink can be subject to misconfiguration, RF noise, interference, and seasonality (foliage) to name a few. It is extremely important to differentiate the normal from the abnormal and a transient from a trend. This requires reliable data collection, data aggregation, and analysis by appropriately trained staff.

2.3 Distribution Automation

Upgrading from narrowband devices was discussed during the Stations and Control stakeholder meeting. There were specific comments relating to the uncertain reliability and high latency of the radio links at times. Upgrading to cellular devices from narrowband devices is generally not a difficult process. The key considerations are power consumption, physical form factor, interface capability, diversity antennas, and intelligent antenna placement. LTE has a rich set of manufacturers which support a broad range of form factors, interface types, port counts and temperature ranges. LTE chipsets also support a wide range of 3GPP frequencies and channel bandwidths to accommodate any of HOL’s current or near future requirements.

2.4 Automatic Metering Infrastructure

The existing HOL AMI 1.0 meters and collector network of almost 370,000 devices is unlikely to be compatible with the long-term reliability, latency, and remote intelligence needs. The 10-year estimate of the AMI meters is approximately 400,000 in total.

In addition to the basic billing function, the stated goals of the AMI 2.0 network are much higher sample rates and greater situational awareness promised by AMI 2.0 vendors. AMI interval changes can be accomplished with existing AMI 1.0 meters. Those will typically allow for consumption and interval reads where intervals can be more granular. Depending on meter type, there may be additional information provided by the AMI 1.0 meter. in addition to the consumption of the kilowatt hours and intervals, AMI 2.0 promises to deliver voltage, current, phase, transformer awareness and perhaps applications which run on the meter microcontroller. A defined HOL roadmap will drive the meter and/or application capability requirements. If a decentralized edge computing approach is sought, bandwidth requirements at the head end and wireless bandwidth use can be reduced. That said, the billing functions will likely stay centralized in the head end for head end to MDMS to billing data hand off, so some bandwidth is still needed for centralized activity.

Other factors to consider would be the calculation of certain parameters vs. actual reads from an AMI 2.0 meter. Power factor can be calculated or measured, but it could add to the meter data payload. If data is already provided from the meter, adding a measured power factor might add to the payload. It would likely be negligible but, if many parameters are added to the meter, it could significantly boost meter payload. In aggregate across the network, increments of 400,000 meters could require additional bandwidth on part or all of the network.

The question of centralization will contribute to awareness of how much additional data is transmitted. Again, there are many factors to consider that could/will affect overall FAN payload. Circuit loading may be done at the substation level. Localized meter data might be delivered to the substation for load accumulation calculations. From here, circuit loading could be reported to a D-SCADA system. This quasi-decentralized approach may increase bandwidth requirements across the network but decrease the bandwidth from a centralized collection point.

The specific AMI vendor and use cases have not yet been defined; however, we have estimates of the required functions and bandwidth requirements associated with each.

2.5 Distributed Energy Resources

HOL has indicated that there will be a need for reliable communications at future battery storage and DER locations. Battery storage and DER application capacity is assessed and estimated in Section 5.1.3.2. The monthly usage estimates appear manageable from a wireless LTE perspective; however, ensuring that coverage and capacity needs are met via site survey is recommended. Without specific siting locations, it is difficult to assess potential donor sites either public or private. In general terms, it is better to have these locations within the footprint of multiple cell sites hosting multiple frequencies for the sake of redundant and reliable communications for these assets.

3.0 Use Case Considerations

3.1 Use Case Matrix

The use case matrix in Table 3 is a tool for estimating wireless data volume that is a response when polled by HOL core assets. These devices are typically "outside the fence" and in the field; thus, the communications are typically wireless. The primary purpose of Table 3 is to sum up the data volume for each class of device, quantity of devices, volume per read and sample rate into a daily total and monthly data volume total. These totals are used to identify sim counts and data quantities per SIM card. The spreadsheet is particularly useful when using a public scenario and purchasing capacity from a public LTE carrier.

The table remains useful for a Private LTE scenario because it provides estimates of data volume over the air which will ultimately be processed and passed through the LTE core appliance. This helps size the server, license sizing and core NIC capacity. Much of these high-level estimates are represented in the propagation coverage estimates (hexagons) in Table 6 which summarizes data usage from AMI and DA on a per LTE base station basis. There are minor differences between the data volume on the two tables due to the device counts and Table 6 using approximate data volume, as opposed to building the data volume up from message size and sample rate. A copy of Table 3 is attached in the Appendices for customer customization and future growth estimates. Black & Veatch has included rows for devices that are potentially not in existence or have not been quantified yet but are being considered. This table builds up the sampled data volume based on data reads and sample intervals. These values are based on stakeholder conversations and may be modified to match the current HOL sample rates and devices to provide a more accurate prediction of data volume.

Table 3 – Wireless Use Case Matrix example

Device Type	Data Vol per read (kB)	Sample Rate (Secs)	data volume hour (MB)	Samples day	per device daily total (MB)	Device Quantity	data volume per day (MB)	data volume per Month (GB)
Reclosers	1.5	10	0.527	8640	12.66	35	443	13
Pad mount Switches	1.5	10	0.527	8640	12.66	50	633	19
Overhead Switches	1.5	10	0.527	8640	12.66	120	1519	44
EV Charging	1.5	10	0.527	8640	12.66	50	633	19
Solar Inverters	1.5	10	0.527	8640	12.66	0	0	0
Fault Indicators	1.5	10	0.527	8640	12.66	15	190	6
Capacitors	1.5	10	0.527	8640	12.66	0	0	0
Battery Storage	250	300	2.930	288	70.31	0	0	0
Solar Farm with Inverter	250	300	2.930	288	70.31	0	0	0
SCADA Totals						270	3417	100
AMI meter Totals					0.017	368509	6368	187

3.1.1 DA use cases

DA use cases are expected to require far less bandwidth than AMI 2.0 applications. This is largely due to the high volume of the AMI devices relative to DA. It is expected that high quality, optimally located antennas in tandem with LTE modems will contribute to lower latency, higher reliability, higher throughput and improved electrical distribution situational awareness.

3.1.2 AMI use cases

The AMI 2.0 use case has been described in the stakeholder meetings in general terms. Black & Veatch has performed a capacity analysis based upon vendor projections of the AMI 2.0 meter application. There are additional capabilities proposed by vendors including meter to meter interaction, source transformer awareness, waveform analysis and edge intelligence. Some or all these factors may contribute to the LTE network usage and loading. Vendor and model selection, along with use case testing validation in lab testing environment, would drastically improve the LTE capacity requirements.

AMI 2.0 or Next-gen AMI consists of edge-computing devices with advanced capabilities that enable a better understanding of how electricity is used or generated—in real time. This intelligence holds many potential benefits for consumers and utilities alike.

Next-gen AMI enables grid edge technologies that provide the consumer with improved power quality, access to appliance level energy use in real time, ability to participate in flexible rate programs, and better tracking and management of DERs and EV charging.

For utilities, AMI 2.0 will provide short- and long-term benefits that include better operability, performance, communication, security, and sustainability.

Black & Veatch's prior engagements with HOL recommended the four (4) key phases of an AMI roadmap below.

1. Capabilities that can be enabled with existing Honeywell AMI system (REX1/REX2 meters, existing mesh network nodes, existing backhaul, existing HES) but which require changes to the downstream systems.
2. Incremental investments in existing AMI system (selective replacement of existing meters or other low volume field devices, network collectors, backhaul, HES) to mitigate obsolescence risks and enable high value capabilities.
3. Investment in operational capabilities which may be enabled by the planned FAN network.
4. Re-investment in AMI replacement technology to enable benefits dependent on mass meter replacement or other endpoint deployments.

Within each phase, the desired and prioritized opportunities were discovered in workshops. These opportunities were further described as Business Releases and mapped to each of the four (4) phases.

The Phase 4 opportunities were based on the complete replacement of the AMI solution. This phase is dependent on the resolution of the HOL Telecom FAN plan. It was not pre-assumed that the next generation solution would be the existing vendor's technology or another vendor's solution. As such, the phase is preceded by a recommended vendor solution selection exercise, with the full understanding of the Telecom FAN solution.

The Phase 3 and 4 business releases in Figure 3 and Figure 4 below can be labeled as transformative consumer-facing and grid-facing initiatives that the utility needs to implement.

- Consumer-facing use cases – utilities have recognized consumer data analytics, consumer-targeting, rate recommendations and communications are some of the top use cases.
- Grid-facing use cases – utilities are required to rethink their power generation and distribution with the key priorities of resiliency, reliability, efficiency, and security.

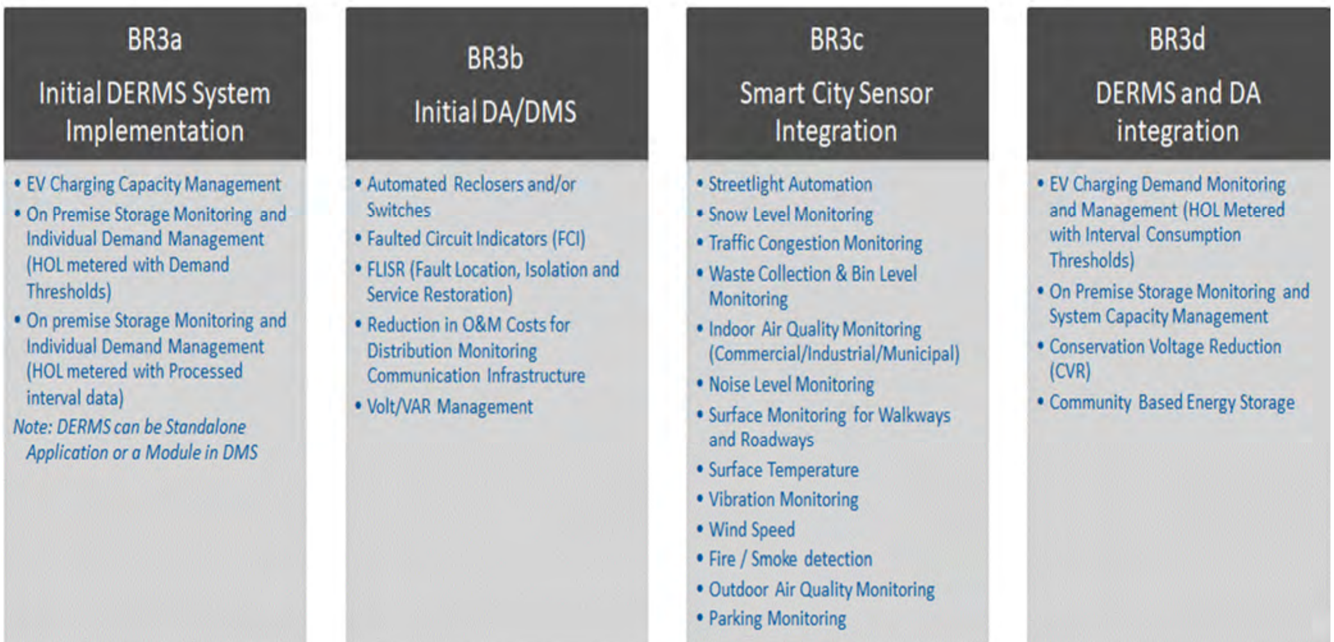

Figure 3 – Phase 3 Business Releases

Figure 4 – Phase 4 Business Releases

3.1.3 Use Cases – Latency and Bandwidth

All the example use cases in Table 3 could be recommended for use with 4G. They are all suitable for Public and Private scenarios and would improve the current system response times and reliability measurements. There are certain low latency use cases that could potentially be implemented, but they would require more detailed analysis and thoroughly defined architectures. The information in Table 3 is intended to quantify data volumes. Transfer trip is dependent on very low, ~5ms latency, which may be achieved with private on prem 5G architecture and QOS marking, but the 25-50ms latency for LTE is generally considered inadequate. The exact architecture and implementation would need to be assessed and tested to recommend any non TDM wireless for transfer trip. The vast majority of transfer trip is implemented on a low bandwidth TDM with 4 to 8ms latency. There are also other applications such as real time video and synchro phasors which can also be implemented over wireless, but they consume large quantities of wireless bandwidth and would need to be evaluated on a case-by-case basis within the RF coverage properties, spectral capacity or data volume limits.

4.0 LTE System Requirements and Network Security

All LTE systems, regardless of which option is chosen, must comply with a set of general requirements. Security, including SIM card authentication and encryption, must also be taken into account. The requirements and security information presented here will apply to any type of LTE system – private, public, or hybrid.

4.1 General LTE System Requirements

The following requirements are generally applicable to LTE systems.

- S1-U and S1-MME interfaces shall be capable of integrity checking and encryption over the air. Encryption and integrity checking will be ON for NAS and OFF for User plane.
- RF Coverage and channel quality: Downlink signal strength and CINR shall support a minimum of 5 Mbps at cell edge and no less than 50 Mbps peak per node to support the initial use cases.
- Radios shall support up to 40 MHz wide bandwidth in blocks of 5 MHz and carrier aggregation.
- Radios and antennas shall allow for all North American LTE bands.
    - New ISED bands may not be supported yet.
- Radios and antennas shall provide 2x2 MIMO operation at a minimum, 4x4 is preferred.
- Radios/eNodeBs shall support Interference mitigation techniques such as intelligent frequency block scheduling.
- The LTE EPS system shall support Quality of Service (QoS) and voice traffic prioritization for end to end for potential future use.
- EPC capacity must support an aggregate continuous throughput capacity of 2.0 Gbps.
- The EPC shall support segmentation and isolation or routing between APNs.
- The EPC shall support micro-segmentation security concept for isolating UEs from each other within an APN.
- The EPC shall be scalable to accommodate 10,000 dormant and 100 simultaneous active sessions.
- The EPC shall support sub 50ms RTT latency from a connected state.
- The LTE Infrastructure shall integrate with Hydro Ottawa's existing IP network access infrastructure and protocols.
- LTE RF Security features require demonstrated encryption, authentication, and access controls.
- The RF sites shall adhere to all RF safety protocols including power density calculations for RF safety signage.

4.2 Network Security

4.2.1 Device Authentication

The UICC or SIM card is one of the primary security methods for LTE. The SIM provides authentication via a shared key which is only known to the SIM and HSS. During the User Equipment (UE) attach process, the SIM is queried for a derivative of that key by the EPC in the AKA process. When the SIM authenticates properly, it is provided temporary identifiers to use in subsequent radio transactions, and it is allowed to attach to the LTE EPC and obtain an IP address. SIM's will be delivered to HOL, arranged by APN for distribution into the appropriate device types. Because the wireless network is intended to be private or virtually private, HOL will control the SIM cards and the devices in which they are installed. Hydro Ottawa therefore has complete control over which devices are allowed to authenticate and therefore utilize the LTE wireless network.

4.2.2 Air Interface Encryption

The S1-U and S1 MME interfaces shall be capable of integrity checking and over-the-air encryption. Assessments of the throughput costs will be tested and evaluated via iPerf within in a lab scenario or upon initial installation at the Hydro Ottawa site. At a minimum, the S1-MME link will be encrypted, and integrity checked. The user plane encryption and/or integrity checking capability will be implemented at HOL discretion. The Black & Veatch recommendation is to leave user plane encryption and/or integrity checking off to enhance throughput since the control plane is already encrypted. Optional services or optional managed services that can be obtained via equipment vendors or service providers include performance monitoring, software configuration, and management functions. These services are provided transparently to HOL in the existing Public LTE scenario since they do not own any of the LTE iinfrastructure. Both Rogers and Bell maintain the network in the background with compliance to a KPI standard. If HOL chooses to implement a private core and base stations, some internal or external team will have to maintain the LTE performance standards. If managing the private network is too burdensome, it will have to be contracted out in the Private or PVNO scenario. Managing the LTE network is typically supported by a carrier or equipment provider over a VPN as depicted in Figure 5.

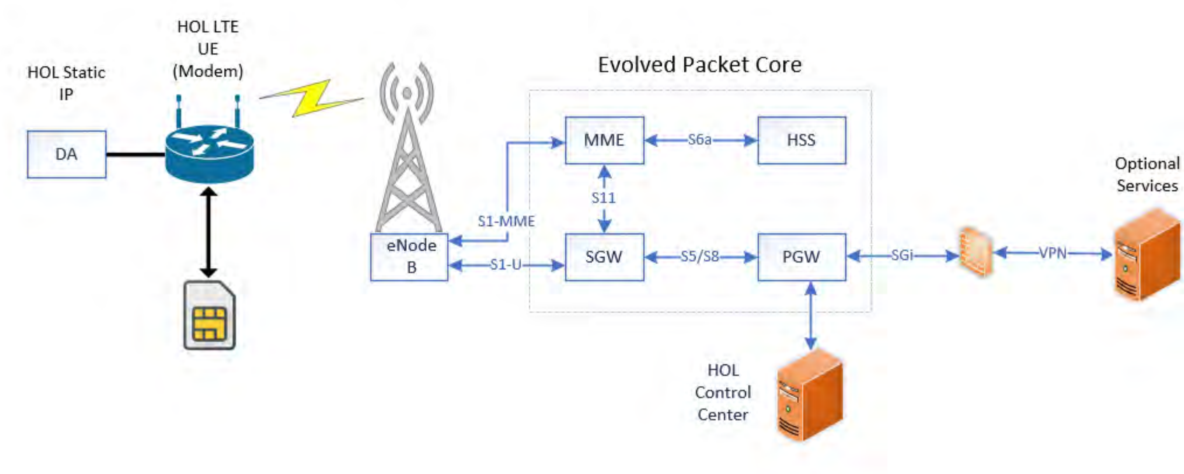

Figure 5 – LTE Detail Diagram

5.0 Private Network Option and Topology

A private network provides the flexibility and security of ownership of all network equipment and the spectrum that it uses. This comes at a cost, however, as HOL or its contractors would be responsible for the design, construction, testing, operation, and maintenance of every component of the network. There are many criteria to consider when selecting and designing a private network. In this section, network architecture, RF predictions, site placement and dimensioning, costs, and RF spectrum options are covered.

5.1 Private Network Architecture

An entirely private network is created where HOL owns the wireless radio spectrum, edge devices/user equipment (UE) and SIMs, radio access network (RAN), Enhanced Packet Core (EPC), and performs the day-to-day management and maintenance. The initial engineering to set up the selected equipment is typically performed with an OEM vendor. After integration with HOL assets and initial acceptance testing, it is turned up and optimized for a period of time. Following site by site testing and final acceptance, it is turned over to HOL to operate. There are also various managed service options available through different vendors.

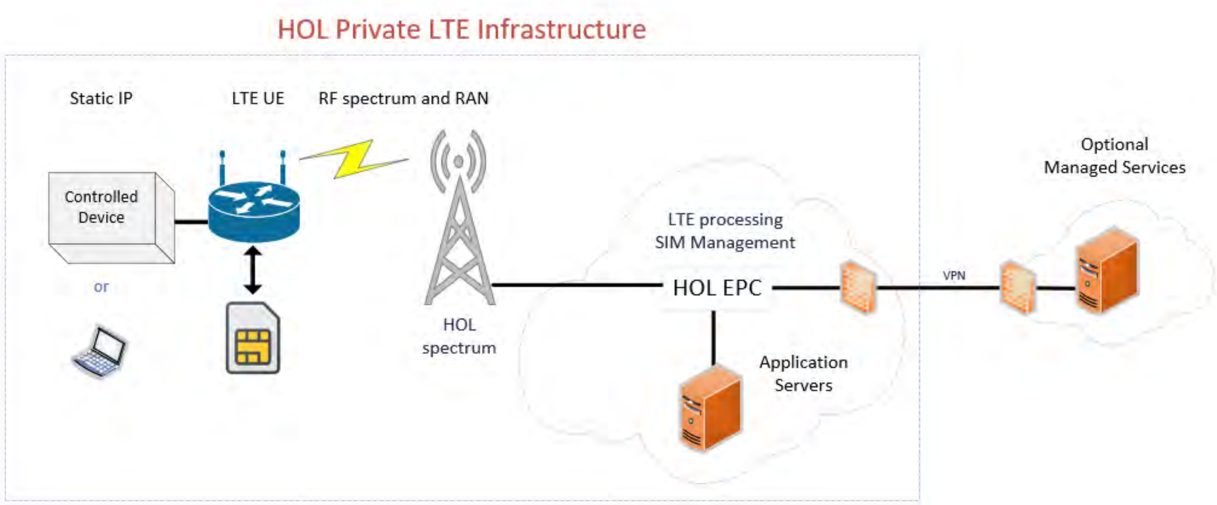

Figure 6 – Private Network Architecture

Some typical exceptions to a completely private scenario include co-location on existing cellular towers or rooftops and leasing backhaul where HOL lacks assets from a base station to HOL fibre. A private network can provide enhanced security and exclusive use of licensed spectrum with the attendant responsibilities and financial layouts.

5.1.1 Wireless Coverage Methodology

Black & Veatch inspected the HOL territory and performed a dimensioning analysis which yields a rough order of magnitude (ROM) cost estimate to build a private LTE network. This analysis was conducted using best practices and estimates by Black & Veatch senior engineers with multiple years of experience designing and deploying private LTE sites across North America. The following steps were involved in conducting this ROM analysis.

5.1.1.1 RF Predictions

Black & Veatch RF Design Engineers placed (2) two hypothetical sites within the HOL territory – one of them in rural morphology and the other in suburban morphology. These sites were chosen in a way as to provide a representation of the major portions of the HOL service area as shown in Figure 7. Both hypothetical sites were configured as 3-sectored LTE sites utilizing FDD in the 900MHz band. This configuration provides for 3MHz uplink and 3MHz downlink channels. Each site was configured with standard directional panel antennas with a 65-degree horizontal beamwidth. Once configured as standard LTE sites, coverage predictions for each site were modeled using an industry-wide accepted RF design tool. A transmit power of 38dBm (EIRP of 50.9dBm) was used in order to maintain compliance per the FCC rules governing the 900MHz Band 8 since Canada has not released any formal stipulations for this band yet.

Propagation studies were run at two representative antenna centre line heights of 23 metres and 38 metres See Figure 8 and Figure 9. The receiver height was defined at 5 metres above the ground level. This represents a typical height for AMI collectors. Based upon previous LTE designs, deployments, field testing, and engineering experience, a reference signal receive power (RSRP) of -118dBm was chosen as the cutoff for a usable signal. Receive Sensitivity is a property of the receiver; it is independent of antenna centre line. Raising the centre line can improve performance due to improved downlink receive signal strength and improving uplink line of site to the serving tower. Adding to the centre line collects more signal since it rises above the clutter which attenuates and diffracts the desired signals.

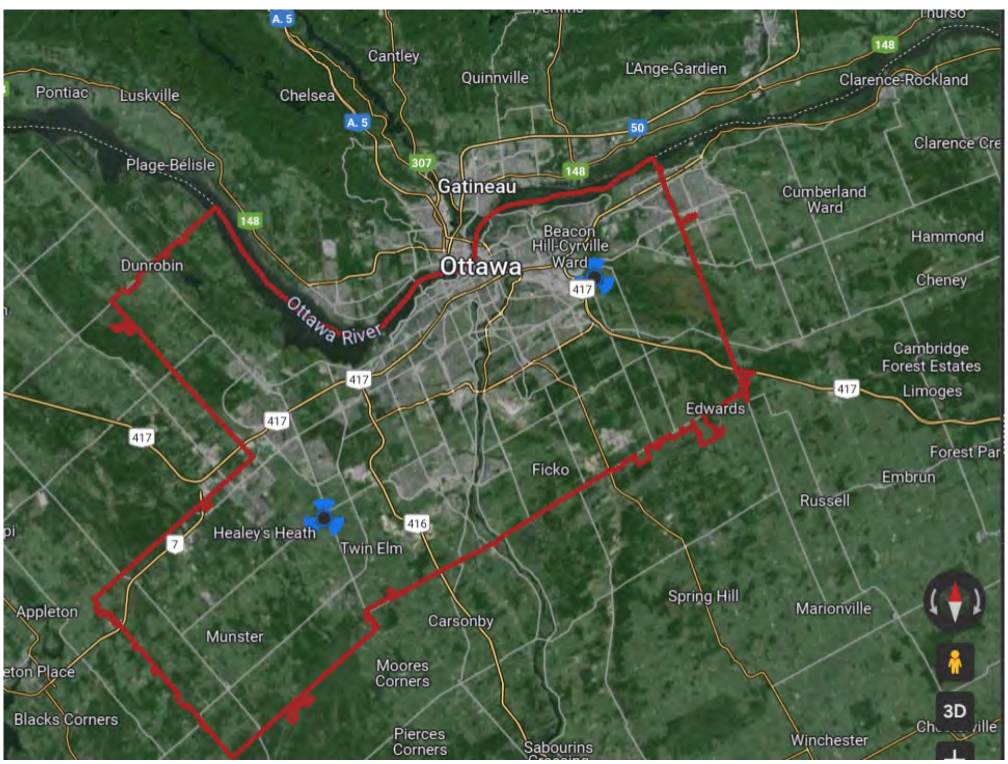

Figure 7 – Coverage Prediction locations

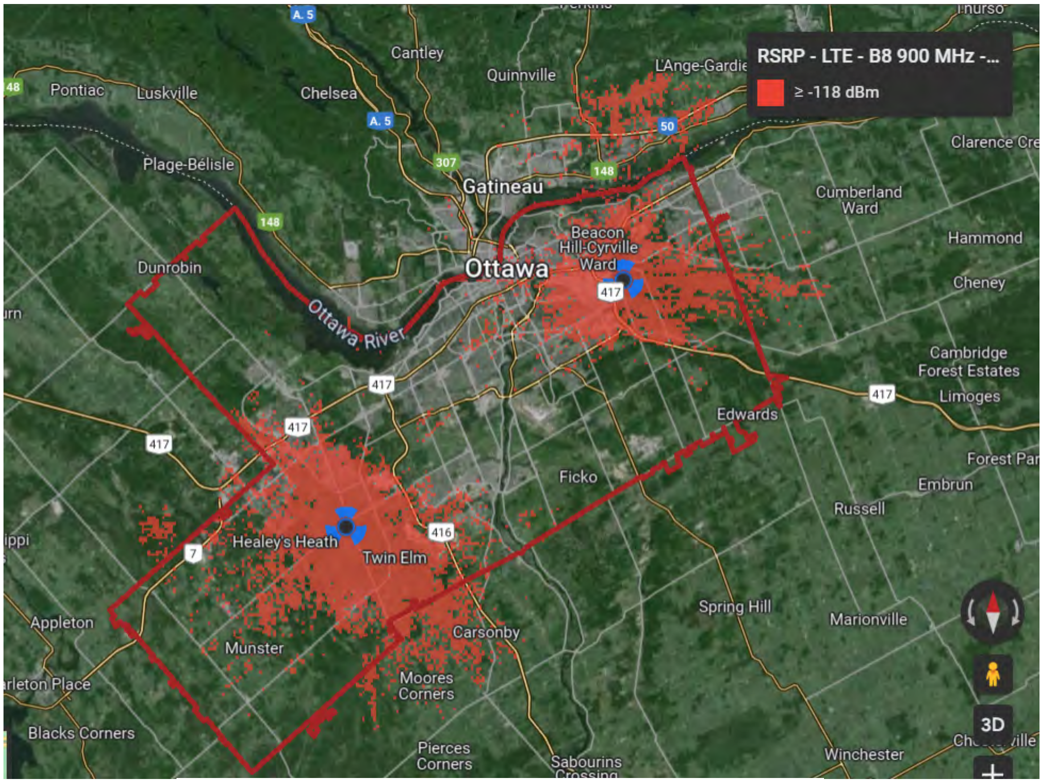

Figure 8 – Coverage Prediction at 23-metre antenna centre line

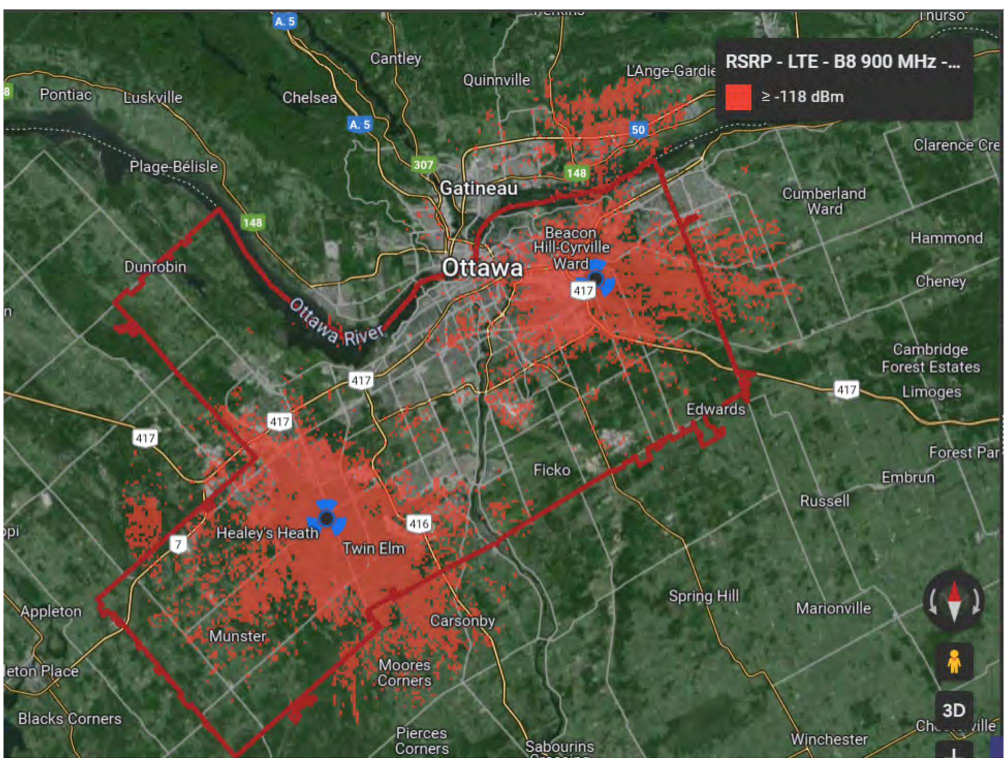

Figure 9 – Coverage Prediction at 38-metre antenna centre line

5.1.1.2 Site Dimensioning

The approximate area covered by these two sites at each of the two heights was obtained using RF propagation study software. The resulting area covered was used to approximate the total number of sites required to cover the entire HOL service area. For each height (23 metres and 38 metres), a +30% adjustment was made to each site to account for coverage overlap between the sites and for non-ideal site location in a real-world scenario. Site placement can be affected or influenced by multiple items including zoning restrictions, willing or non-willing landowners, geographic restrictions, air space restrictions, and many others. Black & Veatch has determined, through multiple LTE designs and deployments, that a +30% overlap adjustment best represents the impact of site placement on initial site counts. This model has been used by Black & Veatch on several projects with a high degree of accuracy for forecasting preliminary site counts as well as for budgetary purposes. The dimensioning results are shown in Table 4 below.

Table 4 – Site Count Estimation

Total Service Area			1,113 km^2				
Rural	724 km^2		**Sub-urban/urban**	390 km^2			
Frequency	**Tower/Antenna Height**		**Site 1 (Rural) Approx Coverage Radius**	**Site 2 (Sub-urban) Approx Coverage Radius**	**Approx Coverage area (Rural)**	**Approx Coverage area (Sub-Urban)**	**Number of sites required**
900 MHz	75 ft	22.9 m	7.0 km	5.5 km	153.9 km^2	95.0 km^2	12
900 MHz	125 ft	38.1 m	7.6 km	6.0 km	181.4 km^2	113.0 km^2	10

5.1.1.3 Site Placement

Once dimensioning is completed, a representative hexagonal cell is created in a GIS tool to approximate the placement of the sites and confirm the initial site count. This cell must correspond to the approximate coverage radius determined during RF predictions. In this case, a 23-metre rural cell was found to cover a radius of approximately 7km. Therefore, the hexagonal cell should be created with side length of 7km or a radius of 14km. These hexagons are arranged in a way that maximizes coverage while minimizing overlap. The resultant placement is shown in Figure 10. When utilizing a 23-metre rural site, we see that the initial estimate was 12 sites (Table 4). Given a 30% correction factor, this closely matches the site placement estimate of 14. The predictions rely on a low band LTE frequency that propagates effectively through and around clutter and foliage. Access to a lower LTE operating frequency minimizes the number of cells required to cover the service territory. As the LTE coverage frequency increases, additional power will be needed to achieve coverage parity with the low band, or else the grid must become more densely packed, and the site density will increase. There is no guarantee that any of the approximated locations are viable options; this process is meant to evaluate the potential number of sites to cover the service territory. In addition to the main Ottawa service territory area, the adjacent Casselman will require one additional site to cover those HOL AMI and DA assets.

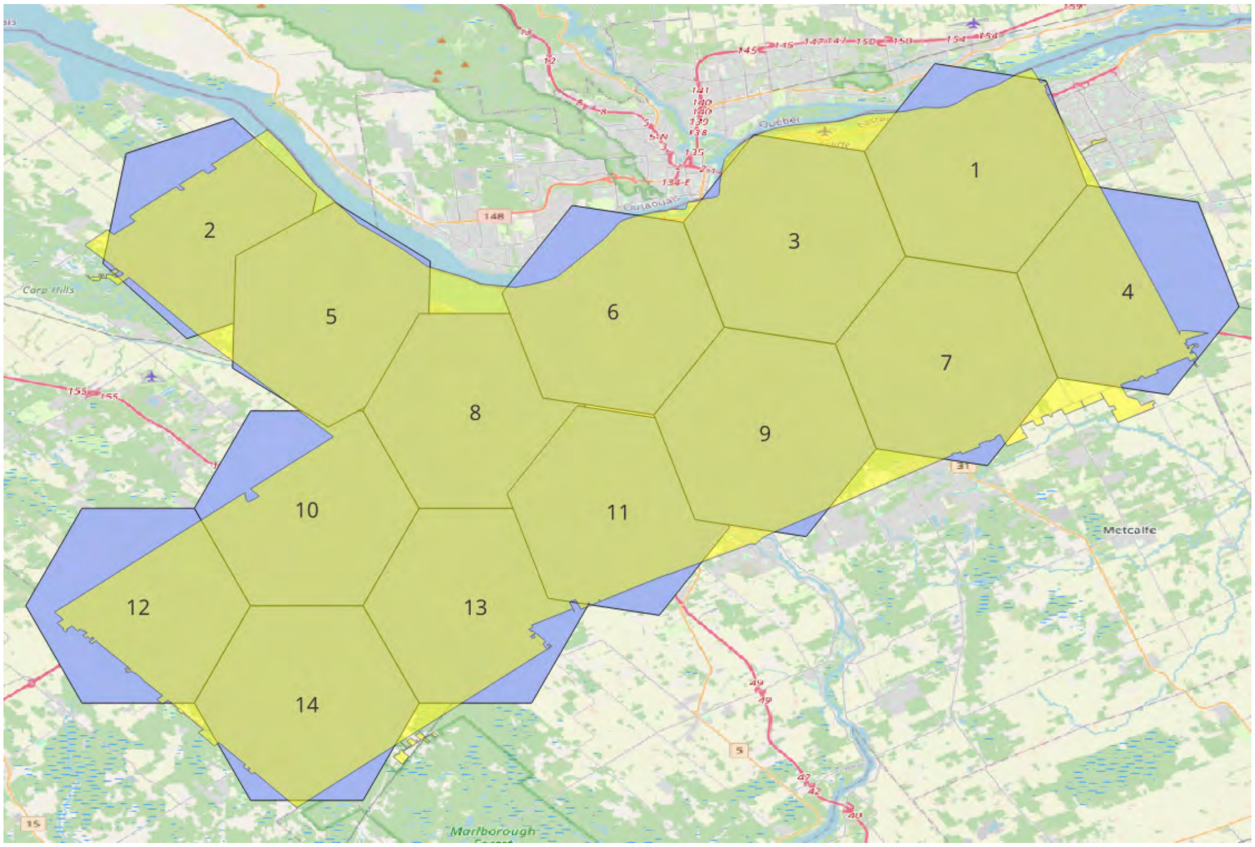

Figure 10 – Hexagonal Cell Placement

5.1.2 RF Capacity Planning discussion

The following per cell capacity estimates are based on securing spectrum and tower centre lines capable of projecting the hexagonal cell footprints described in the Coverage Methodology. The HOL geolocated DA and AMI assets were divided into the hexagonal cells by their relative location. The capacity required per cell will be estimated based on AMI 2.0 and DA traffic estimates.

5.1.2.1 DA

A GIS analysis was conducted to count the amount of DA objects in the service territory which resulted in the division of the existing DA into each hexagonal site. In Figure 11, the red number represents the assigned number of the cell site, and the yellow number represents the number DA objects (modems) occurring in that cell footprint.

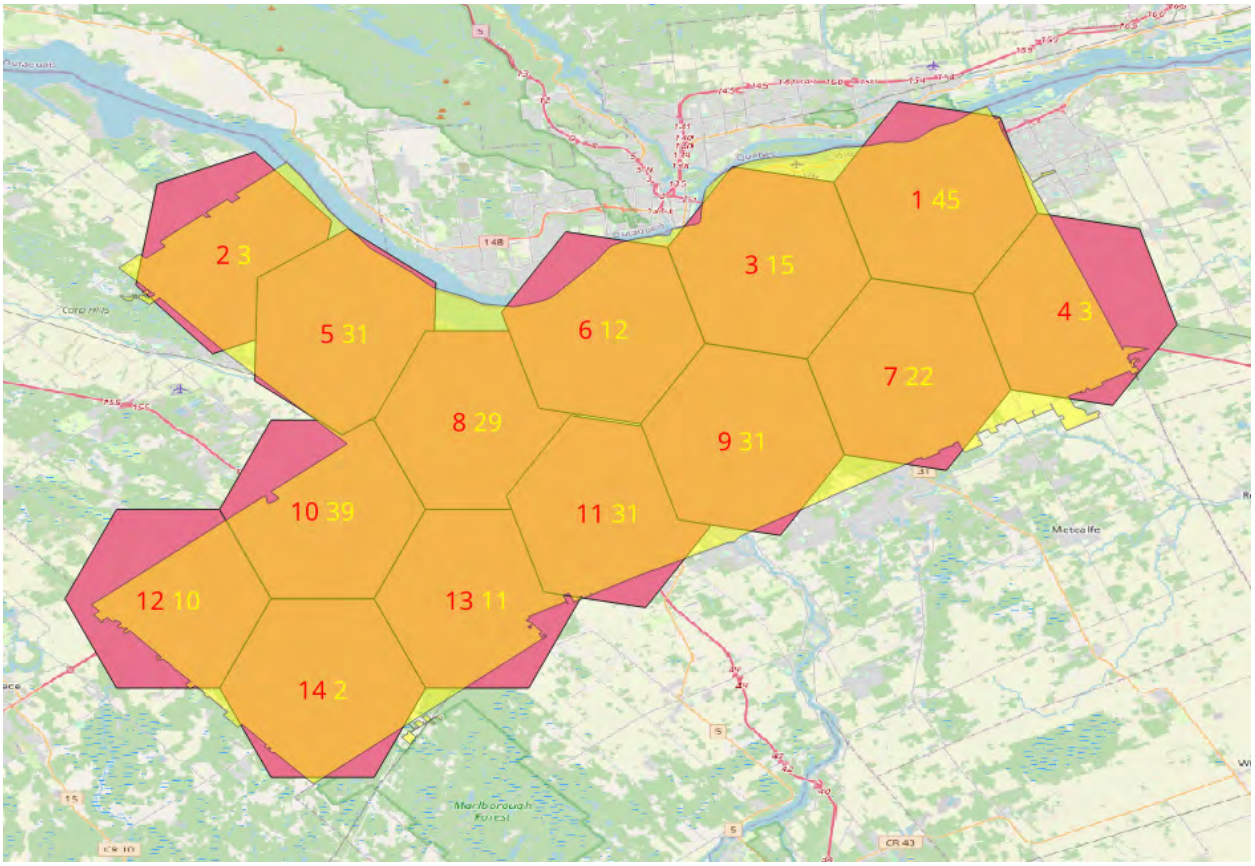

Figure 11 – predicted DA assets per hexagonal cell

DA device bandwidth requirements are determined by the sampling rate and the complexity of DNP points list brought back to the SCADA headend. While this varies between utilities, a 5kB response is a reasonable approximation for each poll response. Assuming 5-minute samples:

Estimate:
12 samples/hour * 24hrs/day * 30 days/month= **8640** samples over a month
5kB/poll * 8640 = **43.2 MB**/month for SIM sizing (MRC)
Cell loading = 50 DA per cell(worst case) * 5kB/poll= 250KB/300sec polling= ~**1kB/sec**

Actual volume of "X_CS" devices with >95% success rates:
Previous Day RTU Stats Summary showed and average of **500KB/day** per device or ~ ½ the estimated value.

5.1.3 AMI

A GIS analysis was conducted to approximate the number of AMI collectors in a geographic area which resulted in the division of the existing AMI meters into the hexagonal cell approximations. In Figure 12, the red number represents the number of the cell site, and the yellow number represents the number Aps or collectors at 1000:1 ratio required in that cell footprint. Table 5 includes the projected total number of required AMI Aps per cell rounded the next whole number.

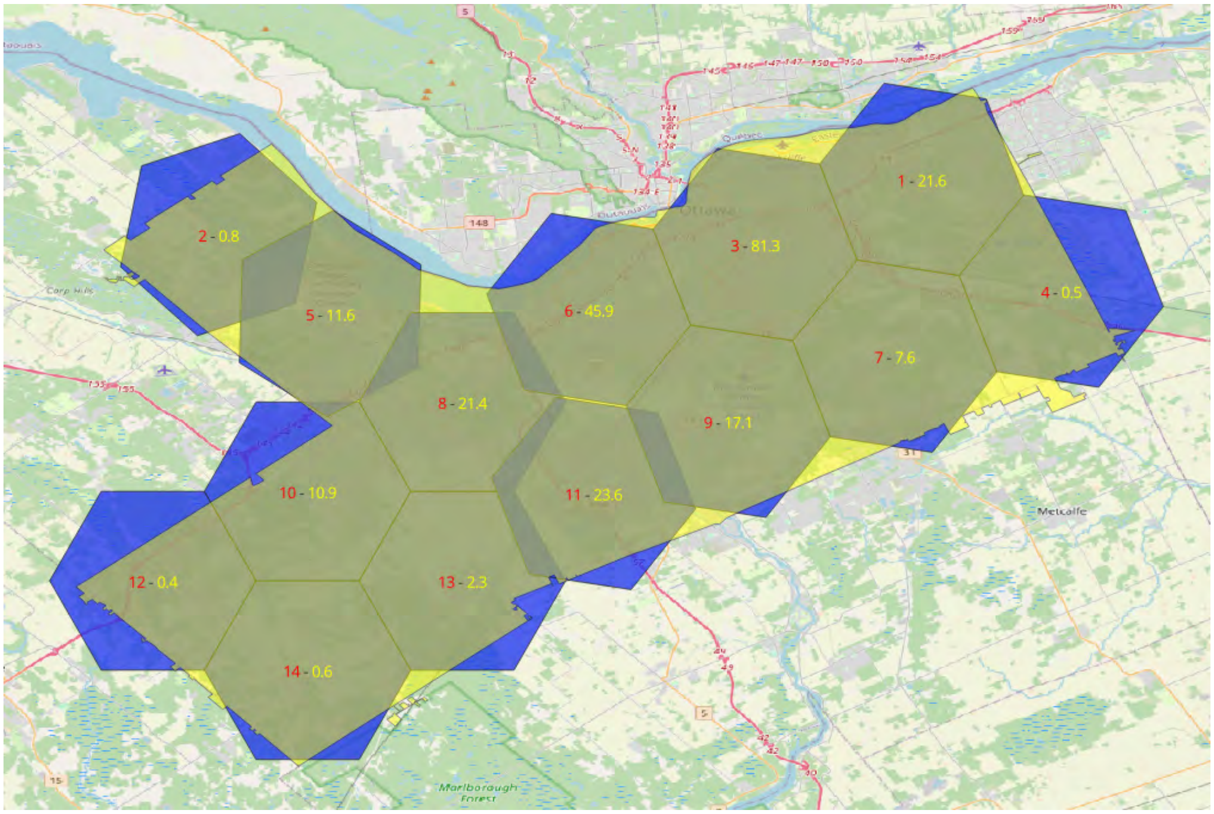

Figure 12 – AMI AP's per cell

When planning specific collector locations, it will be important to ensure that there is site diversity and preferably frequency diversity to decrease the risk of backhaul failures should a cell site/sector fail or undergo maintenance. The projected capacity need of AMI over cellular has been estimated using a Landis and Gyr load profile table that defines ~10 transaction types from firmware upgrades to various read types to last gasp communication. See Table 5.

Table 5 – L and G Load Profile Options

Cellular Data Volume Usage

Commercial	Landis+Gyr Payload Size	Periodicity	Daily with 4 LP @ 1 minute	Daily with 16 LP @ 1 minute	Daily with 4 LP @ 5 minute	Daily with 16 LP @ 5 minute	Daily with 4 LP @ 15 minute	Daily with 16 LP @ 15 minute	Landis+Gyr Payload Size	Periodicity
Load Profile			25,920	103,680	5,184	20,736	1,728	6,912		
Landis+Gyr Meter Firmware Upgrade	1MB	6 months							1MB	6 months
Landis+Gyr Module Firmware Upgrade	1MB	6 months							1MB	6 months
Modem Firmware Upgrade	1MB	18-24 months							1MB	18-24 months
Disconnect	~30B								~30B	
Load Control	~30B								~30B	
On-Demand Read	<1kB								<1kB	
Snap Read	200B	24 hours	200	200	200	200	200	200	200B	24 hours
Event Log	~5kB	24 hours	5000	5000	5000	5000	5000	5000	~5kB	24 hours
Meter Reconfiguration	~5kB								~5kB	
Last Gasp	100B								100B	
Heartbeat	34B		9,792	9,792	9,792	9,792	9,792	9,792	34B	
Total Daily Bytes			40,912	118,672	20,176	35,728	16,720	21,904		
Per month			1,227,360	3,560,160	605,280	1,071,840	501,600	657,120		
In MB			**1.23**	**3.56**	**0.61**	**1.07**	**0.50**	**0.66**		

The L & G meter will store data within the meter at the cadence specified in the load profile above. The rate at which it is picked up by the AMI server is based on how often the AMI meter is polled. The rate at which the AMI meters can be polled and successfully respond depends on the speed of the AMI response. This analysis assumes meters can be polled successfully every 15 minutes, which will likely require few mesh connections and many LTE connections. AMI sample rates can be sampled and stored by the meters and picked up at a rate which the communications support. Some of the variables include the LTE interface (CAT-M) and the depth of unlicensed mesh required prior to getting to an LTE exit point.

Based on stakeholder feedback, 15-minute 4-channel meter channel measurements were selected for the data volume (5th column in Table 6). Additional types of surveys and data rates are possible but based on the volume of the standard configuration (4LP @15 mins), it is unlikely to dramatically skew the expected aggregate data volume for the entire AMI 2.0 meter population. Based on the red highlighted column in Table 5, that sample rate results in the following projection of traffic per site for all collectors. An all P2P network would have LTE interfaces on all AMI devices; however, this does not guarantee that all AMI LTE meters would be in good coverage. Thus, all meters would also require mesh interfaces as well as LTE. The latency performance of the AMI polling would be dependent on the penetration of the LTE signals.

Table 6 – Data Volume Projection

Hex Cell ID	AMI per cell	Count of AP: 1000 to 1	Count of AP: 1500 to 1	4LP @ 15 min Data Volume per Month (MB)	AP (SIM) Volume (MB/month)	AP (SIM) Volume (MB/day)	DA per cell	DA Data Volume (MB/day)	DA Data Volume (MB/month)
1	32389	32	22	0.5	16194.5	540	45	22.5	675
2	1264	1	1	0.5	632	21	3	1.5	45
3	122014	122	81	0.5	61007	2034	15	7.5	225
4	703	1	0	0.5	351.5	12	3	1.5	45
5	17354	17	12	0.5	8677	289	31	15.5	465
6	68878	69	46	0.5	34439	1148	12	6	180
7	11467	11	8	0.5	5733.5	191	22	11	330
8	32122	32	21	0.5	16061	535	29	14.5	435
9	25592	26	17	0.5	12796	427	31	15.5	465
10	16377	16	11	0.5	8188.5	273	39	19.5	585
11	35340	35	24	0.5	17670	589	31	15.5	465
12	630	1	0	0.5	315	11	10	5	150
13	3406	3	2	0.5	1703	57	11	5.5	165
14	973	1	1	0.5	486.5	16	2	1	30
Totals	**368509**	**367**	**246**		**184254.5**	**6142**	**284**	**142**	**4260**

The aggregate expected monthly data traffic between the AMI and the DA is roughly 6.3GB per day and projected to just short of 190GB per month. That capacity will be divided across ~600 LTE devices. Approximately 246 modems and SIMs will be in service providing backhaul for smaller mesh networks of 1500 meters to 1 collector. This can be divided down for the to 1000 to 1 ratio which results in ~370 modems and SIMs. The higher the number of AP's, the lower the meter latency should become. The complexity becomes the number of SIMs and IP's that need to be managed and assigned respectively. Again, accurate recordkeeping and strong SIM process controls will prevent problems. Does HOL have a good handle in its current SIM inventory? Can HOL provide a current inventory of all active SIMs, their individual data usage, and assurances that there is no fraud? If the answer is no, that process should start soon. This is a sample of the traditional point to multipoint scenario with LTE backhaul. This could be over private or public LTE. If it is private, HOL will possibly have to extend fibre to reach the HOL WAN. If it is public, it will aggregate on the LTE carriers network and be returned to HOL over an APN.

The next scenario is a point-to-point AMI network. The point-to-point network has ~367k SIMs and IP addresses. This is where a good process related to SIM management and awareness become essential, as numerous authentications and sessions will have to be hosted on an appliance (server) based LTE core HSS and MME. LTE generally scales easily to this size, but the correct sizing considerations must be evaluated by the core OEM vendor. The other consideration is that mesh solves problems with RF coverage by routing traffic to the node that is closest or has the best RF channel to the AP. A network that is point to point everywhere will likely require some mesh component since LTE may not reach all meter locations. The mesh will allow for the poll to reach the mesh connected meter to communicate. The AMI 2.0 meter should have intelligence that allows for mesh where LTE is unavailable. Well considered planning will locate the APs in good coverage with multiple potential servers and multiple frequencies in service. In a public scenario, this AP planning process could be surveyed for coverage and planned now since the commercial cellular networks are on the air and operational. For a private scenario, HOL would first need to secure the spectrum and clear it, secure the tower locations and centre lines, secure backhaul if it is not on the HOL fibre, select and order all the equipment, and train the staff. Then, HOL would initiate site construction, backhaul, and cores, followed by RF testing and optimization. Once this is completed, all of the remote resources and anything else in the field can be added to the network.

5.1.3.1 Future Battery

Stakeholder meetings indicated that battery usage could exceed 10Gbps/month with polling occurring every minute. The capacity demands are calculated as follows.

1 sample/min * 60 mins/hour. * 24hrs/day * 30 days/month= **43200** samples over a month
10Gb month/43200 = ~**250kb** per read.

250kb is a relatively conservative throughput number for a LTE base station, depending on the spectral bandwidth available. The battery management interface (BMI) devices may need to be placed in a defined SIM data plan since they far exceed the volume of data expected from the DA and AMI devices. It is likely that the BMI located SIM(s) will require an unlimited data plan. In addition, it is strongly recommended to ensure that there is LTE site diversity and frequency diversity, and potentially LTE carrier diversity at these locations so that in the event of a sector radio fail, an antenna sector fail, or a complete site failure, there is still RF diversity to respond back to the monitoring status query. Facilitating the recommended site diversity requirements requires an LTE site survey prior to planning the locations of these battery storage assets. The site survey will find all the available LTE carriers, the bands, signal strengths, and related parameters to provide a higher degree of confidence in the reliability of RF backhaul. Battery and diesel generator backup at those locations would also be advisable.

5.1.3.2 Distributed Energy Resources (DER)

Distributed Energy Resources (DER) can be large isolated solar farms, commercial building rooftops, or even residential homes. The stakeholder meeting alluded to the need for monitoring and control of these applications. Exact sampling and throughput values have yet to be determined, but current estimate is ~50 Mb/month of data volume per station.

6 samples/hour * 24hrs/day * 30 days/month= **4320** samples over a month
10kB/poll * 4320 = 43.2 MB/month

5.2 RF Spectrum Options

Black & Veatch has researched the various frequency spectrum options that are available for HOL. Each band has specific licensing requirements, and each has advantages, disadvantages, and restrictions. For each band, the band plan, licensing rules, other requirements, restrictions, and potential risks are provided.

Below is a list of the spectrum options under consideration with bandwidth and maximum theoretical throughput (downlink/uplink).

- 700 MHz, Band 14, public safety broadband network
  - 10 MHz x 10MHz FDD – 75Mbps/25Mbps
- 900 MHz ISM
  - 10 MHz x 10 MHz
- Band 8 FDD option (Anterix)
  - 3 MHz x 3MHz FDD – 22.5Mbps/7.5Mbps
- 1800 MHz
  - 10 Blocks of 5MHz x 5MHz FDD – 37.5Mbps/12.5Mbps
  - 1 Block of 15MHz x 15MHz – 112.5Mbps/37.5Mbps
- Globalstar 2400 MHz – Low power
  - 10MHz TDD* – 18.4Mbps/15.5Mbps
- 3900 MHz
  - 10MHz TDD* – 18.4Mbps/15.5Mbps
- Subordinated Licensing

* TDD throughput assumes frame configuration 0 (2x2 MIMO radio, 64QAM/16QAM for DL/UL modulation)

Spectrum licensing services can be found at the following link: Spectrum Licensing Services (canada.ca). Here, it is possible to browse existing and available licences and to apply for licences.

5.2.1 700MHz - Band 14:

This band has excellent propagation characteristics and is expected to have excess capacity, so it would appear to be a viable option. However, public safety entities have priority over this band, so this excess capacity might not be guaranteed over the long term. As a utility with ownership of critical infrastructure, HOL could potentially qualify for priority access to Band 14 for certain purposes. Regulations for this band have not been finalized, and the current and near future availability of licences is uncertain. For further information, contact ISED Eastern and Northern Ontario District Office, 1-855-465-6307 or spectrumenod-spectredeno@ised-isde.gc.ca.

Band Plan:

- ISED has allocated 20MHz (10 MHz UL & 10 MHz DL) of 700MHz spectrum for spectrum licences to one or more public safety network entities. The 700MHz band gives excellent propagation characteristics. See Figure 13.
- The primary spectrum of the Public Safety Broadband Network (PSBN) is Band 14, but it could include other bands where capacity is available and it is economically feasible.
- It is expected that PSBN allocated spectrum will have significant surplus capacity. Otherwise, PSBN users must have priority and the ability to pre-empt commercial users as and when needed.

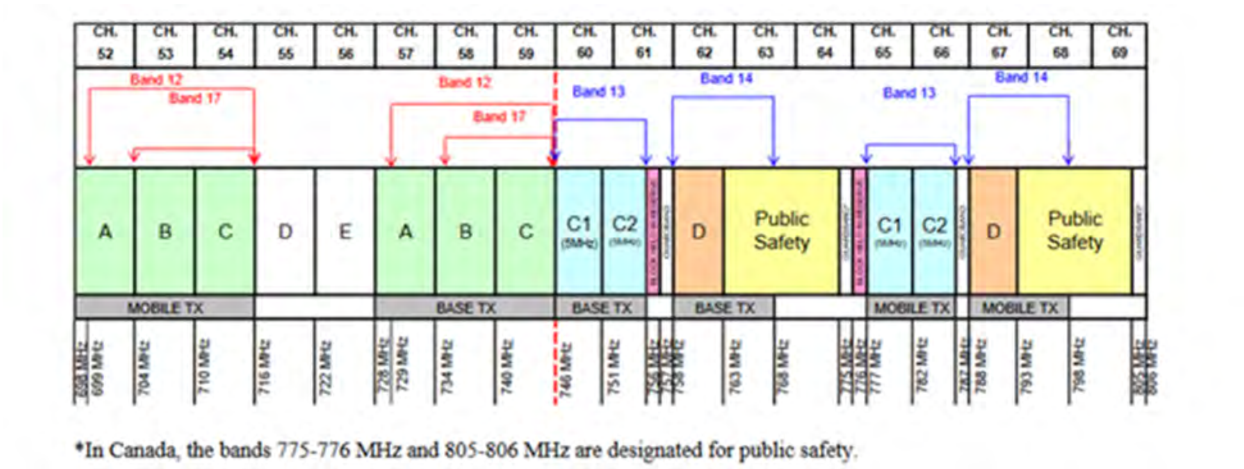

Figure 13 – 3GPP Technical Specifications for equipment operating in 700MHz band with Block C subdivided into two separate blocks

Licensing:

- ISED will establish the Band 14 conditions of licence and award spectrum.
- Spectrum will not be auctioned.
- The current licensing framework on its own is not sufficient and should be supported by additional governance.
- The Temporary National Coordination Office (TNCO) recommends that the PSBN be implemented using a shared network approach.

Spectrum Utilization Model:

The TNCO considered three broad models of spectrum utilization for the implementation of a PSBN in Canada:

1. **Public Safety Exclusive Dedicated Network:** A dedicated public safety network used exclusively by public safety users (using 700 MHz Public Safety Broadband).
2. **Shared Public Safety-Commercial Network:** A network that supports both public safety and commercial usage (with distinct public safety and commercial cores), with priority access and pre-emption rights for public safety use during emergencies and other times of need.
3. **Commercial Network:** The public safety community obtains services from one or multiple commercial carriers using that carrier's existing network spectrum and/or acquired Band 14 spectrum.

A dedicated network is not preferred due to the low likelihood of satisfying the principles of coverage, sustainability, affordability, and efficient use of spectrum.

Strategic Partnerships

Under mutually beneficial agreements, infrastructure owners could choose to share some of their infrastructure for installation of new equipment for the PSBN or could become a regional PSBN operator, depending on the circumstance. This should start with clarification on regulatory completion and adoption of ISED directives regarding 700MHz spectrum. Developing relationships with the Ottawa public safety entities, specifically those which maintain and operate the existing radio networks, will promote insight regarding the Ottawa Public Safety 700 MHz LTE adoption and implementation roadmap. The local LTE carriers will also have some insight as to the disposition of the spectrum. Black & Veatch recommends hosting a call with one or more of the local LTE carriers along with HOL.

5.2.2 900 MHz – Unlicensed Industrial, Scientific, and Medical (ISM) Bands

The Industrial, Scientific, and Medical (ISM) frequency bands are designated radio frequency bands as defined by the ITU Radio Regulations. These frequency bands were set aside for RF use for purposes other than telecommunications. Hence, using the ISM bands for telecommunications is possible, but telecommunications devices using these frequencies must be able to withstand interference from other RF and microwave technologies, such as microwave ovens, RF heating, and other potentially electromagnetic interference (EMI) producing devices. This band has the advantage of not requiring licensing, but its potential for interference makes it a risky solution.

Various wireless services operate in the 900 MHz band. These services include utilities, railroads, and other private land mobile radio services. The 900 MHz frequency band can be used for land mobile, paging, multipoint communications systems, narrowband-PCS, and fixed services. Equipment availability could be a risk here. Equipment options will require further research. This band is not suitable for large scale LTE deployments, but there could be specific applications in which it might be considered.

Band Plan:

- 902-928 MHz is designated for industrial, scientific, and medical (ISM) applications.
- Stations operating on this band must accept harmful interference.
- Being first to deploy a system in this band does not grant any rights to continued operation without interference.

Licensing:

- 902-928Mhz is a licence-exempt band.
- Radio equipment operating in this band must be ISM certified.

5.2.3 900 MHz / BAND 8 FDD – Anterix Band

This is a licensed band that is likely to have some capacity available, but it is limited to rural and remote areas, and railways are making heavy use of it, but if capacity is available inside of HOL's service area, it may be an option.

Band Plan:

- This band was for 3/3 MHz for broadband services in the range 897.5-900.5 and 936.5-939.5 MHz portion (US Band 8). The 3/3 was also supported by multiple respondents during the commenting period.
- ISED will make access radio licences available in the rural and remote Tier 5 service areas.
- ISED will allow fixed and mobile use under access radio licence.
- First come first service with a licence fee.
- The railway industry has a significant deployment of radios which would need to be protected regardless of which band plan is utilized.

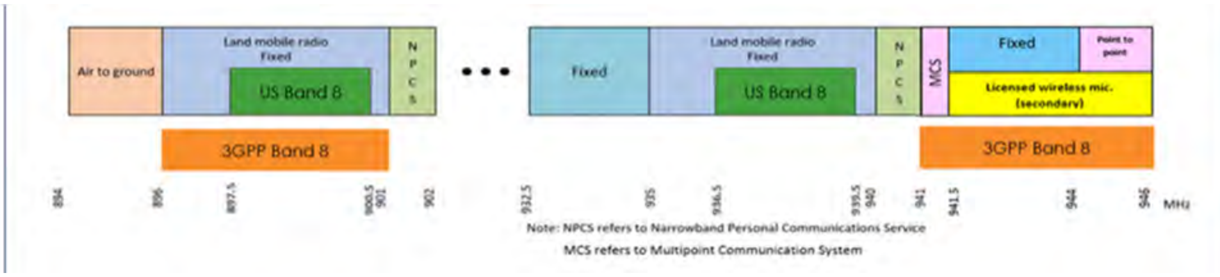

Figure 14 – Proposed Band Plans for 900MHz Radio Access Licensing

Licensing:

- ISED typically releases spectrum using a first come first serve (FCFS) licensing approach where the demand for spectrum is not expected to exceed the supply and a competitive process is not required.
- ISED will determine the rural and remote areas where there is unused spectrum on a band-by-band basis.
- Access licences will be made available where ISED has determined there is unused spectrum, defined by the Tier 5 service area categories.
- Access spectrum licences will have a term of 3 years and cannot be transferred or subordinated.

Additional details are available at

https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/spectrum-allocation/decision-new-access-licensing-framework-changes-subordinate-licensing-and-white-space-support-rural

5.2.4 1800 MHz

This is a licensed band that currently has older, non-standard systems, but new, standardized requirements have come online. This band could be an option if spectrum is available in the HOL service area. This band will require a higher density of sites than the 700 MHz or 900 MHz bands.

Licensing process:

- Existing radio systems in 1700-1710 MHz and 1780-1850 MHz bands remain standard.
- Requests to extend or expand existing systems reviewed case-by-case by ISED.
- New systems in these bands must comply with SRSP requirements.

Systems Originally Licensed on a Non-Standard Basis:

- Non-standard licensed systems may require modification, replacement, or removal to comply with SRSP or SP/RP at a later date.
- A two-year notice will be given unless Regional Executive Director determines shorter notice period is warranted.
- The five-year protection and two-year warning rule don't apply to systems initially licensed as non-standard.

Systems Authorized on a Secondary Basis:

- Secondary system licensees must relinquish their assignment if the frequency is needed for primary service growth.
- Non-standard and 5- and 2-year rule provisions don't apply.
- Regional Executive Director may grant up to 2 years notice before relinquishing the frequency for primary service use, depending on local circumstances.

Band Plan:

- The bands 1850-1915 and 1930-1995 MHz are divided into two sub-bands: the lower sub-band (1850-1915 MHz) and the upper sub-band (1930-1995 MHz). These sub-bands are further divided into 11 paired blocks with a frequency separation of 80 MHz: 10 blocks of 10 MHz (5 + 5) and one block of 30 MHz (15 + 15) as seen in Figure 15.

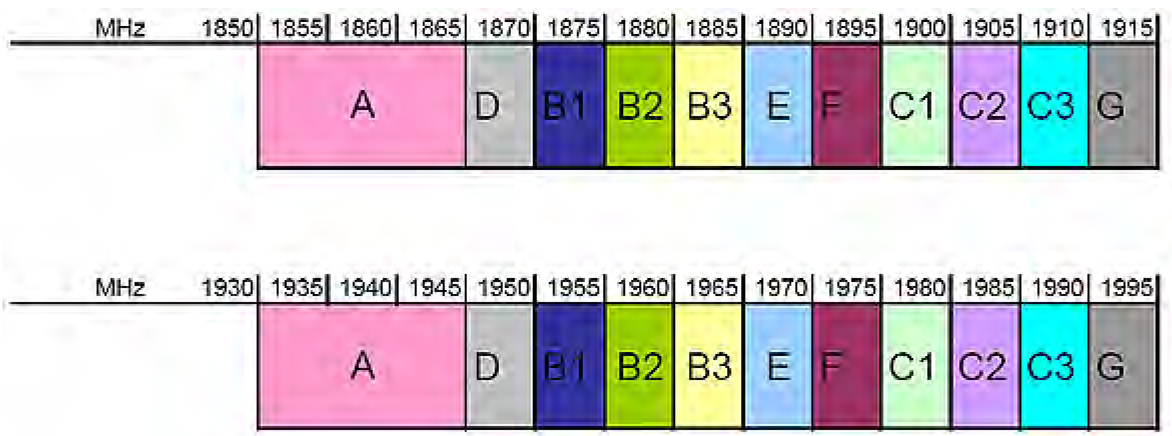

Figure 15 – 1800MHz Band Plan

5.2.5 2400 MHz

Globalstar Canada has applied to operate in this band, and they have the option to subordinate their licence. The details of this arrangement and requirements for this band follow.

Band Plan:

- Globalstar Canada's ATC application outlines plan for deploying low-power time division duplex (TDD) LTE systems in "downlink duplex mode" (also known as "non-forward-band mode") in a small cell configuration within its MSS downlink spectrum (2483.5-2500 MHz).
- ISED proposes to permit this mode of operation and adopt similar technical rules as in the U.S., including power limitations, the use of a Network Operating System (NOS) for base station control, and unwanted emission limits to address harmful interference concerns.
- Although Globalstar Canada's ATC application covers the 2483.5-2500 MHz band, ISED notes that in the U.S., Globalstar was authorized to operate its low-power ATC system only in the 2483.5-2495 MHz band.
- ISED will authorize Globalstar Canada to operate only low-power ATC in the 2.4 GHz band through a spectrum licence, subject to specific technical, policy, and licence conditions.
- Globalstar Canada may choose to subordinate the spectrum to a major mobile carrier.

- A 10MHz TDD channel could operate at low power in the downlink section of this band. It would provide both uplink and downlink to the deployed network. See Section 5.2.

Technical and operational requirements:

- Equipment shall operate in the 2483.5-2495 MHz frequency band.
- The transmitted signal shall be digitally modulated.
- The 6 dB bandwidth shall be at least 500 kHz.
- Transmitter output power shall not exceed 0 dBW.
- The maximum equivalent isotropically radiated power (e.i.r.p.) shall not exceed 6 dBW.
- The equipment's maximum power spectral density conducted to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.
- Compliance with this limit may be based on the use of a measurement resolution bandwidth of at least 1% of the occupied bandwidth. If 1% of the occupied bandwidth is less than 1 MHz, the power measured shall be integrated over the required measurement bandwidth of 1 MHz.
- The 2.4 GHz low-power ATC system meeting the technical requirements in this section may operate in non-forward-band mode.
- The 2.4 GHz low-power ATC system meeting the technical requirements in this section is not required to use dual-mode user equipment.
- The ATC licensee shall utilize a Network Operating System (NOS), consisting of a network management system located at an operations centre or centres. The NOS shall have the technical capability to address and resolve interference issues related to the licensee's network operations by:
  - reducing operational power
  - adjusting operational frequencies
  - shutting off operations
  - any other appropriate means
- The NOS shall also have the ability to resolve interference from the terrestrial low-power network to the licensee's MSS operations and to authorize access points to the network, which in turn may authorize access to the network by end-user devices. The NOS operations centre shall have a point of contact in Canada available 24 hours a day, seven days a week, with a phone number and address made publicly available by the licensee.
- All access points operating in the 2483.5-2495 MHz band shall only operate when authorized by the ATC licensee's NOS, and all client devices operating in the 2483.5-2495 MHz band shall only operate when under the control of such access points.

Spectrum Licences and Fees:

- Spectrum licences will be issued for Ancillary Terrestrial Components (ATC) systems and will be subject to spectrum licence fees.
- The specific fees will be established through a separate public process.
- Innovation, Science and Economic Development Canada (ISED) indicated that the fee for each assigned transmit or receive frequency "channel" would be $41 per "channel."
- For a transmitter and receiver using the same frequency channel, the current annual fee would be $82.
- Licensees are required to pay the applicable annual licence fee on or before March 31 of each year for the subsequent year (April 1 to March 31).
- Innovation, Science and Economic Development Canada (ISED) will mandate Ancillary Terrestrial Components (ATC) Licensees to apply for and maintain a radio licence under the Radiocommunication Regulations for each operating site.

- Once a spectrum licence fee is established, ISED plans to amend the provision requiring radio licences and authorize equipment operation through the spectrum licence.
- Annual spectrum licence fees will be required to be paid at that time.
- The spectrum licence is non-transferable and indivisible, except in cases of internal reorganization of the Licensee or its affiliate.
- In such cases, the Licensee may apply to the Minister of Innovation, Science and Industry for authorization for a transfer, following the procedures outlined in the Client Procedures Circular.

5.2.6 3900-3980 MHz

This band is licensed under a first come, first served approach, and an auction for licences is scheduled for April 2024. Subordination is not permitted. It offers eight 10 MHz blocks, and it is intended for multiple licensees to coexist, so there is potential for interference. At higher frequencies, such as this band, a higher density of sites is required, resulting in higher cost.

Band Plan:

- The 3900-3980 MHz band offers frequency blocks for licensing, primarily for time division duplexing (TDD) systems.
- The band is divided into eight unpaired blocks (Figure 16 below), each spanning 10 MHz.
- Adjacent 20 MHz guard band in 3980-4000 MHz
- Frequency blocks can be aggregated.

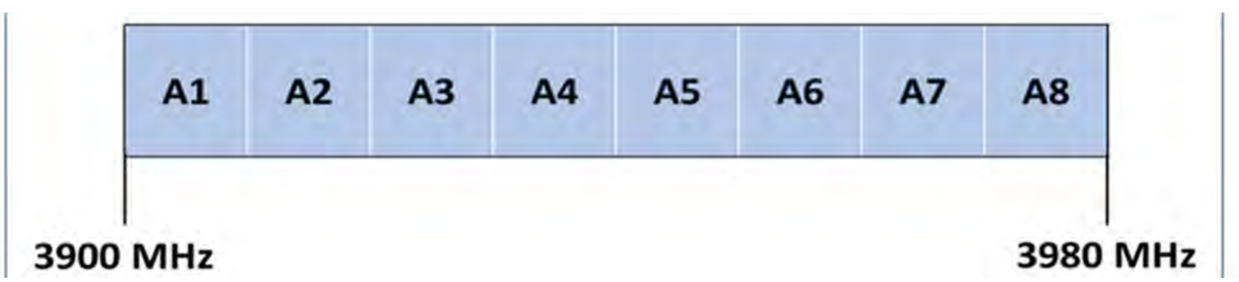

Figure 16 – 3900MHz NCL Licensing Band Plan

Licensing:

- Innovation, Science and Economic Development Canada (ISED) will oversee access to the 3900 MHz band via an automated Non-Competitive Local (NCL) licensing system, subject to potential modifications.
- The automated system aims to enable coexistence among licensees sharing the same frequency block.
- Subordinations will not be permitted in this licensing framework.

Coexistence with other radio services:

- The automated Non-Competitive Local (NCL) licensing system will aid in coexistence between NCL licensed systems and other systems.
- Innovation, Science and Economic Development Canada (ISED) will utilize planning parameters and technical assumptions outlined in Annex A of the automated NCL licensing system to

establish appropriate separation distances from NCL licensed representative base stations to other systems.

- In cases of harmful interference conflicts, licensees are responsible for resolving conflicts through mutual arrangements after consultation and coordination.
- If conflicts persist and cannot be resolved promptly, affected parties shall notify ISED. ISED will then determine the necessary course of action following consultations with involved parties.

Certification requirements:

- Equipment operating in the 3900-3980 MHz band under NCL licences must be certified according to the latest version of Radio Standards Specification RSS-198.
- This equipment falls under Category I and requires certification.
- Certification can be obtained through a technical acceptance certificate (TAC) from ISED's Certification and Engineering Bureau (CEB) or a certificate from a recognized certification body (CB), such as the American Certification Body, Inc. (CAB Identifier: US0101).
- Equipment under this standard fall under Category I and must be certified.
- Certification can be obtained through a technical acceptance certificate (TAC) from ISED's Certification and Engineering Bureau (CEB) or a certificate from a recognized certification body (CB).
- The Standard Radio System Plan (SRSP) aligns with current and future technologies for non-competitive local (NCL) licensed systems in Canada.
- NCL licensees must ensure their fixed and base stations are professionally installed to meet SRSP compliance standards.

Fee Order for Non-Competitive Local Licences: (3.9 GHz)

- First come first served (FCFS) licensing approach.
- Fees for these licences are based on the amount of spectrum authorized in MHz, and the geographic size of the licence area in km^2, multiplied by a base fee rate.
- The fees take effect as of April 1, 2024 and are applicable to all non-competitive local spectrum licences in accordance with the conditions of each licence. Licences are valid for 1 year.
- Deploy within 2 years of acquiring the licence.
- No subordinations

Spectrum Licence fee for Non-Competitive Local Licences at Frequencies below 10 GHz

For non-competitive local spectrum licences at frequencies below 10 GHz, the annual fee payable is the total assigned spectrum, multiplied by the licence area, multiplied by the base rate specified below ($/MHz/$km^2$), for the assigned frequency band(s).

- $1.80 per MHz per km^2 for non-competitive local spectrum licences in metropolitan and urban areas
- $0.45 per MHz per km^2 for non-competitive local spectrum licences in rural areas
- $0.01 per MHz per km^2 for non-competitive local licences in remote areas

5.2.7 Subordinated Licensing

A subordinate licence allows for more efficient use of spectrum by permitting licensees to enter into agreements that allow another party to operate within the licence area, using the licensed spectrum or a portion of their frequency or geographic area without having to completely transfer their spectrum licence(s).

- A subordinate licence enables licensees to efficiently utilize spectrum by allowing other parties to operate within the licensed area.
- It permits licensees to enter agreements for another party to use the spectrum without transferring the entire licence.
- Primary licensees can jointly apply with another party to request a subordinate licence.
- ISED reviews the application, and if satisfied, approves the request, and issues a subordinate licence to the third party.
- The subordinate licence includes a subset of the primary licence conditions and additional terms.
- Both primary and subordinate licences exist simultaneously.
- Commercial mobile spectrum subordinate licence requests are subject to specific requirements outlined below.
- Requests for subordinate licences in these bands must address criteria as outlined below.
- ISED maintains a publicly accessible database listing all licences.

In general, the issuance of a subordinate licence will be subject to, but not limited to, the following conditions and guidelines.

- The subordinate licence term can be for a term of less than or equal to the duration of the primary licence. The term for which a subordinate licence is being sought must be clearly specified in the application.
- Subordinate licences are not divisible or transferable.
- Where implementation of spectrum usage requirements exists, the responsibility for being in compliance rests with the primary licensee. Implementation by the subordinate licensee will count toward meeting the primary licensee's responsibilities and should be reported accordingly to ISED.
- Where a displacement and transition policy exists, either the primary licensee or the subordinate licensee may invoke the transition policy provisions; however, a subordinate licensee must notify the primary licensee of any displacement request submitted to ISED.
- ISED's approval is required for all proposed subordinate licences.
- ISED will contact the primary licensee directly for non-compliance issues of the primary licence conditions and the subordinate licensee directly for non-compliance issues of the subordinate licence conditions. ISED also has the authority to contact either the primary or the subordinate licensee regarding compliance issues and, if necessary, to revoke or suspend the primary licence and/or the subordinate licence, in accordance with the Radiocommunication Act.
- Access licensing should be a secondary option to subordination and only be granted if an applicant attempted to receive a subordination and was denied.
- Subordination will normally be completed within 12 weeks from the time of receipt of all required information.
- Primary licensees may apply to ISED jointly with another party in order to request a subordinate licence. The request would then be reviewed and, subject to ISED's satisfaction with the application, the request would be approved and the third party would be issued a subordinate licence.

- The subordinate licence would include a subset of the primary licence conditions, as well as additional terms and conditions that may vary from those of the primary licence.
- The primary licence and subordinate licence would both exist at the same time.

5.3 Cost Estimate

Black & Veatch used a standard 3-sectored site Bill of Material (BOM) (Table 7) to estimate the total cost to build the network for the above number of forecasted sites. This BOM includes estimates of both labour and materials. Backhaul is not included in this estimate since it is unique and may vary depending on the location. SIMs would be an additional cost and can be acquired from a variety of vendors. An MNC can be obtained by registering for it.

Table 7 – Private Network ROM cost estimate

pLTE Bill of Material			
Line Item	**Qty**	**Unit Cost**	**Total Cost**
Site Specific Costs	**$**		**438,175.00**
Valmont 100' Monopole	1.00	$ 80,000.00	$ 80,000.00
Tower Install (foundation, etc)	1.00	$ 55,000.00	$ 55,000.00
Sector frame for monopole tower	1.00	$ 4,750.00	$ 4,750.00
Pipe Mounts (one per antenna)	3.00	$ 225.00	$ 675.00
Generic Sector Antenna (single band 900)	3.00	$ 750.00	$ 2,250.00
Generic Sector Antenna (dual band 900/PCS or CBRS)	3.00	$ 1,000.00	$ 3,000.00
Raycap box	1.00	$ 2,500.00	$ 2,500.00
Misc hardware (Jumpers, grounding, coax, etc.)	1.00	$ 5,000.00	$ 5,000.00
Shelter/Cabinet Cost	1.00	$ 40,000.00	$ 40,000.00
Site Survey, Construction Drawings, etc	1.00	$ 45,000.00	$ 45,000.00
Site selection, zoning, permitting, etc	1.00	$ 15,000.00	$ 15,000.00
Site preparation (Power, fiber, grading, etc)	1.00	$ 60,000.00	$ 60,000.00
Install Lines, Antennas, etc	1.00	$ 20,000.00	$ 20,000.00
Install Shelter/Cabinet	1.00	$ 30,000.00	$ 30,000.00
Engineering, PMO, CM	1.00	$ 75,000.00	$ 75,000.00
Base Station Equipment	**$**		**466,346.33**
Nokia RRH, BBU and Hybrid Cable	3.00	$ 129,624.67	$ 388,874.00
Base Station integration and setup	1.00	$ 15,500.00	$ 15,500.00
Licensing (Base Station) per year	1.00	$ 61,972.33	$ 61,972.33
TOTAL PER SITE			**$ 904,521.33**
Core Equipment	**$**		**1,353,217.67**
CMU Core Hardware	2.00	$ 432,039.00	$ 864,078.00
CMU Software Load and RTU (Hypervisor, licensing, etc) per year	2.00	$ 57,443.67	$ 114,887.33
Network Management	1.00	$ 319,398.00	$ 319,398.00
Network Management License per year	1.00	$ 26,354.33	$ 26,354.33
Questionairre and Integration (IP planning, QOS, SIM imports, Acceptance testing)	1.00	$ 28,500.00	$ 28,500.00
Spectrum Costs per year	**$**		**5,000,000.00**
Estimated	1.00	$ 5,000,000.00	$ 5,000,000.00
TOTAL Network Cost 900MHz (14 sites + Redundant Core)	**$**		**19,016,516.33**
900MHz Yearly recurring costs	$		6,008,854.33
TOTAL Network Cost 1.8GHz (35 sites + Redundant Core)	**$**		**38,011,464.33**
1.8GHz Yearly recurring costs	$		7,310,273.33
TOTAL Network Cost 3.9GHz (88 sites + Redundant Core)	**$**		**85,951,095.00**
3.9GHz Yearly recurring costs	$		10,594,807.00

5.4 Conclusion

A private network offers exceptional flexibility and security. Having control over the entire network is certainly advantageous, but it comes with a high degree of complexity and responsibility. All aspects of design and construction must be overseen and executed by HOL and its subcontractors, and the choice of spectrum may require detailed trade studies accounting for cost, licensing, competition with other entities for capacity, interference, and other risks. However, the complexity and risks associated with this approach can be managed, and a robust and secure private network is a potentially feasible option.

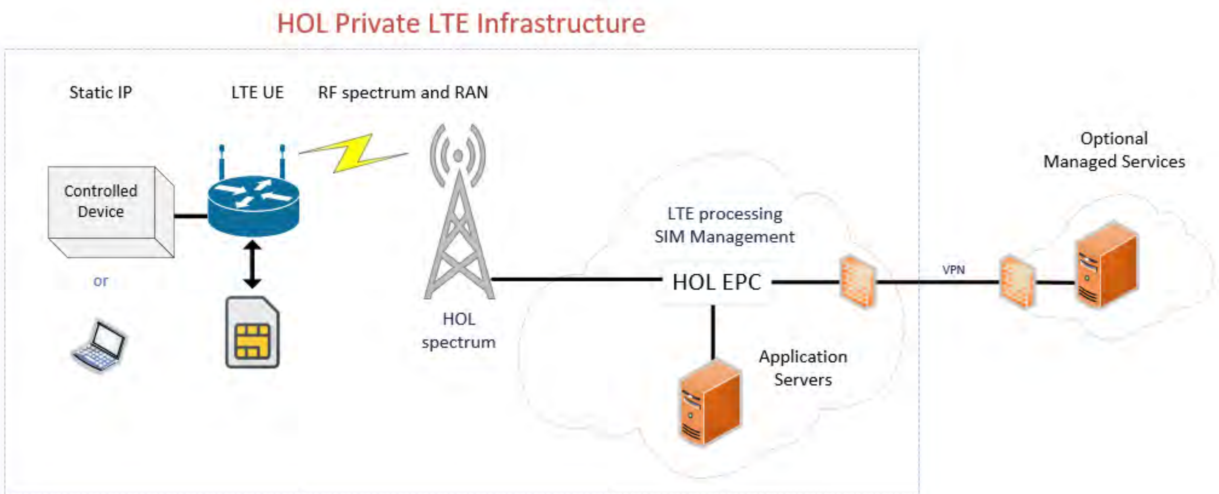

Figure 17 – Private LTE Architecture

Managed Services

HOL could construct an entirely private network with private spectrum, individual base stations exclusive to HOL, and a private core. While this is buildable, it needs to be manageable. Currently, HOL does not have the staffing, tools, or training to support such a network. It could be engineered, configured, lab tested, and constructed by one of the Local LTE service providers or equipment providers. In addition to the implementation there is the day-to-day operation, monitoring, and performance management. These so-called managed services include real-time monitoring within the terms of a service level agreement (SLA), software patching, coordinated change controls, trouble ticket resolution, SIM management, and other functions. These managed services can help HOL bridge the knowledge gap until appropriate staffing can be acquired or trained to support the system internally. There may need to be a combination of internal and external services for the lifespan of the equipment. Existing HOL field technicians could potentially be trained to serve as cell technicians, IT staff could be trained to support the EPC cores and collect and review KPI's.

6.0 Public LTE Network utilizing an APN

Utilizing a public network would allow HOL to avoid many of the complexities of a fully private network. The RF spectrum and the radio access network (RAN) are owned, operated, and maintained by a public carrier, and HOL leases capacity on this network. This solution eliminates the cost and complexity associated with the design, construction, operation, and maintenance of the private network, but it adds the recurring cost of leasing capacity. Furthermore, this solution creates a dependency on the public carrier's network, so risks of unexpected cost increases, future capacity reductions, and security concerns must be considered. This section covers the basic architecture, management considerations, and costs associated with this solution.

6.1 Architecture

In the Public option, edge devices/user equipment (UE) and SIMS are owned by HOL. SIM management can be performed via web Portal by Jasper or equivalent. Jasper provides the customer an interface to evaluate the radio links and to selectively enable or disable SIMs. The wireless radio spectrum, radio access network (RAN), backhaul, and core (EPC) are owned and maintained by the public wireless LTE carrier. This may be Rogers, Bell, Tellus or any other LTE carrier. Public is the simplest scenario for the customer to adopt since it does not require specific knowledge of LTE nor specialized staffing. Effectively utilizing the public LTE infrastructure can improve operational improvements for HOL in a short period of time at relatively low cost. It may provide an important transition period to develop operational and monitoring expertise prior to operating a Hybrid (PVNO) or Private network.

The Public APN arrangement depicted in Figure 18 allows HOL to simply attach to the wireless network assets of the public carrier and quickly leverage their resources without having all the overhead of operating the network. Some of these requirements include purchasing spectrum, securing tower space and leases, purchasing, and maintaining equipment, upgrading software, troubleshooting, understanding LTE protocols, troubleshooting PIM or interference, and managing on premises LTE Core infrastructure assets. Except for SIM distribution, DA field modem and AMI Aps/collectors, most all responsibilities belong to the carrier. As depicted below, HOL can connect to the Bell and/or Rogers Network wherever they have coverage including in Casselman. The carriers provide Jasper/Control centre or an equivalent to test the RF link for each modem. There are also APIs to collect and database performance information to track/trend the integrity/reliability of the wireless network. Jasper also allows grouping of SIMs, looking at aggregate usage and selectively enabling or disabling SIMs to manage expenses and prevent fraud.

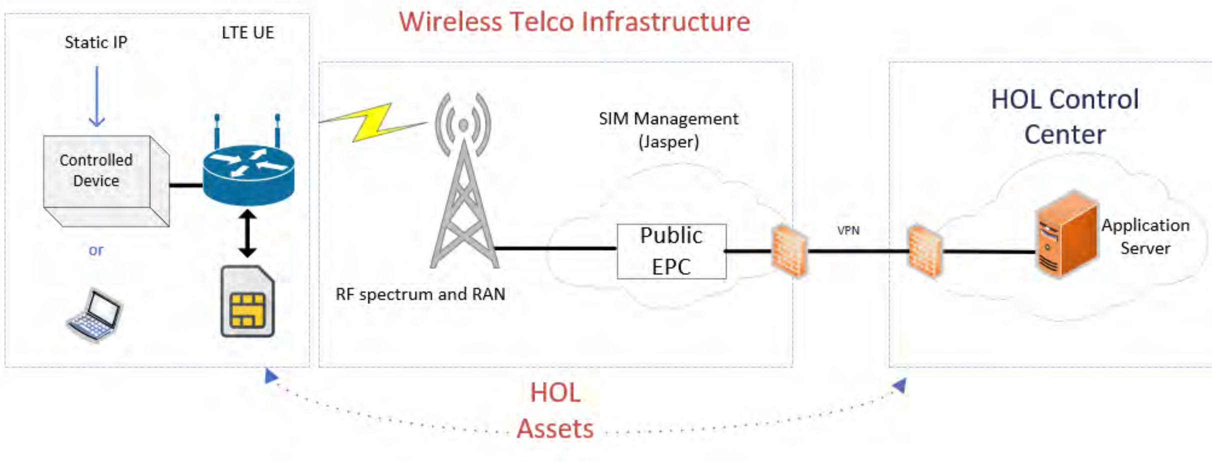

Figure 18 – Public APN Architecture

The stakeholder meetings revealed that the AMI network utilizes a Bell APN. That APN could be reevaluated and grown to support the DA infrastructure. Swapping narrowband modems and antennas for LTE modems and antennas could be planned and accomplished quickly depending on the APN dimensions and IP's currently allocated. In most cases, site reliability via sector, polarity, and frequency diversity would be enhanced, with lower latency and higher throughput than the performance provided by the existing narrowband network does today. All the traffic would be delivered over the APN and easily routed to HOL control and monitoring systems. During the stakeholder meetings, it was not known if any QOS has been applied to the Bell APN SIMs, but in the event of busy cells, QOS can prioritize traffic and avoid signaling delay.

6.2 Management Considerations

SIM and IP management responsibilities would still belong to HOL. Well organized and disciplined IP control, SIM distribution, and related documentation are essential to success and will remain so in any scenario. There are various methods for keeping modem configurations consistent and software/firmware up to date and patched. As the numbers of devices and SIMs increase over time, robust automated methods save time and allow staff to focus on HOL power delivery as opposed to struggling with wireless reliability and management.

6.3 Rogers Budgetary APN build

In Table 8, the three gray rows show the cost of the appropriate SIM pool size per month based on usage, 10MB, 100MB and 1GB. Top and bottom lines of the monthly recurring costs (MRC) table are MRC fees, and the gray lines are data volume allowances per SIM. One SIM size would be selected per device; the preliminary forecast indicates that 1GB would be appropriate for all DA devices and AMI collectors. Black & Veatch is also working to establish bulk pricing with data pool sizes of 200, 300, and 400 GB tiers of aggregate data volume for all devices. This simplifies SIM distribution and decreases the need for per SIM data volume management. Table 9 represents the non-recurring (NRC) setup charge to build the APN and preconfigure the SIMS in the HSS. Ruggedized SIMs are optional.

Both the MRC and NRC are negotiable; terms improve as the volume increases.

Table 8 – (MRC) Monthy Recurring Costs

Product	Qty	Unit	List Price	Monthly Recurring Charges (MRC)	Term
IoT Data Connectivity Rate Card Platform Fee	1	Per **ACTIVE** SIM Monthly	$0.50	$0.50	60
CC - IoT Data Connectivity **Rate Card 10 MB Per SIM** - CDN LTE Data for IoT, Pooled, CC Advantage platform, Month to Month (**Overage $0.75 / MB**)	1	Each	$3.75	$4.15	60
CC - IoT Data Connectivity **Rate Card 100 MB Per SIM** - CDN LTE Data for IoT, Pooled, CC Advantage platform, Month to Month (**Overage $0.15 / MB**)	1	Each	$6.00	$5.40	60
CC - IoT Data Connectivity **Rate Card 1 GB Per SIM** - CDN LTE Data IoT, Pooled, CC Advantage platform, Month to Month (**Overage $7.50 / GB**)	1	Each	$12.00	$10.80	60
CC - IoT Data Connectivity Rate Card Custom **APN** Monthly Fee	1	Each	$500.00	$500.00	60
			IOT MRC	**Sums Depend SIM quantities: See Table 12 and Table 13.**	

Table 9 – (NRC) One Time Costs

Product	Qty	Unit	List Price	Non-Recurring Charges (NRC)	
CC - IoT Data Connectivity Rate Card CC IoT SIM Card (2FF, 3FF, 4FF) pack of 20 SIMs	100	Each	$40.00	$4,000.00	
CC - IoT Data Connectivity Rate Card CC Rugged IoT SIM Card (2FF) pack of 20 SIMs	1	Each	$80.00	$80.00	
CC - IoT Data - Connectivity Rate Card Custom APN Set up Fee	1	Each	$5,000.	$5,000.00	
			IOT NRC	**$9,080.00**	

Table 10 – Public LTE Cost Estimate - AMI

Hex Cell ID	AMI per cell	Count of AP: 1000 to 1	Count of AP: 1500 to 1	4LP @ 15 min Data Volume per Month (MB)	Total AP (SIM) Volume (MB/month)	Each SIM data Vol 1000:1	Each SIM data Vol 1500:1	AMI AP Cost per hexagon per month	AMI AP Cost per hexagon per year	AMI AP Cost per hexagon per 5 yr. term
1	32389	33	22	0.5	16195	491	737	495	5940	29700
2	1264	2	1	0.5	632	316	632	22.5	270	1350
3	122014	123	82	0.5	61007	496	744	1845	22140	110700
4	703	1	1	0.5	352	352	352	22.5	270	1350
5	17354	18	12	0.5	8677	483	724	270	3240	16200
6	68878	69	46	0.5	34439	500	749	1035	12420	62100
7	11467	12	8	0.5	5734	478	717	180	2160	10800
8	32122	33	22	0.5	16061	487	731	495	5940	29700
9	25592	26	18	0.5	12796	493	711	405	4860	24300
10	16377	17	11	0.5	8189	482	745	247.5	2970	14850
11	35340	36	24	0.5	17670	491	737	540	6480	32400
12	630	1	1	0.5	315	315	315	22.5	270	1350
13	3406	4	3	0.5	1703	426	568	67.5	810	4050
14	973	1	1	0.5	487	487	487	22.5	270	1350
Totals	**368509**	**367**	**246**		**184254.5**	**6297**	**8949**	**$ 5,535**	**$ 68,040**	**$ 340,200**

Table 11 – Public LTE Cost Estimate - DA

Hex Cell ID	DA per cell	DA Data Volume (MB/day)	DA Data Volume (MB/month)	DA Cost per hexagon per month	DA Cost per hexagon per year	DA Cost per hexagon per 5 yr. term
1	45	22.5	675	1012.5	12150	60750
2	3	1.5	45	67.5	810	4050
3	15	7.5	225	337.5	4050	20250
4	3	1.5	45	67.5	810	4050
5	31	15.5	465	697.5	8370	41850
6	12	6	180	270	3240	16200
7	22	11	330	495	5940	29700
8	29	14.5	435	652.5	7830	39150
9	31	15.5	465	697.5	8370	41850
10	39	19.5	585	877.5	10530	52650
11	31	15.5	465	697.5	8370	41850
12	10	5	150	225	2700	13500
13	11	5.5	165	247.5	2970	14850
14	2	1	30	45	540	2700
Totals	**284**	**142**	**4260**	**$6,390**	**$76,680**	**$383,400**

6.4 Private vs. Public Budgetary Comparison

When comparing the costs presented above for Private vs Public wireless network options, several factors come into play. To understand the overall financial implications of each, both capital and operational expenses should be considered.

Private networks require a higher upfront cost. Physical infrastructure such as towers, monopoles, shelters, and real estate may be required. Base stations, redundant cores, software licenses, configuration, and installation add additional costs to deploy and optimize a private network. Ongoing expenses include maintenance, training, upgrades and repair. Initial deployment cost is estimated to be $19,016,516 with additional yearly recurring licensing of approximately $6,008,854 for software and network management subscriptions. Total cost over 5 years for a private network is roughly $49,060,788.

Using a public network, capital expenses are greatly reduced; however, recurring fees are higher. As shown in Table 12, initial NRC (600 SIM's + APN setup) would total $6200. The MRC cost for the SIMs, data usage and APN is ~$6500. The five year usage projection is approximately $400k; this does not yet include the cost of LTE DA devices or AMI collectors.

Table 12 – Public LTE usage cost projections (Mesh scenario 1500:1 LTE)

AMI SIMs	DA SIMs	Total SIMs	Jasper MRC	MRC SIMs	MRC 1GB SIM	MRC data	MRC APN	MRC Monthly	Term Months	5 year Total
246	284	530	0.5	$265.00	$10.80	$5,724	$500	$6,489	60	$389,340

Table 13 – Public LTE usage cost projections (P2P scenario - based on Table 8)

AMI SIMs	DA SIMs	Total SIMs	Jasper MRC	MRC SIMs	MRC SIM	MRC data	MRC APN	MRC Monthly	Term Months	5 year Total
0	284	284	0.5	$142.00	$10.80	$3,067	$500	$3,709	60	$222,552
370000	0	370000	0.5	$185,000.00	$4.05	$1,498,500	$500	$1,684,000	60	$101,040,000

6.5 Conclusion

A public network is simpler to implement than a private network, but a public network must work within the carrier's system and is therefore less flexible. There are many aspects to security, including physical and network, that must be managed as work proceeds. Table 12 represents recurring costs of leased LTE capacity (Mesh AMI) over the lifetime of the system, which will be significant, but this will be offset by lower capital cost. Table 13 represents the potential burden of opting for LTE P2P everywhere.

7.0 Hybrid Network (PVNO)

Hybrid private/public solutions can be considered if fully private or public options do not satisfy all of HOL's requirements. Wireless private networks have multiple implementation options which are partially private and partially public depending on how the network is envisioned, engineered, and implemented. The Private and Public options are described in Sections 5.0 and 6.0, respectively. This section covers the basic architecture of the Private Virtual Network Operator (PVNO) solution and advantages and challenges associated with this option. Much of the PVNO architecture will depend on what the carrier will accept and how existing PVNO networks are designed. Since there are many variations in how a PVNO solution can be implemented, a detailed solution cannot be presented here and would be negotiated with the carrier.

7.1 Shared Architecture

In a Hybrid option there are multiple different scenarios. The Hybrid option usually moves the EPC within the customer's infrastructure. This scenario can improve call processing speed and improve control. There are variations on how it the EPC is configured; this can be entirely private, or it may peer with one or more LTE Carriers to facilitate seamless roaming. This configuration is complex, and an appliance (consolidated) grade EPC may be insufficient. The terms, requirements and costs of this scenario have yet to be determined since there are so many options in scenarios. In the PVNO scenario, which is a hybrid option, HOL would appear as its own entity since it will have a distinct mobile network code (MNC). To support this arrangement, carrier grade infrastructure may be required.

The hybrid scenario also allows for the customer to own its own spectrum and radio access network. If the spectrum acquired is 3GPP compatible, there are typically multiple vendors which will support those frequencies. If the radio spectrum is not 3GPP compatible or not widely used throughout the world, it can be difficult, if not impossible to secure appropriate equipment.

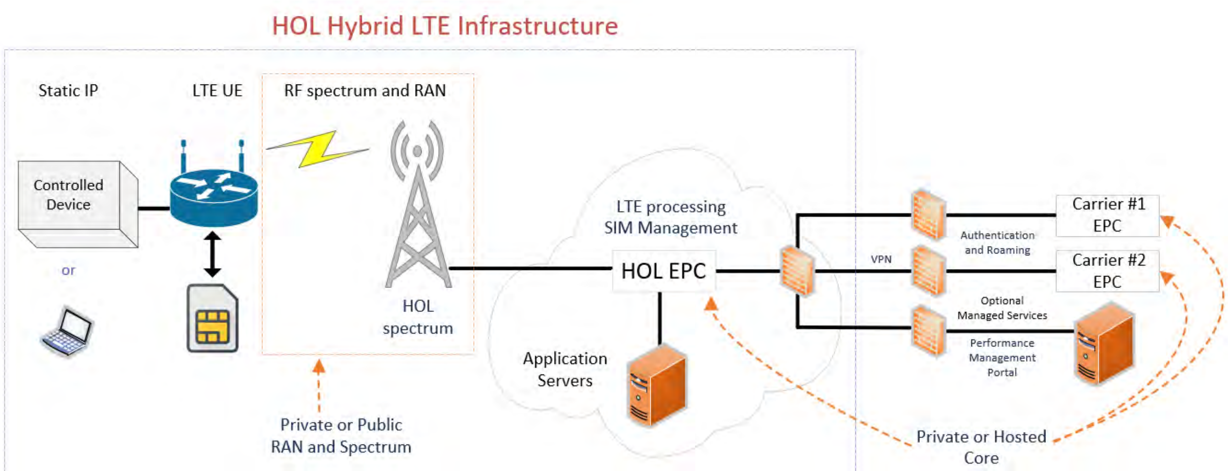

Figure 19 – Hybrid Network Architecture

The scenario that seems most preferable to HOL is private EPC, which facilitates roaming with multiple carriers and a public RAN. Based on stakeholder meetings, it appears that this arrangement is being pursued by Hydro Quebec. The details of the proposed Hydro Quebec architecture, the equipment vendors, LTE carriers, costs, and maintenance arrangements have not been obtained by HOL or Black & Veatch. PVNO architecture appears to provide desirable benefits to HOL; however, initial discussions with carriers reveal that substantial expenses from EPC hardware selection, peering to the LTE carriers, and related business agreements may be very expensive. Carrier grade equipment and licensing volumes, as opposed to consolidated appliance EPC such as provided by Nokia, are likely required.

7.2 Hybrid Considerations

A Private Virtual Network Operator (PVNO) is a network connectivity option that can provide utilities some of the advantages of a fully private field area network (FAN) without the necessity to build out every physical component of the network. It is a customizable solution, but it is also relatively new, and there is currently no single, standardized approach. This solution allows for the use of the networks of multiple cellular carriers, providing redundancy, and it allows for more privacy due to HOL's ownership of MNC, as opposed to using the carrier's MCC-MNC.

In a PVNO, the utility owns and operates the core functions of the network but leases the RAN (radio access network) from one or more carriers in the form of bulk wholesale capacity. Customized interface devices and SIM cards form the boundary between the utility's network equipment and the carrier's RAN. This system provides flexibility on matters such as security and network configuration. Furthermore, it can rely on the networks of multiple carriers, potentially providing coverage equivalent to the full cellular phone network, but it may not be suitable for all areas since there are holes and regions of poor reception in the cellular network. For any implementation, an evaluation of coverage in the region is necessary. Typically, this will be less of a problem in urban areas than in remote rural areas.

Given the increase in needs for highly distributed, low bandwidth monitoring and control, a PVNO is potentially useful for applications such as rooftop solar, electric vehicle charging, line monitoring and control, and use cases specific to certain industries, including existing and emerging high tech, in addition to common existing applications such as SCADA and metering.

Though the PVNO concept has been used in other industries, it is relatively new for utilities, and architecture could be evolving until there is wider adoption among utilities and some standard configurations are developed.

When considering PVNO as an option, cost/benefit and risk analyses are necessary. The cost of bulk leased capacity should be compared to the capital and maintenance costs of a private RAN over the useful lifetime of the equipment. Risks associated with changing costs of leased capacity and reductions in available network capacity should also be considered. Costs may also be incurred due to training and other activities associated with the shift in operation. Additional risks to be analyzed include security, availability of standard and custom equipment, reliability of equipment, SIM card management and security, and interfaces between the PVNO and the utility's network.

Coverage may be a concern with a PVNO. If the PVNO does not cover the entire required area or if capacity is limited in some areas, a gap filler solution, such as a fully private FAN or services from another carrier, might be required.

7.3 Conclusion

A hybrid network is a complex approach that will have to be tailored carefully to HOL's needs. Though it presents risks due to security, equipment availability, and a lack of experience with this approach in the utility sector, it may be necessary to consider a hybrid approach if neither a fully public nor a fully private option satisfies all requirements. Depending on the results of cost/benefit and risk analyses and on the specific use cases, a PVNO can be a viable solution for utilities willing and able to be relatively early adopters of this approach.

8.0 Gap Analysis

HOL's existing systems have gaps in tower coverage and provision of backhaul that will have to be addressed. Depending on the option chosen (private, public, or hybrid network), new tower sites may be necessary, and extensions of backhaul coverage, including new fibre runs and microwave installations, may have to be constructed.

8.1 Tower gap assessment

HOL has approximately 19 "tower" locations with narrowband 900 MHz radio antennas within the Ottawa service territory. These towers will require individual assessment to ensure that they can support typical LTE site infrastructure, which typically includes one or two 6' cross polarized antennas along with a fibre feed radio per sector. By visual KML street inspection of the tower types, is it unlikely that any of HOL's current towers are capable of supporting a sectored LTE site with panels and the corresponding LTE radios per face. It is possible to place the amplifiers on the ground rather than on the tower, but that can decrease performance and add the complexity of multiple coaxial cable runs.

In addition to the HOL towers there is a large variety of cell sites exceeding 25 metres within the service territory. That inventory, which is depicted in Figure 20, creates the option of colocation in a private or hybrid scenario. The hexagons that are likely to be a colocation challenge are numbers 2, 13 and 14 due to the lack of adequate height at the centre of the hexagon. It is also assumed that the hexagons with sites of adequate heights near the centre of the hexagon also have available centre lines with sufficient RF isolation. There is also the possibility that some towers may have very high centre lines that could cover the extent of the hexagon without being centred or sufficiently covering the DA/AMI/Battery/DER in that service territory.

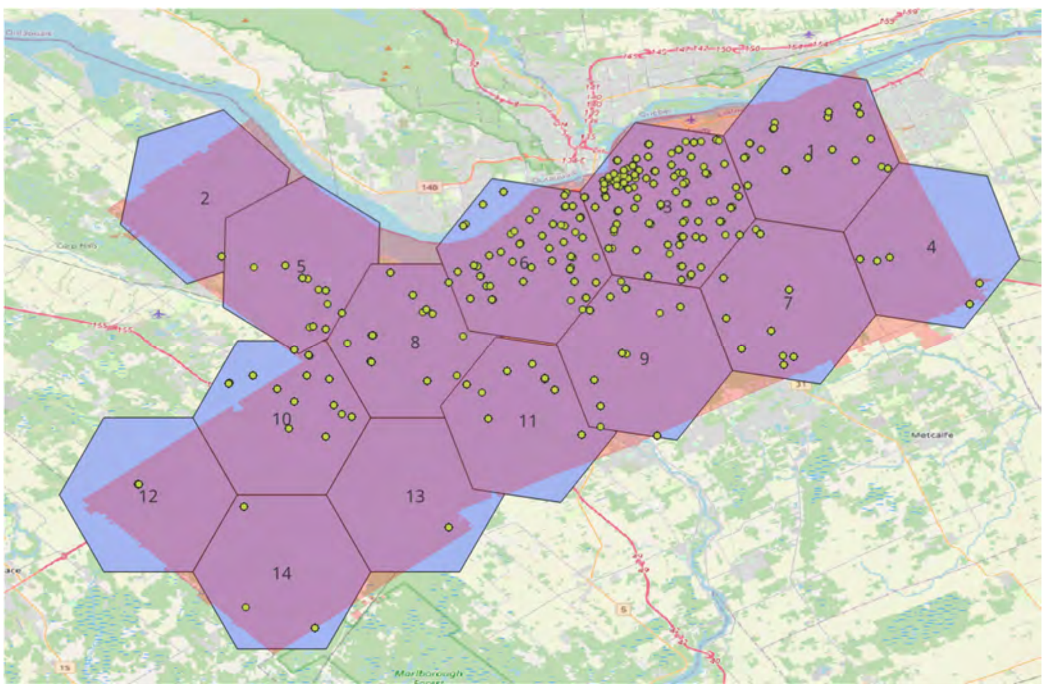

Figure 20 – Possible colocation opportunity locations (>25m heights)

8.2 Backhaul gap assessment

As was considered in Section 2.1.3, Adding a 1.6km buffer around the existing fibre assets provides 43% reach within the main service territory. This leaves a substantial void in the potential for economical backhaul coverage outside that buffer. In some locations, it may be economical to extend fibre to provide backhaul coverage, but where this is not economical, other options, including microwave and public carrier solutions, can be considered.

8.3 Microwave Backhaul Alternative

Line of sight microwave paths can provide options for redundancy or for primary access to locations where it is not practical or cost effective to run fibre. A microwave path requires a clear line of sight, free of obstructions such as tall trees, buildings, or towers, so this solution will only be practical for places where a tower can be built to a height sufficient to meet this requirement.

The microwave backhaul planning process follows a number of steps, beginning with a search for candidate sites and culminating in preliminary designs for sites and paths. During the initial site search and identification phase, the first step is to list all sites for which backhaul is required and for which fibre or other methods do not provide the required access, bandwidth, or redundancy. Additionally, nearby sites that have sufficient backhaul capacity and might be reached via a microwave link are identified.

Next, candidate frequency bands are identified. As a general rule, lower frequencies, typically in the 6GHz and 11GHz bands, are used for paths longer than approximately 7km, while higher frequencies, such as the 18GHz and 23GHz bands, are used for shorter paths. In urban areas, spectrum availability might be limited, so the spectrum licensing agency or a consultant should be contacted to determine availability.

Once the candidate sites and frequencies are chosen, possible microwave paths are checked for obstructions using GIS tools and/or a microwave path design tool such as Pathloss with appropriate terrain and clutter data. The antenna heights required to clear the obstructions are calculated, and candidate paths for which antennas heights are excessive are eliminated. Note that for paths longer than approximately 15km, space diversity (two antennas on each end mounted at different heights) is likely to be required to counteract multipath interference.

For those paths where existing mounting structures are available and those where towers can be constructed, site surveys, path surveys, and tower location studies can proceed. Site surveys and path surveys may be required at this point or during the previous activity, especially if the paths are crossing congested urban areas, if tall structures are close to the paths, or if tree clearance appears tight. For new towers, locations within the site will be narrowed down at this point. Sometimes, the optimal location is unclear, and two or three alternatives will be identified, leaving the final decision for the detailed design phase. Geotechnical analysis may be required at this point or later for new tower sites, and preliminary structural analysis may be required at this point for existing towers that appear to be high risk.

Cost estimations and trade studies are performed for the candidate paths that remain. Capital and recurring costs associated with the microwave paths are compiled. These include towers or other mounting structures, antennas, radios, cables/waveguides, building or tower modifications, and any other necessary equipment. If microwave is being considered in competition with other possible solutions, such as fibre or leased services, a trade study comparing these costs and other concerns, including reliability, is performed.

A preliminary design will result from this process. If microwave is chosen, detailed design can proceed. Microwave backhaul will not be suitable or even possible for all situations, but where it is possible, it can be a cost effective and reliable backhaul solution, and it can be useful for providing redundancy, so it should be considered among other options.

9.0 Roadmap

The existing DA use cases have sufficient capacity on the narrowband network; however, the performance and reliability of that narrowband network was described as lacking at times. The existing 900 AMI mesh has been previously described as slow to complete all the required meter billing reads. The narrowband network could be improved and expanded, but it will always suffer due to the use of unlicensed frequencies, lack of diversity and the inherent SD9 duplexing method. Narrowband communications impose bandwidth and latency performance limitations which conflict with many proposed future use cases. Future widespread uses of narrowband unlicensed communication are therefore not recommended, but licensed narrowband may be useful in specific situations where LTE coverage is unavailable or for mission critical equipment.

A broadband LTE Network, if properly planned, engineered, implemented and maintained, has the ability to serve Hydro Ottawa operations decades into the future. These three LTE design options, private, public and hybrid, must be carefully considered to ensure the selected path achieves an appropriate balance among manageability, capacity, reliability, and cost.

The **private** option will require private broadband spectrum. Black & Veatch researched a variety of spectrum options. The most important consideration is frequency and the coverage that follows. In order to build a lower density grid, a low frequency band is required; for Hydro Ottawa, the recommended spectrum is the PSBN 700 block. ISED makes specific provisions allowing for commercial traffic coexisting with public safety traffic. Public safety does have priority and can preempt commercial traffic; however, the available bandwidth makes this unlikely. Furthermore, it is in the public's best interests to have a robust and reliable communications capability in order to restore power. Acquiring access to PSBN spectrum will require partnerships with public safety entities to gain access and monitor performance and usage parity. A secondary option may be to partner with an LTE carrier to subordinate a portion of their low-band spectrum in the event that it is underutilized or not in service. Underutilized spectrum could be allocated and used as a test bed via a public APN scenario. At this time, it is unclear what the wireless carriers are obligated by ISED to accept or willing to accept if not obligated.

Beyond the spectrum portion, there are choices to be made regarding the location of the LTE core resources, in particular if HOL prefers an owned physical core to a core hosted and managed by the selected carrier. The owned core would be implemented in a private and likely a hybrid scenario, where the hosted core would be implemented in a public scenario. The spectrum will impact the RAN architecture, which may be a long lead time item. The subordination conversations with LTE carriers should be planned and undertaken in tandem with the PSBN spectrum negotiations to establish the most economical and advantageous path forward.

HOL currently operates a **public** APN. This arrangement serves ~1500 AMI SIMs through the Bell LTE network. Hydro Ottawa could reevaluate the terms of its existing Bell APN contract for expansion and consolidation of additional ~40 individual DA IP SEC tunnels. Depending on the existing configuration, an additional IP range could be allocated to the APN to move existing DA assets on to the Bell cellular APN.

Narrowband DA assets could be configured, lab tested, and migrated to LTE. Those assets will likely experience substantial reliability, latency, and performance improvements at relatively low cost. LTE performance schemes could be developed and implemented, which will begin to develop staff competencies for any future LTE scenario. The preceding steps will lead to public expansion and potentially long-term adoption if that is what HOL prefers. These upgrade and public LTE consolidation efforts are also not pointless efforts since, at a minimum, DA performance and reliability will improve. Expanding the public LTE scope will enhance understanding of LTE and allow for development of performance schemes and staff expertise over time. The public option can easily be rehomed or migrated to private assets at a later time. APN negotiations with Rogers may serve to improve Bell pricing terms, extend contract length, and combine professional services offers. These conversations serve to refine cost in terms of CAPEX and OPEX and illustrate what an alternate network and professional service team offers.

The last option is hybrid or PVNO. This is a bit more complex to evaluate since there are many uncertainties related to EPC core equipment requirements, the interfacing requirements with commercial LTE providers, each of which may have different terms and requirements, and 3GPP standards related to this arrangement. The PVNO would also almost certainly require one or more highly trained and experienced core engineers to manage and maintain the LTE carrier interfaces. At a minimum, considering PVNO will require further discussions with both the incumbent LTE service providers and EPC core equipment manufacturers to consider costs, necessary hardware for the required capabilities. The business agreements with each of the LTE providers may also prove challenging.

Appendix A. Equipment Reliability Standards

The LTE EPCs and BBU's shall be engineered to provide 99.995% reliability.
Individual LTE radios shall provide 99.9% reliability.
Table 14 is an industry standard for describing system reliability.
Table 15 presents recommended general high level LTE KPI's.

Table 14 – Availability Percentage

Availability %	Downtime per year	Downtime per quarter	Downtime per month	Downtime per week	Downtime per day (24 hours)
99.5% ("two nines five")	1.83 days	10.98 hours	3.65 hours	50.40 minutes	7.20 minutes
99.8% ("two nines eight")	17.53 hours	4.38 hours	87.66 minutes	20.16 minutes	2.88 minutes
99.9% ("three nines")	8.77 hours	2.19 hours	43.83 minutes	10.08 minutes	1.44 minutes
99.95% ("three nines five")	4.38 hours	65.7 minutes	21.92 minutes	5.04 minutes	43.20 seconds
99.99% ("four nines")	52.60 minutes	13.15 minutes	4.38 minutes	1.01 minutes	8.64 seconds
99.995% ("four nines five")	26.30 minutes	6.57 minutes	2.19 minutes	30.24 seconds	4.32 seconds
99.999% ("five nines")	5.26 minutes	1.31 minutes	26.30 seconds	6.05 seconds	864.00 milliseconds

Table 15 - RAN KPI

KPI Type	KPI Name	Target
ACCESSIBILITY	E-UTRAN E-RAB Setup Success Ratio	99.40%
ACCESSIBILITY	E-UTRAN Initial E-RAB Accessibility	98.50%
ACCESSIBILITY	E-UTRAN Initial E-RAB Setup Success Ratio	99%
ACCESSIBILITY	E-UTRAN E-RAB Setup Attempt	Count
ACCESSIBILITY	E-UTRAN RACH Setup Completion Success Rate	95%
ACCESSIBILITY	Total E-UTRAN RRC Connection Setup Success Ratio	99%
RETAINABILITY	E-UTRAN E-RAB Drop Ratio, User Perspective	2%
RETAINABILITY	E-UTRAN E-RAB Drop Ratio, RAN View	0.50%
RETAINABILITY	E-UTRAN Total HO Success Ratio, intra eNB	97.50%
MOBILITY	E-UTRAN HO Success Ratio, S1	95%

Table 16 - EPC KPI

EPC KPI	Target
Memory and CPU loading	<50%
MME Paging Success Rates	>98%
SGW-PGW Active Bearers	Count
SGW-PGW Idle Bearers	Count
PGW Attach Failure Rate	1%<
PGW UL Volume (MB)	Volume (MB)
PGW DL Volume (MB)	Volume (MB)

Appendix B. Lexicon

Term	Description
3GPP	3rd Generation Partnership Project
AKA	Authentication and Key Agreement
AWS	Advanced Wireless Services
BBU	Baseband unit
CAPEX	Capital Expenditure
CPRI	Common Public Radio Interface
DER	Distributed Energy Resources
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
HSS	Home Subscriber Server
LTE	Long Term Evolution
MME	Mobility Management Entity
MPE	Maximum permissible exposure, an RF power density (mw/cm2)
MRC	Monthly recurring cost
NMS	Network Management System
OPEX	Operational Expenditure
OTT	Over the top, voice and video delivered with no prioritization
PAPR	Peak to Average Power Ratio
PCRF	Policing and Charging Rules Function
PGW	Packet Gateway
PS	Packet Switched
QoS	Quality of Service
RAN	Radio Access Network
SAE	System Architecture Evolution
SC-FDMA	Single Carrier Frequency Division Multiple Access
SGW	Serving Gateway
TDD	Time Division Duplex
TOR	Top of Rack switch to allow for enhanced I/O for the EPC
TTI	Transmission Time Interval
UE	User Equipment
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network

Appendix C. Attachments

Document	
Example Use Case Matrix	HOL_Use_Case_Matrix.xlsx

GENERAL PLANT INVESTMENTS

1. SUMMARY

Hydro Ottawa's planned General Plant Capital Investments for 2026-2030 total $121.2M (net), comprising ten key programs focused on maintaining and advancing Hydro Ottawa's infrastructure, operational capabilities, and customer service excellence. These investments address areas such as critical infrastructure reliability, fleet renewal, customer engagement, and IT and cyber security infrastructure. Hydro Ottawa's plans include two cloud-based software solutions, which are considered operations, maintenance and administration (OM&A) costs under current International Financial Accounting Standards and are discussed in Attachment 4-1-1(A) - Transition to Cloud Computing, which should be read in conjunction with this schedule. All together, these programs ensure Hydro Ottawa remains well-equipped to meet evolving industry demands, regulatory requirements, and customer expectations.

General Plant Capital Programs:

Section 2. Meter to Cash ($8.9M - CAPEX)

This program supports critical business functions such as billing, meter reading, collections, and reporting. Upcoming upgrades to systems like Oracle's Customer Care & Billing (CC&B) and Advanced Metering Infrastructure (AMI) aim to ensure compliance, improve customer self-service options, and address end of life infrastructure.

Section 3. Customer Engagement Platform ($2.5M - CAPEX, $4.3M - OM&A)

This program encompasses tools such as MyAccount, outage communication systems, Hydro Ottawa's website, and energy management tools platforms. It prioritizes enabling intuitive self-service, delivering detailed energy insights, and enhancing customer satisfaction through seamless digital experiences. Furthermore, these digital platforms enable Hydro Ottawa to gather valuable customer insights that can also be used to enhance customer experience, inform grid planning, and identify opportunities for future NWSs and customer programming. By supporting scalability, it addresses the increasing demand for electrification and distributed energy resource (DER) integration, empowering customers with actionable data to make informed energy decisions.

Section 4. Enterprise Solutions ($1.4M - CAPEX, $0.6M - OM&A)

This program focuses on maintaining and upgrading applications such as Enterprise Resource Planning (ERP) and IT Service Management systems. These enhancements ensure business continuity, streamline workflows, and reduce cyber security risks. Over the rate period, the program includes business continuity software and expanding self-service HR capabilities.

Section 5. Data and System Integrations ($3.5M - CAPEX, $0.5M - OM&A)

This program consolidates fragmented data systems to create an integrated, reliable, and efficient framework. It aims to reduce manual interventions, enable real-time decision-making, and ensure compatibility across platforms to support both operational and strategic initiatives.

Section 6. Grid Technology ($4.3M - CAPEX, $1.5M - OM&A)

This program addresses the maintenance and upgrade of tools and software that support modernization of grid operations, integrate new technologies like DERs and support grid planning. The program focuses on network visualization and management, data collection and network modelling and simulation.

Section 7. CCRA - Connection Cost Recovery Agreement ($45.9M - CAPEX)

The CCRA program funds Hydro Ottawa's share of transmission infrastructure upgrades, determined through system capacity assessments. These upgrades include connections for new and upgraded stations and addressing equipment limitations at Hydro One Networks Inc. (Hydro One)-owned stations. Hydro Ottawa contributes to the costs of these upgrades, ensuring grid reliability and supporting growth. Key projects include new stations (Hydro Road, Mer Bleue, Kanata North, Greenbank) and upgrades to existing stations (Cyrville, Bronson, Carling, King Edward, Hinchey). This investment will increase station capacity by over 811MVA, improving DER hosting capacity and reliability, and supporting customer growth. Driven by the need to address capacity constraints, the CCRA program responds to load requests and, without these investments, Hydro Ottawa may not be able to meet future demand.

Section 8. Infrastructure & Cyber Security ($11.9M - CAPEX, $1.0M - OM&A)

This program invests in strengthening IT systems to protect against cyber threats, maintain data integrity, and support business continuity. The program aims to ensure systems are secure, scalable, and aligned with industry best practices to safeguard critical infrastructure.

Section 9. Tools Replacement ($4.9M)

This program updates and replaces outdated equipment and tools to enhance operational efficiency, support field staff, and improve safety. The program ensures workforce readiness and aligns with modern operational standards.

Section 10. Buildings - Facilities ($6.6M)

This program focuses on maintaining and upgrading office and operational facilities to support workforce needs, improving energy efficiency, and providing a safe working environment. These investments also align with Hydro Ottawa's sustainability goals and level of organizational growth.

Section 11. Fleet Replacement ($40.6M)

This program plans for additional vehicles required for increased staffing needs as well as to replace aging vehicles with modern, efficient alternatives that support safety and operational needs and reduce carbon emissions.

2. METER TO CASH

2.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $3.6M

2026-2030: $8.9M

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Operational Efficiencies, Regulatory Compliance, Customer Experience

Outcomes: Operational Effectiveness, Customer Focus

The Meter-To-Cash (MTC) program enables vital business capabilities such as accurate customer billing for electricity revenue, meter reading, customer relationship management, collections, related financial reporting and more. The MTC technology landscape includes a Customer Information System (CIS), applications to support Automated Metering Infrastructure (AMI) and Commercial Billing & Settlement System (CBSS), all of which are tightly integrated internally and externally to provincial regulatory systems. MTC is responsible for supporting all technology components used in the billing process that is critical to Hydro Ottawa’s revenue stream.

Hydro Ottawa’s CIS uses Oracle’s Customer Care & Billing (CC&B) platform to provide core billing services critical to the MTC process for the entire customer base of approximately 364,000 customers. As any typical software shelf life at Hydro Ottawa, the CIS platform is upgraded every five to seven years and the current version of CC&B platform was last upgraded in June 2020. The CC&B platform requires a technical version upgrade - planned for 2028 - to version 25A to ensure continued vendor support and system reliability. The timing of these upgrades coincides with the expiration of the managed services contract (held by IBM, a long-time Oracle partner) at the end of 2027.

Hydro Ottawa will perform technology upgrades to its AMI head end systems which collect meter data and serve as the foundation of billing and reporting for its customer base. This includes both Honeywell Connexo and Itron MV90 systems. These systems must remain up-to-date in order to be eligible for vendor support and to minimize the risks of not being able to accurately track meter reads and/or bill its customers.

Continuous technology investments are planned to unlock efficiencies through automation of internal business processes, achieve regulatory compliance, simplify system maintenance and create self-serve options to improve the customer experience. Hydro Ottawa recognizes the industry shift in the energy sector and these investments will help to support customer demands for decarbonization, electrification and grid modernization that may impact future regulatory requirements. Funds will be allocated annually to implement the changes outlined in Section 2.7.1 - Implementation Plan, subheading Regulatory Compliance and Operational Enhancements.

2.2. PERFORMANCE TARGETS AND OBJECTIVES

Table 1 outlines the performance targets and objectives that will be achieved via the Meter to Cash Program.

Table 1 - Performance Outcomes for Meter to Cash

Performance Outcome	Target
Operational Effectiveness	● Upgrade to a "Cloud ready" version of CC&B in preparation for the transition to a Software as a Service (SaaS) solution in the 2031-2035 rate period.
	● Maintain Regulatory compliance.
	● Improve internal workflows to drive operational efficiencies.
	● Reduce the risk of rising operational costs associated with outdated systems by investing in upgrades and enhancements that improve efficiency, security, and the overall performance of customer engagement platforms.
	● Keep critical metering systems on fully supported platforms.
Customer Focus	● Reduce volume of calls and call handling times.
	● Provide best-in-class customer service/experience to be measured via surveys and focus groups.
	● Enhance Hydro Ottawa brand image and reputation.

2.3. PROGRAM DRIVERS AND NEED

2.3.1. Main and Secondary Drivers

Primary Driver: Business Operations Support

Secondary Drivers:

- Business growth and scalability; prepare for increasing billing complexity and higher transaction volumes
- Customer Experience and Satisfaction: Improve self-service and reduce cycle times transacting with Hydro Ottawa on a modernized billing platform
- Operational Efficiency and Productivity: More automation and integration with other systems, new and modernized functionality and a reduction of custom / legacy code
- Regulatory Compliance: Meet all applicable OEB compliance obligations

- Technology Advancements: Utilize Application Programming Interfaces (API) architecture and emerging artificial intelligence to simplify integrations, which will achieve better interoperability and productivity

2.3.2. Current Issues

Technical Upgrades

Hydro Ottawa's current CIS infrastructure components, including the Oracle CC&B application, are reaching end of life and must be upgraded to avoid being out of vendor support. Similar upgrades are required for existing AMI head end systems critical for tracking energy consumption, in-depth reporting and the production of bills. Being on an unsupported platform for critical systems such as its CIS and AMI is risky as there would be limited vendor support in the event of software issues, added security risk of unpatched vulnerabilities, and no access to new features. This will limit Hydro Ottawa being able to expand its offering to its customers and keeping up-to-date with newer technologies.

Regulatory Compliance and Operational Enhancements

In order to maintain a high level of service to its customer base, Hydro Ottawa must make annual updates to:

- Maintain Regulatory Compliance;
- Provide customers with self-serve options for answering common questions; and
- Automate time-consuming manual processes, allowing staff to focus on higher-value activities.

2.4. PROGRAM BENEFITS

2.4.1. Reliability and Aging Infrastructure

Upgrades to the CIS system and AMI headends allows Hydro Ottawa to keep pace with technology, mitigate risks and ensure sustained operational excellence.

2.4.2. Resilience and Climate Change Adaptation

Enable Hydro Ottawa to respond to and implement regulatory changes related to electrification.

2.4.3. Customer Experience

Accommodate more customers, more complexity and increased transaction volume on modernized technology stacks, allowing the business to scale efficiently. Enhance customer experience and loyalty by providing easily accessible self-serve options rather than having to make a call to its call center.

2.4.4. Grid Modernization and DERs

Upgraded metering infrastructure to support the demands of grid modernization and increase in data flows and frequency. Enable Hydro Ottawa to respond and implement regulatory changes related to DERs and associated billing impacts

2.4.5. Workforce Planning and Renewal

Automation of manual processes and leveraging base functionality will free up time for staff to focus on more meaningful work.

2.4.6. Productivity and Innovation

An upgraded CIS system will ease adoption of future regulatory and business requirements through configuration changes instead of developing code.

Increased cooperation and sharing of best practices among Ontario LDCs who are also on CC&B (Toronto Hydro, Alectra & Enova Power), leading to cost savings and improvements in customer service.

Introduce more automation and self-serve options and take advantage of new features and functionality such as AI to improve productivity

2.5. PROGRAM COSTS

Table 2 details the historical, bridge and test year spending for the MTC Program.

Table 2 - Historical, Bridge, and Test Year MTC Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 0.5	$ 1.4	$ 1.1	$ 0.3	$ 0.4	$ 0.3	$ 1.0	$ 6.8	$ 0.4	$ 0.4
ANNUAL TOTAL	**$ 0.5**	**$ 1.4**	**$ 1.1**	**$ 0.3**	**$ 0.4**	**$ 0.3**	**$ 1.0**	**$ 6.8**	**$ 0.4**	**$ 0.4**
5-YEAR TOTAL					**$ 3.6**					**$ 8.9**

2.5.1. Cost Factors

Program costs reflect regulatory and operational enhancements over the term, system upgrades to AMI head ends in 2027, and system upgrades to CIS in 2028. Hydro Ottawa has received preliminary quotations for the technical upgrades and has used knowledge of past projects to estimate the expected costs.

2.6. ALTERNATIVES EVALUATION

Hydro Ottawa is committed to growing and providing best-in-class customer service while remaining regulatory-compliant. Investments are required to improve existing services and to meet yearly regulatory obligations as set forth by the OEB.

2.6.1. Alternatives Considered

Hydro Ottawa's existing AMI infrastructure and CIS systems are critical to servicing and billing its customers, so it is important to avoid unnecessary risk and to remain on a well-supported platform with modernized technology. These systems must be upgraded every five years to avoid technology obsolescence.

Deferral or "doing nothing" would negatively impact Hydro Ottawa and customers in the following ways:

- Increased OM&A costs for both licensing and managed services for end-of-life technology.
- Business risk with limited vendor support available in the event of software error or failure.
- Increased cyber security risk if vulnerabilities are found by malicious actors and the vendor is no longer producing security patches.
- Limited ability to implement technology and process innovations (e.g. AMI 2.0) due to an aged system.
- Negatively impact collaboration across the LDC community as systems would be incompatible with peers.
- Regulatory requests are non-discretionary and must be implemented by Hydro Ottawa, but may not be possible if systems are not kept current.
- Restricts ability to execute operational enhancements (e.g. continuous improvement) by streamlining internal processes and/or improving the customer experience.

2.6.2. Evaluation Criteria

The evaluation criteria for these initiatives are:

- Regulatory requirements must be fulfilled by all LDCs in Ontario, including Hydro Ottawa.
- Technical upgrades are required to sustain operations with its current support vendors.
- Existing CIS and AMI implementation partners are best positioned to perform system upgrades.

2.6.3. Preferred Alternative

Upgrading the CIS and AMI systems are preferred to allowing the systems to fall out of date.

2.7. PROGRAM EXECUTION AND RISK MITIGATION

2.7.1. Implementation Plan

CIS Upgrade

In 2028, Hydro Ottawa will initiate a 10-month project to perform a technical upgrade of CC&B from version 2.7.0.3 to 25A (new version numbering). This will include a full refresh of the infrastructure and bring Hydro Ottawa to the most up-to-date functionality of the CC&B

application.

AMI Head End Upgrades

The existing Honeywell Connexo and Itron MV90 AMI head ends were last upgraded in 2022 with an expected life of five years. A technology upgrade and infrastructure refresh will be required during the 2026-2030 rate period as these are critical systems in the MTC process. The target timeline to upgrade both systems is 2027 to align with the implementation of the AMI 2.0 system, which requires these upgrades to read the AMI 2.0 meters.

Regulatory Compliance and Operational Enhancements

The scope of these enhancements is to improve operational efficiencies while staying regulatory-compliant. Hydro Ottawa reserves funds each year to implement changes from the OEB, such as new rate options, as well as automate manual, intensive processes in order to allow staff focus on value-added work. Among other projects, Hydro Ottawa plans to address the following known regulatory changes, enhancements and process automations over the rate period:

- New EV rate for low-utilization EV charging stations (due January 1, 2026)
- Potential for new future rate options
- Revamp Incremental Synchronization process with the provincial Meter Data Management/Repository (MDM/R) to resolve synchronization issues
- Rate reclassification automation
- Equal Monthly Payment Plan (EMPP) process automations
- Introduce self-serve automation for collection processes via Hydro Ottawa's MyAccount portal

2.7.2. Risks to Completion and Risk Mitigation Strategies

Table 3 - Key Risks to Completion for MTC Program and Mitigation Strategies

Risk to completion	Mitigation
Resources	Resources allocation will be performed to ensure Hydro Ottawa delivers on the projects set to complete.
Prioritizing projects	Projects will be prioritized based on customer and financial impacts.
Large Regulatory Initiative	Projects will need to consider Regulatory initiative deadlines and allocate the proper cycles to meet the timelines.

2.7.3. Other Factors

The following identify key factors influencing the timing and costs:

- Aging infrastructure (Operating system, application, hardware and database)
- Product obsolescence dates and vendor support ending
- CIS Managed Services contract ending in 2027 (Hosting, Infrastructure and Support)
- OEB deadlines for regulatory changes

3. CUSTOMER ENGAGEMENT PLATFORMS

3.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $7.1M (CAPEX)

2026-2030: $2.5M (CAPEX) $4.3M (OM&A)

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Scalability and Adaptability, Cost Effectiveness, Regulatory Compliance, Risk Mitigation, Data-Driven Decisions

Outcomes: Operational Effectiveness, Customer Focus, Public Policy Responsiveness

Hydro Ottawa's digital engagement tools are the primary platform for daily customer interaction, shaping Hydro Ottawa's brand and online reputation. These tools are crucial for delivering essential information, new programs, billing and usage insights, self-serve options, energy decision making tools and outage communications.

To enhance customer experience and meet evolving needs, Hydro Ottawa is investing in a Customer Engagement Platform Program. This program will continue to modernize Hydro Ottawa's digital platforms, making them more scalable and user-friendly. The enhancements to these platforms will improve the customer experience, drive operational efficiencies and equip customers to better navigate the complexities of the evolving energy landscape as described Schedule 1-4-1 - Customer Engagement Ongoing, Attachment 1-4-1(B) - Customer Experience Strategy.

Key areas of focus over the 2026-2030 rate period include:

MyAccount - This platform, available online and via mobile app, has become an increasingly important point of access for customers to a widening range of information and services such as billing, energy usage, rate plan options, and outage information. Hydro Ottawa will continue to refine and improve the MyAccount platform, ensuring it remains a primary personalized point of access for customers to manage their accounts, access information and services, and receive tailored support. This includes adapting to new interactive billing technologies and energy management tools to meet evolving customer expectations, while addressing legacy technology issues. Hydro Ottawa will leverage data analytics and disaggregation[1] to empower customers to make better informed energy choices to save money, while providing Hydro Ottawa with valuable data on behind-the-meter insights to inform planning, improve grid management, and develop and amplify customer energy efficiency, demand response and DER programs as Non-Wires Solutions (NWSs).

Hydro Ottawa (.com) - Hydro Ottawa's website will undergo a redesign to improve visual appeal, optimize for mobile devices, and enhance usability for all customer types.

24/7 Chat Support - Hydro Ottawa will integrate an AI-powered chatbot to provide customers with 24/7 assistance for common inquiries and personalized responses, with seamless hand-off to a live agent when needed.

Outage Communications - Hydro Ottawa will build on previous outage communication enhancements by integrating planned outage information into the outage map and automating planned outage notifications to customers.

[1] Hydro Ottawa previously used Behind the Meter load disaggregation technology to provide customers with Home Energy Reports and appliance specific energy usage data as a CDM initiative. This practice was discontinued due to various factors (e.g. CDM program funding, MyAccount redesign, etc.). However, Hydro Ottawa intends to reintroduce disaggregation and data analytics capabilities as part of future updates to its MyAccount platform.

3.2. PERFORMANCE OBJECTIVES AND TARGETS

Table 4 describes the expected performance targets of the Customer Engagement Platform Program.

1 **Table 4 - Performance Outcomes for Customer Engagement Platform**

Performance Outcome	Target
Operational Effectiveness	● Improve grid planning and grid management with data-driven decision-making capabilities using insights gained from customer meter data analytics tools, including consumption patterns, and the identification of behind-the-meter DERs (such as battery storage, EVs and heat pumps). These will inform opportunities for NWSs & demand-side management programs that increase grid flexibility and reliability.
	● Increase customer self-service adoption by offering intuitive and user-friendly online and mobile platforms, integrating automated processes that optimize resource allocation and enable staff to focus on higher-value, more complex activities.
	● Reduce manual processing to minimize errors and improve processing times.
	● Achieve cost savings through: ○ 24/7 access to virtual assistants (chatbot), self-serve options and online support resources that will reduce call center volumes. ○ automation of common customer service inquiries such as bill payments, account updates, payment reporting, rate selection and outage reporting.
	● Mitigate the risk of increased operational costs by proactively modernizing customer engagement platforms so that they remain efficient, secure, and scalable to meet evolving customer needs and industry standards.
	● Ensure regulatory compliance by implementing and maintaining secure and privacy-compliant customer engagement platforms.
Customer Focus	● Enhance customer engagement with expanded energy management tools, including interactive digital bills within MyAccount that provide access to detailed energy use data. These tools will give customers personalized insights into energy consumption, identify opportunities for enhanced energy efficiency and cost savings, and enable greater control over energy use and billing management.
	● Provide 24/7 customer support through a chatbot, allowing timely responses to customer inquiries outside of business hours.
	● Enhance outage communication capabilities to provide timely and accurate information across all channels, including planned outages, ensuring clarity and facilitating efficient customer support.
	● Empower customers with expanded, flexible self-service options available 24/7, enabling them to resolve issues, submit requests, and manage their accounts at their convenience.
	● Contribute to increased customer satisfaction by providing a modern, user-friendly online experience and expanding self-service options.
Public Policy Responsiveness	● Support the OEB's expectation that utilities incorporate consideration of NWSs into the distribution system planning process. This will be informed through gaining deeper insights into customer-owned DERs from meter data to identify opportunities for Customer NWSs Programs.

3.3. PROGRAM DRIVERS AND NEED

3.3.1. Main and Secondary Drivers

Primary Driver: Business Operations Support

Hydro Ottawa's investment in digital customer engagement platforms is driven by a commitment to both enhance the customer experience and achieve operational excellence. Investing in this digital-first approach aligns with Hydro Ottawa's overarching strategy to empower customers through touchpoint improvements, self-service, personalized interactions, and higher levels of understanding, control, and management of their energy use.

By investing in user-friendly tools like the website, MyAccount portal, and a chatbot, Hydro Ottawa aims to make it effortless for customers to obtain immediate assistance, manage their accounts, understand their energy use, and make informed choices. Outage communications, for example, ensure customers receive timely and accurate updates during power disruptions to help them prepare and make informed decisions. This, in turn, improves operational efficiencies by streamlining core business processes, automating tasks, and reducing manual workloads, ultimately increasing efficiency and cost savings. Furthermore, these digital platforms enable Hydro Ottawa to gather valuable insights that can also be used to enhance customer experience, inform grid planning, and identify opportunities for future NWSs and customer programming.

Secondary Drivers:

- Scalability and Adaptability: Ensure services are available and evolving to meet customer demand.
- Cost Effectiveness: Realize efficiencies in automation, reliability, lifespan and preventative maintenance.
- Regulatory Compliance: Meet and exceed mandated requirements and service obligations.
- Risk Mitigation: Stay current with technology to mitigate the risks associated with obsolescence.

- Data Driven Decisions: Better understand and analyze customer choices, channel usage, service issues and energy usage.

3.3.2. Current Issues

MyAccount

Significant progress has been made with the redevelopment of MyAccount in recent years, but there remains legacy technology underpinning some components, opportunities in self-service options to leverage, automation potential, and an absence of advanced insights for customer-driven energy decisions. As the main platform for customer account management, MyAccount requires ongoing updates to meet evolving technology and customer expectations.

Hydro Ottawa can enhance the MyAccount experience and transform how customers interact with their billing information by transitioning to interactive digital bills. The bill is the most frequent touchpoint with customers, playing a crucial role in their understanding of energy usage and costs and their comfort in managing their accounts. Static traditional bills can lead to confusion due to increasing complexity and limited detail regarding rates, charges, energy usage, payment plans, services and programs. A digital bill presented through MyAccount will provide customers with clear, personalized information, allowing them to interactively delve into the specific details relevant to their needs.

At present, Hydro Ottawa customers lack the detailed energy insights needed to understand and lower their energy footprint using existing self-serve tools. Customers have no line of sight to granular electricity usage broken down by appliance or device, making it harder to track consumption patterns and adopt energy-saving measures. With growing EV use, electrification, and new energy sources, the grid and customers are becoming more interconnected. Customers should have better "behind-the-meter" energy intelligence to gain insights and make informed choices. Energy analytics tools, using meter data, can visually identify which devices or end-uses (e.g. EV charging or heating/cooling) consume the most electricity. These tools create opportunities for customers to prioritize energy efficiency, pinpoint savings, and analyze rate options.

Hydro Ottawa also lacks visibility into behind-the-meter DERs and customer electrification trends. Having greater visibility into DERs, and large and/or controllable loads like heat pumps and EV usage, would aid with load forecasting, grid planning, and grid management by uncovering opportunities for NWSs programs and engaging customers to participate in them. Refer to Section 9.2 of Schedule 2-5-4 - Asset Management Process for additional detail.

Providing these tools to customers and accessing behind-the-meter data at a more granular level will support the transition to a smarter, more flexible grid, strengthening customer engagement and empowerment.

Hydro Ottawa has also identified opportunities to expand self-service capabilities within MyAccount for high-volume interactions like collections activities. Currently, customers must contact Hydro Ottawa's contact center to report payments or set up payment plans. This requirement contributes to longer wait times, limited to business hours, and can lead to miscommunication or a lack of clarity regarding payment details. Customers may feel rushed or unable to fully process the information during a phone call, hindering their ability to review options and obligations at their own pace. Automating these routine interactions presents an opportunity to improve both customer experience and contact center efficiency.

Hydro Ottawa (.com)

Hydro Ottawa's website was last significantly redesigned in 2019 to modernize its technology and content management system (CMS). While the site's underlying technology has proven reliable and robust, particularly during periods of high traffic and emergencies, the front-end design is out-dated and the navigation makes it difficult for different customer types to access essential information and services efficiently. Some areas for improvement include updating the visual design and structural elements to align with current standards, updating and enriching the content, and enhancing usability for different customer types, all with the goal of improving the overall user experience and adapting to changing customer expectations.

24/7 Chat Support

Hydro Ottawa is committed to proactively enhancing the customer experience and optimizing operational efficiency. The current customer support model, with limited live chat availability and reliance on traditional service channels such as phone and email, presents an opportunity for improvement. By implementing a 24/7 AI-powered chatbot, Hydro Ottawa can offer a more accessible and convenient support option, streamline processes, and enable customer service agents to focus on more complex issues, ultimately improving the overall customer experience.

Outage Communications

The 2023 shift to a new outage communications solution, including a new map and individual outbound customer notifications via SMS and email, has elevated the reliability and scalability of Hydro Ottawa's ability to provide accurate information to customers when they need it most. Following this work, communication gaps around planned outages still remain. Currently, planned outages are not visible on the outage map in advance, and planned outage notifications rely on a labor-intensive manual process. Hydro Ottawa will continue to evolve its outage communication tools and processes to address these gaps and meet the changing needs of its customers and its operations.

Implementing "unplanned" regulatory requirements within its customer engagement platforms

Hydro Ottawa is committed to providing customers with accessible, up-to-date, and accurate information in response to any specific guidance and expectations by the OEB. An example of this is the electricity load capacity map - phase 1 work which Hydro Ottawa completed and posted to its website by the OEB's March 3, 2025 deadline. It is anticipated that other ongoing consultations by the OEB will lead to other enhancements to Hydro Ottawa's customer engagement platforms that benefit customers.

3.4. PROGRAM BENEFITS

The benefits associated with the proposed Customer Engagement Platform Program are detailed below.

3.4.1. Reliability and Aging Infrastructure

By investing in cutting-edge technology, Hydro Ottawa can provide its customers with best-in-class self-service options through a secure, intuitive, and modern interface. This empowers them to access support via their preferred channels, such as Hydro Ottawa websites, mobile applications, or other digital platforms.

Benefits of Upgrading Technology

- **Enhanced User Experience:** Modern interfaces prioritize user-friendliness, making it easier for customers to navigate and find the information they need.
- **Improved Accessibility:** Upgraded systems can be optimized for accessibility, ensuring that all customers, regardless of their abilities, can use self-service options.
- **Increased Efficiency:** Streamlined processes and automation reduce the time it takes for customers to resolve issues or access information.
- **Enhanced Security:** Modern technologies come with advanced security features, protecting customer data and ensuring privacy.

Informed Decision-Making

By equipping customers with the right tools and information, Hydro Ottawa enables them to make informed decisions. This reduces their reliance on direct inquiries, minimizing delays and uncertainties during critical situations like outages.

Security and Privacy as a Priority

As Hydro Ottawa upgrades its systems and processes for greater efficiency, it prioritizes security and privacy. Each step of the modernization process involves a thorough examination of security measures, ensuring that customer data is protected at all times.

3.4.2. Customer

Hydro Ottawa's investments in customer engagement platforms and customer service technologies will deliver an improved customer experience, ensuring convenient access to the information and tools customers need, when they need them, with enhanced reliability and scalability.

These benefits will be delivered through enhancements to the redesigned MyAccount portal, improving customers' online experience. The work will include transitioning to interactive digital bills combined with energy management tools that will offer a more dynamic and user-friendly billing experience. By leveraging meter data and AI, Hydro Ottawa can deliver more detailed usage data, enhanced visualizations, and targeted communications through digital billing that improve comprehension, promote informed energy decisions and increase customer engagement. The enhancements will simplify bill management and provide personalized insights, especially as energy information and billing become increasingly complex. It will also facilitate the exploration of new service offerings and empower customers to manage their accounts with greater ease and efficiency, while building in platform reliability and scalability to ensure 24/7 access to all necessary information and tools.

Hydro Ottawa is committed to empowering customers to manage their energy use effectively. Interactive digital bills will incorporate new energy management tools that will leverage disaggregation technology to provide detailed insights into electricity usage and identify which end-uses such as appliances, lights, heating and cooling, and EV chargers are using the most electricity. This increase in transparency gives customers greater control over their energy consumption, so they can identify efficiency opportunities or cost savings measures such as load shifting or assessing the impact of different rate options.

Hydro Ottawa envisions MyAccount as a platform where customers can easily track their energy usage and generation, accessing detailed breakdowns of energy use by appliance, understand rate structures, compare costs, and receive personalized insights. All these features contribute to a more transparent, engaging, and satisfying customer experience. The flexibility of a digital platform allows for adaption to evolving customer needs and seamless integration of new services and offerings, creating a future-proof solution. This initiative offers an opportunity to increase customer satisfaction and operational efficiency by providing enhanced self-service options, which will, in turn, reduce customer inquiries.

Expanding self-service options for high-volume interactions, including collections activities, provides customers with greater convenience and control. Online tools for reporting payments and setting up payment plans offer an alternative to phone calls, giving customers 24/7 access and the ability to manage their accounts on their own terms. This self-service approach also facilitates a full understanding of options and obligations by presenting clear, concise payment details that customers can review at their own pace, minimizing the risk of miscommunication.

Hydro Ottawa's website will be refreshed with a visually appealing design, improved mobile responsiveness, and streamlined customer journeys. By enhancing usability for different customer types, it will be easier for customers to find the information they need and access essential services. This will enable customers to self-serve more solutions, and reduce customer inquiries, improving the customer experience.

Customers will benefit from improved communication and support. Communication regarding planned outages will be timely and accurate, minimizing disruption and inconvenience. These outages will be integrated into the outage map to provide a comprehensive view of all service disruptions. Additionally, an AI-powered chatbot will provide 24/7 assistance, offering immediate answers to common questions and enabling customers to complete tasks at any time. This allows customer service agents to dedicate more time to complex issues, ensuring faster and more personalized service.

3.4.3. Grid Modernization and DERs

Utilizing behind-the-meter load disaggregation tools to detect appliances and DERs and collect consumption and generation data enables Hydro Ottawa to put this data in front of customers in the form of improved self-serve tools to make better decisions about their energy usage, identify issues and promote a conservation mindset. These tools also help to better forecast power needs across the grid by gaining a better understanding of behind-the-meter loads, identifying trends, and opportunities to take advantage of new DERs emerging on its system for grid planning and management.

3.4.4. Productivity and Innovation

Optimization and automation of internal processes, including the integration of self-serve capabilities and additional inquiry resolution tools like the 24/7 chatbot, intuitive website information, and detailed insights on energy usage, will reduce manual workload, increase efficiency, and decrease call volume. This will create a more effortless experience for customers, reducing inquiries, delays, disputes and costs.

3.4.5. Digitization and Technology Evolution

Provides Hydro Ottawa's customers with improved options and services while further developing a platform and infrastructure of applications and data that is designed to meet the continuous evolution of technology and the expectations it sets for customers.

3.5. PROGRAM COSTS

The proposed Customer Engagement Platform expansion, evolution and maintenance is anticipated to cost $2.5M (CAPEX) and $4.3M (OM&A) over the 2026-2030 rate period. The shift from capital to OM&A costs is largely due to the move to cloud-based solutions and completion of the MyAccount Redesign capital project in 2022-2024. Further enhancements to MyAccount and the Hydro Ottawa (.com) redesign are capital solutions, while the remainder of the program is based on cloud solutions and OM&A spend. For additional information on cloud computing in general refer to Attachment 4-1-1(A) - Transition to Cloud Computing.

Table 5 - Customer Engagement Platform Expenditures ($’000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 0.2	$ 1.1	$ 2.2	$ 2.6	$ 1.0	$ 0.9	$ 0.7	$ 0.3	$ 0.3	$ 0.3
OM&A	-	-	-	-	-	$ 1.0	$ 0.8	$ 0.8	$ 0.8	$ 0.8
ANNUAL TOTAL	**$ 0.2**	**$ 1.1**	**$ 2.2**	**$ 2.6**	**$ 1.0**	**$ 1.9**	**$ 1.5**	**$ 1.1**	**$ 1.1**	**$ 1.2**
5-YEAR TOTAL					**$ 7.1**					**$ 6.8**

3.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations from vendors to inform the expected costs of the program, including:

- Purchase of licenses and subscriptions
- Vendor services to implement and/or develop software
- Internal labor costs
- Annual support for each part of the platform

3.6. ALTERNATIVES EVALUATION

3.6.1. Alternatives Considered

Alternative One - Do Nothing: This approach represents a complete cessation of any further development or improvement to the existing platforms. This would immediately freeze the current state of customer knowledge and account management tools, preventing any future enhancements and contributing to an increasingly outdated customer experience.

Alternative Two - Limited Enhancement: This approach, while acknowledging the need for some improvements, would selectively defer or eliminate key projects, including an interactive digital bill, energy management tools, and additional self-serve functionality. While this approach might offer short-term cost savings, it would limit the potential of these platforms, hindering Hydro Ottawa's ability to meet evolving customer expectations for modern digital experiences and self-service capabilities.

Alternative Three - Recommended approach: Implement the program as described above in Section 3.1 - Program Summary.

Risks associated with Alternatives One and Two, and their direct impact, are further detailed in Table 6.

1 **Table 6 - Customer Engagement Platform Program Alternatives Risks and Impacts**

Risk Category	Risk	Impact
Customer Satisfaction	Declining Information Accessibility Across Channels	Customers will experience increasing difficulty accessing necessary information on their preferred device or channel, leading to frustration, increased call volumes to customer service, and confusion.
Operational	Ongoing Reliance on Manual Processes	Continued reliance on manual processes will perpetuate inefficient resource allocation and accumulate technical debt, eventually leading to support issues and an inability to adapt to evolving technology and customer expectations.
Customer Satisfaction / Operational	Limited Self-Service Evolution	Customers will face restricted options, increased reliance on customer service support, and delays due to manual processes. This will also contribute to accumulating technical debt, creating future support challenges and hindering adaptability to technological advancements and changing customer needs.
Customer Satisfaction	Limited 24/7 support options	While customers can access information through MyAccount, the absence of 24/7 live agent chat support limits their ability to resolve issues and receive personalized guidance outside of business hours.
Customer Satisfaction / Operational	Limited adaptability of Outage Communications	Outage Communications will continue to have limitations and exceptions around different outage scenarios and the customer's communication channel of choice. Not continuing the expansion of Hydro Ottawa's outage communications capabilities will detract from the customer experience and may require the continuation of inefficient and manual processes.
Customer Satisfaction / Operational / Financial	Limited Energy Insights for Customers and Hydro Ottawa	Customers will have limited access to data-driven insights at the appliance level and will have limited knowledge and tools to take control of their energy usage without disaggregation. Hydro Ottawa will have limited insight into how consumer energy is being used and changing with DER adoption which hinders informed load forecasting in grid planning, customer engagement, and opportunities for targeted program design.

3.6.2. Evaluation Criteria

Customer Engagement and touchpoint improvements: Convenient and easy-to-use tools and touchpoints across multiple channels to enhance customer engagement.

Personalization and Self Service: Personalized self-service options to empower customers with choice and control over their accounts.

Energy Enablement: Effective tools and resources to enable customers to understand, control, and manage their energy consumption.

Productivity & Operational Effectiveness: Automation and system integration for increased productivity, streamlined operations, and reduced costs.

Reliable scalability: Ensure reliable handling of increased traffic and customer inquiries during periods of high demand.

3.6.3. Preferred Alternative

Alternative Three: Implement the program as described above in Section 3.1 - Program Summary

3.7. PROGRAM EXECUTION AND RISK MITIGATION

3.7.1. Implementation Plan

The various initiatives and activities that are planned for the Customer Engagement Platform Program are coordinated with other programs and projects over the course of the 2026-2030 rate period. Additionally, each year there is allocation for ongoing enhancements for several of the platform's pillars to ensure they meet customer needs, are kept updated, are secure, and put customer experience and privacy on the forefront.

Table 7 - Proposed Projects under the Customer Engagement Platform Program

Year	Proposed Projects
2026	• MyAccount Enhancements and Projects ○ Interactive Digital Bill & Energy Management Tools • Implementation of Hydro Ottawa (.com) Redesign • Outage Communications Enhancements
2027	• 24/7 Chatbot • Outage Communications Enhancements • MyAccount Enhancements • Hydro Ottawa (.com) Enhancements
2028	• Outage Communications Enhancements • MyAccount Enhancements • Hydro Ottawa (.com) Enhancements
2029	• MyAccount Enhancements and Projects ○ Collections Self-serve Automation • Outage Communications Enhancements • MyAccount Enhancements and Projects • Hydro Ottawa (.com) Enhancements
2030	• Outage Communications Enhancements • MyAccount Enhancements and Projects • Hydro Ottawa (.com) Enhancements

3.7.2. Risks to Completion and Risk Mitigation Strategies

The risks to completion and mitigation strategies for the Customer Engagement Platform Program are outlined in Table 8.

Table 8 - Key Risks of Customer Engagement Platform Program and Mitigation Strategies

Risk	Mitigation
Planning and scope definition	Develop a comprehensive set of project plans with clear objectives, deliverables, timelines, and a risk management strategy.
Data Design and Availability	Plan for data availability, transformation and integration challenges early in the project and allocate sufficient resources to address them.
Resourcing	Ensure that the project team has the necessary technical and functional expertise to support project deliverables and ongoing support.
Level of change for employees and customers	Implement change management strategies to address employee responsibilities to ensure smooth transition of customers to new features and functionality.
Executive Support and Stakeholder Engagement	Maintain open communication with champions, stakeholders and steering committees to address concerns promptly.
Vendor Management	Selection and renewal of vendors with proven track records and establish clear expectations within contractual agreements.

A risk to completion of initiatives across the platform is the availability of internal and external resources to support the implementations. Each project within the plan will require internal expertise and support to ensure its successful completion. Limitations on internal resources due to competing projects, general availability, and any potential labor disruptions could impact the initial delivery timelines. Unforeseen major weather events and unexpected regulatory requirements may also have an impact should they occur within an individual project's development timelines. As each major endeavor of the Customer Engagement Platform is also dependent on external vendors, Hydro Ottawa will require that they are able to demonstrate their own redundancy capabilities through procurement processes.

Mitigating the availability of resources can be accomplished through careful planning and coordination of projects, ensuring that there is a backup for each role and working with vendors to plan for any unexpected delays caused by unforeseen events.

4. ENTERPRISE SOLUTIONS

4.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $5.7M (CAPEX)

2026-2030: $1.4M (CAPEX) $0.6M (OM&A)

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Efficiency and Productivity Improvements, Risk Mitigation Cost-Effectiveness, Enhanced Performance

Outcomes: Operational Effectiveness, Financial Performance

Hydro Ottawa's Enterprise Solutions team is responsible for the management of approximately 40 corporate business applications, including commercial-off-the-shelf, in-house developed, and cloud-based solutions. Central to the application portfolio is a large JD Edwards Enterprise Resource Planning (ERP) system providing core back-office functions such as Finance, Supply Chain, Job Costing, and Capital Asset Management. The ERP is heavily integrated with Workday Human Capital Management (HCM) which provides core HR, time management, and payroll services.

Annual investments are required to maintain these systems and deliver improvements by way of application upgrades, system enhancements, integration developments, and technology advancements. Remaining current with technology is imperative to secure vendor support, gain access to software upgrades and mitigate cyber security vulnerabilities. Additionally, Hydro Ottawa intends to implement business continuity management software, evolve Workday HCM with more self-service options and expand the IT Service Management solution. Together, these investments will enable Hydro Ottawa to optimize daily operations, streamline processes through reengineering, and bolster system resilience to mitigate risk and promote continuous improvement.

4.2. PERFORMANCE OBJECTIVES AND TARGETS

Modernizing applications within the Enterprise Solutions portfolio will accelerate progress toward the following objectives, as shown in Table 9:

Table 9 - Performance Objectives and Targets

Performance Outcome	Target
Operational Effectiveness	• Upgrading and enhancing applications will ensure its systems remain functional and relevant, supporting continuous operations and reliability.
	• Enhancements to applications will facilitate process efficiencies, optimize resource utilization, and enhance overall performance, effectively meeting organizational objectives.
	• Establish seamless communication and data consistency between applications through robust system integrations and workflows.
	• Strengthen cyber security defenses and safeguard sensitive information from threats and vulnerabilities.
Financial Performance	• Enable cost-effectiveness associated with prolonged support, break-fix scenarios, and emergency repairs by proactive upgrades.
	• Streamline IT infrastructure, optimize resource utilization, and enhance system agility by reducing the footprint of legacy applications.

4.3. PROGRAM DRIVERS AND NEED

4.3.1. Main and Secondary Drivers

Primary Driver: Business Operations Support

Secondary Drivers:

- Efficiency and Productivity Improvements: Upgrades will unlock new functionalities and capabilities, driving incremental improvement across the organization.
- Risk Mitigation: Modernize aging infrastructure and applications to improve reliability, business continuity, and disaster recovery. Maintain a solid cyber security posture by

minimizing vulnerabilities, safeguarding information and critical software assets.

- Cost-Effectiveness: Enable automation and integrations between new and existing systems to improve information flows and reduce manual effort. Modernized technology will simplify support requirements, allowing resources to be redirected to higher value activities.
- Enhanced Performance: Ensures that systems and operations are optimized, supporting a well-planned and capable workforce. Upgraded systems enable faster processing speeds, smoother multitasking, and improved application performance.

4.3.2. Current Issues

Modernizing and Replacing Outdated Systems

Addressing the retirement or technological obsolescence of legacy systems requires upgrades and/or migrations to new platforms

Adopting and Evolving Technologies

Keeping pace with industry advancements and meeting organizational needs through the adoption and evolution of new and existing technologies.

Process Gaps

Addressing inefficiencies in current processes is a significant challenge due to fragmented systems and silos, which leads to disconnected data flows and manual interventions.

Reliance on Manual Processes

Moving away from reliance on spreadsheets, ad hoc databases, and manual processes to more streamlined, automated solutions to enhance accuracy, reliability, and efficiency.

4.4. PROGRAM BENEFITS

4.4.1. Reliability and Aging Infrastructure

Proactively upgrading and modernizing technology will enable Hydro Ottawa to mitigate risks associated with cyber security, performance, cost-effectiveness, and business continuity.

4.4.2. Customer

Transform operations and enable more intuitive, user-friendly, and personalized experiences that improve customer satisfaction and engagement.

4.4.3. Digitization and Technology Evolution

Moving away from manual processes reliant on spreadsheets, ad hoc databases, and manual processes to more streamlined, automated solutions will minimize human error risk and improve collaboration.

4.4.4. Workforce Planning and Renewal

Enhanced self-service will empower employees to access and update their own information, increasing engagement. Access to real-time data allows for more agile and responsive workforce planning, allowing Hydro Ottawa to adapt quickly to changing needs.

4.4.5. Productivity and Innovation

- Unlock new features and functionality to drive innovation and process improvements.
- Modernized technology will allow Hydro Ottawa to automate more tasks, eliminate redundancies, and optimize workflows, creating significant gains in efficiency and productivity.
- Modern applications are designed to integrate seamlessly with other systems and technologies, facilitating better data exchange and collaboration.

4.5. PROGRAM COSTS

The Enterprise Solutions program will see a total investment of $1.4M (CAPEX) and $0.6M (OM&A) over the 2026-2030 rate period.

Table 10 - Enterprise Solutions Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 1.0	$ 1.2	$ 1.8	$ 1.0	$ 0.7	$ 0.2	$ 0.1	$ 0.9	$ 0.1	$ 0.1
OM&A	-	-	-	-	-	$ 0.1	$ 0.1	$ 0.2	$ 0.1	$ 0.2
ANNUAL TOTAL	**$ 1.0**	**$ 1.2**	**$ 1.8**	**$ 1.0**	**$ 0.7**	**$ 0.4**	**$ 0.2**	**$ 1.1**	**$ 0.2**	**$ 0.3**
5-YEAR TOTAL					**$ 5.7**					**$ 2.0**

4.5.1. Cost Factors

Estimates are formulated based on existing vendor agreements and insights gained from past projects and initiatives. However, it's crucial to acknowledge the potential impact of unknown regulatory pressures that could introduce additional unanticipated development costs. Furthermore, the scope of projects may expand due to emerging business requirements and pressures from vendors, necessitating flexibility in budget allocation and contingency planning to accommodate unforeseen expenses.

4.6. ALTERNATIVES EVALUATION

Each application within the portfolio is a vital component of an integrated landscape, with significant implications for functionality and data flow both upstream and downstream.

Effective management of technology risks and implementation of enhancements to achieve Hydro Ottawa's business objectives necessitate adequate funding. Collaborating with support partners is crucial to mitigate potential risks, maintain seamless operations, and allow continuous improvement.

Hydro Ottawa recognizes the indispensability of maintaining its corporate business applications. Given the interconnectedness of these applications and their critical role in supporting various business functions, investing in their upkeep and enhancements is imperative for sustaining operational efficiency, fostering innovation, and meeting demand from organizational growth.

4.6.1. Alternatives Considered

The impact of deferring or "doing nothing" for the Enterprise Solutions portfolio, including the JD Edwards ERP system and other major enterprise systems, could be significant. Without appropriate funding, the organization will face increased risks of system failures, security breaches, and operational inefficiencies. Adequate funding and investment prioritization in system maintenance and enhancements enable Hydro Ottawa to mitigate risks, seize opportunities, and position itself for long-term success in a rapidly evolving business landscape.

Risks associated without adequate funding, and their direct impact, are further detailed in Table 11.

1 **Table 11 - Enterprise Solution Program Alternatives Risks and Impacts**

Risk Category	Risk	Impact
Operational, Financial, Cyber Security	Delayed Refresh of Assets Driving Risks Associated with Software and Hardware Obsolescence	Increased maintenance costs, decreased system reliability, heightened cyber threats, system failures, data breaches, business disruptions, impacting customer satisfaction and revenue.
Operational, Business	Negatively Impact the Ability of Employees to Support Business Outcomes	Hindered ability to leverage JD Edwards ERP and integrated applications, missed opportunities, operational inefficiencies, decreased competitiveness.
Operational	Decreased Productivity Due to Prolonged Applications/Systems Gaps	Impeded workflow automation, collaboration, decision-making processes, manual workarounds, data discrepancies, project delivery delays, diminished productivity and efficiency.
Financial, Operational	High Unit Cost of Supporting and Servicing Applications	Escalated support costs, increased reliance on reactive measures, strained IT resources, inflated operational expenses, diversion of funds from strategic initiatives.
Operational, Vendor	Limited Vendor Support	Reduced access to updates, patches, technical assistance, prolonged issue resolution times, exacerbated system vulnerabilities, hindered adaptation to changing business needs.
Cyber Security, Regulatory	Lack of IT Security Controls	Heightened cyber security risks, data breaches, ransomware attacks, regulatory non-compliance, damaged reputation, eroded customer trust, financial losses, legal liabilities.
Operational, Business	Loss of System Integration and Data Consistency	Challenges in system integration, fragmented data silos, hindered communication between systems, reduced visibility, impacted decision-making, reduced business agility.
Financial, Operational	Risk of Project Delays and Cost Overruns	Project delays, cost overruns, missed deadlines, unmet business requirements, stakeholder dissatisfaction, affected project success, and realization of benefits.
Operational, Financial	Compromised Business Continuity and Disaster Recovery	Vulnerability to data loss, prolonged downtime, financial losses due to inadequate system maintenance and disaster recovery mechanisms.
Business, Strategic	Diminished Innovation and Adaptability	Stifled innovation, hindered ability to adapt to market trends, missed opportunities for differentiation and growth, impacted long-term sustainability and relevance.
Operational, Technical	Increased Operational Complexity and Technical Debt	Accumulation of technical debt, hindered system performance, scalability, maintainability, increased future upgrade costs and effort, reduced agility.

4.6.2. Evaluation Criteria

The alternative of not maintaining the Enterprise Solutions application portfolio is deemed impractical, as all business applications must continuously evolve alongside the dynamic landscape of the business itself. Standing still in technology equates to falling behind, and without ongoing evolution, the applications risk becoming outdated, hindering operational efficiency, innovation, and desired business outcomes.

4.6.3. Preferred Alternative

Hydro must maintain its existing portfolio of business applications to mitigate risk and support business outcomes.

4.7. PROJECT EXECUTION AND RISK MITIGATION

4.7.1. Implementation Plan

The Enterprise Solutions program outlines strategic investments aimed at proactively enhancing its technology landscape to support organizational growth, efficiency, and resilience. These investments are carefully prioritized to align with business objectives and address anticipated challenges, rather than reactively managing issues as they arise. The plan includes:

- **Annual Investments**: Focused on proactive software upgrades, implementation of new capabilities, strengthening system resilience, and optimizing processes.
- **Planned Enhancements**: The portfolio encompasses regular evaluations and updates to key systems such as JD Edwards (ERP), Salesforce, ServiceNow, and Workday, and Copperleaf C55, ensuring alignment with evolving business requirements.
- **Optimized Financial and Operational Management**: Investments to streamline financial and procurement processes, improve system integrations, and deliver a superior user experience.

Additionally, some focus areas include:

Implementation of New Business Continuity Software: A 6-month initiative to implement

BCM software that will support the preparation and management of documentation, plan and exercise implementation and action tracking. With an increase in the severity, duration and variation in types of disruptive events facing the organization, an associated increase in plan development and action management has occurred and requires a solution to consolidate and manage these items across the organization.

Evolution of Workday Human Capital Management : A six-month initiative to streamline and automate HR processes to increase efficiency, reduce manual intervention, and improve the overall employee experience. This includes automating routine tasks, implementation of more self-service tools and resolution of existing pain points.

Expansion of ServiceNow ITSM Platform: An eight-month effort focused on increasing IT service management capabilities, enhancing automation, and driving efficiency in IT operations.

Planned Upgrades and Legacy Technology Replacements: Over the 2026-2030 rate period, Hydro Ottawa will take a phased approach to upgrading or replacing aging technology, prioritizing critical systems that impact finance, HR, and customer service functions.

This structured approach ensures Hydro Ottawa not only maintains but also continuously improves the internal technology ecosystem to stay ahead of industry advancements and organizational needs.

4.7.2. Risks to Completion and Risk Mitigation Strategies

The risks to completion and mitigation strategies for the Enterprise Solutions program are outlined in Table 12.

1 **Table 12 - Key Risks of the Enterprise Solutions Program and Mitigation Strategies**

Risk	Mitigation
Resource Constraints	Implement detailed resource management plans, including internal staff training and upskilling, to reduce reliance on external vendors.
Vendor Management	Establish clear Service Level Agreements (SLAs) with vendors and engage in regular communication to mitigate scheduling risks and ensure timely service delivery.
Cost Control	Maintain a contingency budget and implement cost tracking mechanisms to monitor expenditures and address potential overruns promptly.
Cyber Security	Incorporate robust cyber security protocols, including regular vulnerability assessments, penetration testing, and vendor security checks, to mitigate risks during integrations and upgrades
Business Continuity Planning	Develop and test comprehensive business continuity and disaster recovery plans to minimize operational disruptions during system updates.
Change Management	Create a technology roadmap to prioritize upgrades and system enhancements, ensuring critical systems remain current and functional.

5. DATA AND SYSTEM INTEGRATIONS

5.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $1.6M (CAPEX)

2026-2030: $3.5M (CAPEX) and $0.5M (OM&A)

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Risk Mitigation, Scalability and Performance, Process Automation, Efficiency, Improved Customer Experience, Agility and Innovation, Regulatory Compliance, Data-Driven Culture and Decision Making

Outcomes: Operational Effectiveness, Financial Performance, Organizational Efficiency

Hydro Ottawa's Data and System Integrations program is focused on the management of corporate databases, system integration technologies, and data warehouse activities across the application landscape. These components are foundational in enabling Hydro Ottawa to sustain daily operations; deliver on strategic initiatives; and improve the quality, accessibility, and maturity of data across the enterprise. Recognizing the critical importance of transactional databases to Hydro Ottawa's operations, a robust infrastructure was implemented in the historical period to ensure its reliability, performance, and security.

Transactional databases are hosted on state-of-the-art, engineered systems with a purpose-built platform designed to deliver optimal performance for demanding workloads. These systems, which are both on-premise and cloud-based, must exchange information effectively. This is currently done automatically via multiple integration technologies established over the years, Oracle Data Integrator (ODI) being the primary. The Oracle components will be reaching end-of-life in 2027 and need to be replaced to mitigate risks associated with hardware failures and software obsolescence.

The plan aims to transition away from ODI, instead consolidating information flows on a single, modernized integration platform with redundancy and performance in mind. Improving the security posture of integrations, taking advantage of innovation and new functionality, enabling better monitoring and handling of exceptions are desirable and part of the plan.

Finally, Hydro Ottawa's Data and System Integrations program will focus on use-case automations to break down transactional silos, unlock powerful insights, identify trends, predict maintenance needs, optimize energy distribution, and enable better business intelligence. By ensuring the integrity, accessibility, and integration of data, Hydro Ottawa will drive informed decision-making, deliver exceptional customer experiences, and drive innovation in the energy sector.

5.2. PERFORMANCE OBJECTIVES AND TARGETS

Table 13 - [Performance Objectives and Targets]

Performance Outcome	Target
Operational Effectiveness	• Increase data availability across the application landscape
	• Unlock operational efficiencies through integrations and workflows
	• Reduce integration risks through upgrades and enhancements
	• Maintain Regulatory compliance
	• Better application programming interfaces (APIs)
	• Integrated cyber security and privacy by design
Financial Performance	• Reduce integration costs by eliminating legacy platforms
	• Lower IT infrastructure costs and optimize return on investment
Organizational Efficiency	• Improve data quality and awareness
	• Enhance collaboration through data integration
	• Enable data-driven decision-making
	• Improve overall business intelligence
	• Focus on continuous improvement

5.3. PROGRAM DRIVERS AND NEED

5.3.1. Main and Secondary Drivers

Primary Driver: Business Operations Support

Secondary Drivers:

- Scalability and Performance: Real-time data processing and streaming, implementation of robust data ingestion pipelines and diverse data sources (e.g., smart meters, sensors).
- Data Silos and Fragmentation: Break down of transactional silos, enabling data sharing and collaboration.
- Process Automation and Efficiency: Automate manual tasks and streamline workflows to reduce errors and improve productivity.
- Improved Customer Experience: Integrate customer data from different sources to build a 360-degree view of customers, enabling personalized interactions and better service.
- Agility and Innovation: Connect new applications and services, supporting innovation and adapting to market changes.
- Regulatory Compliance: Integration platforms help meet compliance requirements by ensuring appropriate data security and privacy.
- Risk Mitigation: Stay current with technology and mitigate the risks associated with obsolescence.
- Data-Driven Culture and Decision Making: Promote data sharing and collaboration, enabling teams across different departments to leverage data insights for improved outcomes.

5.3.2. Current Issues

Some of the current issues are as follows:

- Transactional databases are nearing end-of-life and require hardware refreshes.
- Transactional database application components require a technology upgrade to avoid obsolescence and to maintain vendor support.
- Legacy integration platform must be phased out due to obsolescence.
- Desire to implement an enhanced security posture and functionality to system integrations.

- Desire to raise and manage integration incidents into the IT Service Management system (ServiceNow) before they manifest as larger service disruptions.
- Desire to implement various use-case automations to improve business intelligence, generate customer insights, enable self-service capabilities and drive increased data maturity across the enterprise.

5.4. PROGRAM BENEFITS

5.4.1. Reliability and Aging Infrastructure

Proactively upgrading and modernizing technology will enable Hydro Ottawa to mitigate risks associated with cyber security, performance, cost-effectiveness, and business continuity.

5.4.2. Resilience and Climate Change Adaptation

Data-driven insights on assets and operations enable informed choices about resource allocation, infrastructure development, and environmental regulations.

5.4.3. Customer

Transactional databases and integrations enable critical customer data to flow to and from the billing system, customer portal, and outage communications system that are foundational to Hydro Ottawa service offerings. Data warehouses enable customer segmentation and targeting, which enhance the customer experience and power self-service analytics.

5.4.4. Cost Control and Rate Mitigation

Aligning to a single, modern integration platform will improve productivity through the reduction of manual intervention needed between systems, control maintenance costs by reducing the number of systems requiring maintenance, and optimize infrastructure costs by eliminating the need for on-premise software that becomes obsolete in a short timeframe.

5.4.5. Digitization and Technology Evolution

Modernized data warehouse platforms provide Predictive Analytics, AI and modeling capabilities to rapidly automate use case scenarios. A modern integration platform will allow for more effective use and management of APIs to improve overall productivity and efficiency in daily operations.

5.4.6. Productivity and Innovation

Automation of manual and/or repetitive tasks improves resource utilization and streamlines operational processes. Data warehouses streamline data access, promote data governance and data quality practices fueling collaboration, insights and innovation.

5.4.7. Energy Transition and Electrification

Data warehouses support sophisticated analytical tools and modeling techniques to uncover hidden trends, patterns, and anomalies to unlock within Hydro Ottawa's energy data.

5.5. PROGRAM COSTS

The Data and System Integrations program cost over the 2026-2030 rate period is $3.5M CAPEX and $0.5M OM&A.

Table 14 - Data and System Integrations Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 0.0	$ 0.3	$ 0.4	$ 0.4	$ 0.4	$ 0.8	$ 0.6	$ 0.5	$ 0.5	$ 1.1
OM&A	-	-	-	-	-	$ 0.1	$ 0.1	$ 0.1	$ 0.1	$ 0.1
ANNUAL TOTAL	**$ 0.0**	**$ 0.3**	**$ 0.4**	**$ 0.4**	**$ 0.4**	**$ 0.8**	**$ 0.7**	**$ 0.5**	**$ 0.5**	**$ 1.2**
5-YEAR TOTAL					**$ 1.6**					**$ 3.7**

5.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations from reputable vendors to inform the budget proposed, including:

- Purchase of licenses and subscriptions
- Vendor services to implement and/or develop software
- Internal labor costs
- System monitoring (OM&A)

5.6. ALTERNATIVES EVALUATION

Transactional databases are the storage engines behind modern business applications and must be upgraded to avoid the risks associated with obsolescence, including cyber security concerns. Likewise, integration technology facilitates critical information flows between systems and this automation is key to productivity and efficiency gains. Existing integrations must be maintained and new integrations will be built to support future business objectives.

There is no suitable alternative as these existing platforms and assets are foundational in sustaining business operations. Further, Hydro Ottawa has invested in Snowflake, a cloud based data warehouse platform, purpose built for use case automations and to bolster both business intelligence and enterprise data maturity. The platform was chosen in 2018 after a comprehensive study of the market and was deemed as a best fit for Hydro Ottawa requirements. Further use case automations are planned in the near future.

5.6.1. Alternatives Considered

Hydro Ottawa's existing transactional databases, system integrations, and data warehouse program are foundational components necessary to sustain business operations. A deferral or "do nothing" approach could result in the realization of the risks outlined in Table 15.

Risks associated with adequate funding, and their direct impact, are further detailed in Table 15.

Table 15 - Data and System Integration Program Alternatives Risks and Impacts

Risk Category	Risk	Impact
Operational	Data silos and inconsistency	When integrations break down, data may not flow seamlessly between systems, leading to outdated or conflicting information. This hampers decision-making and can result in costly errors. Without a centralized data warehouse repository, data remains scattered across various systems and departments, creating silos that hinder access and analysis.
Operational	Data loss and corruption	Unmaintained databases and integrations may lead to lost or corrupted data, impacting application performance, reporting, analytics, and overall business intelligence.
Regulatory	Compliance and Security Risks	Outdated databases and integrations may not adhere to evolving security standards, increasing the risk of data breaches and regulatory non-compliance.
Operational	Technical debt	Neglecting database and integration maintenance can create a backlog of technical debt, making future updates and improvements even more challenging and expensive.
Operational	Hindered innovation and growth	Data warehouses are essential for enabling advanced analytics, such as machine learning and predictive modeling. Data warehouses provide the agility and flexibility needed to adapt to changing market conditions.
Operational	Impaired Decision-Making and Missed Opportunities	Hampers the ability to perform complex queries, trend analysis, and data mining. This limits the organization's ability to derive actionable insights and identify growth opportunities.

5.6.2. Evaluation Criteria

Hydro Ottawa transactional databases, integration technologies, and data warehouse platforms must be maintained and evolved to meet business objectives. These technologies are actively in use today and integrated into core business processes across Hydro Ottawa. There is no viable alternative without stagnating and introducing additional business risk.

5.6.3. Preferred Alternative

Hydro Ottawa's existing transactional databases, system integrations, and data warehouse program are foundational components and must be maintained to sustain business operations

5.7. PROGRAM EXECUTION AND RISK MITIGATION

5.7.1. Implementation Plan

Hydro Ottawa's transactional database predominantly uses Oracle technology and will be end-of-life in 2027. Recognizing the critical importance of transactional databases to Hydro Ottawa's operations, software upgrades will be required to ensure continued access to critical updates, security patches, and technical support. These upgrades will not only extend the lifespan of transactional databases but also unlock access to new features and enhancements to further optimize operations. To mitigate risks associated with hardware failures and obsolescence, a hardware refresh is planned in conjunction with the database software upgrades.

Hydro Ottawa uses a legacy integration platform based on ODI, which manages critical information flows to and from the metering systems, Customer Care & Billing system, bill print provider, and third-party systems. Oracle has advised that the ODI product will be end-of-life in 2027. Therefore, Hydro Ottawa will transition away from ODI migrating these interfaces to Boomi - a modernized data integration platform - that will simplify and streamline integration processes to better connect and collaborate.

Enhancements will be made to improve the security posture of integrations - not limited to API management, but also better encryption protocols, better identity/role-based access management, and exception reporting. Hydro Ottawa intends to integrate the Boomi platform with the IT Service Management system (ServiceNow) to provide timely visibility and collaboration on negative system events (e.g. low disk space, poor performance, failed transactions) that require human intervention to correct. Proactive monitoring and capture of these events early will minimize service disruptions and create a positive customer experience.

Finally, Hydro Ottawa has adopted Snowflake as a centralized data platform for analytical, business intelligence (BI), and reporting purposes. This cloud-based data warehouse platform offers scalability, flexibility, and powerful analytical capabilities, enabling valuable insights from the wealth of company data to be discovered. Visualization tools such as Tableau are utilized by information workers to create interactive dashboards and reports for effective data communication. Hydro Ottawa will continue to identify, prioritize and automate various use-case opportunities, driving efficiency gains and productivity improvements to unlock value for the organization and its customers.

More specifically:

- Hydro Ottawa will upgrade transactional database and system integration technology in alignment with a vendor obsolescence roadmap and will procure new hardware as needed.
- The legacy ODI platform will be decommissioned after all integrations have been successfully migrated over to the modernized Boomi integration platform in 2026.
- A new, enhanced security posture will be implemented to bolster integration cyber security efforts, minimize maintenance overhead, improve reusability through APIs, and enable more granular security controls.
- System events from database and integration monitoring will be captured and recorded into ServiceNow to be visible, trackable and actioned before they manifest as larger service disruptions.
- The data warehouse program will see various use case automations to improve business intelligence, generate customer insights, enable self-service capabilities, and drive increased data maturity across the enterprise.

5.7.2. Risks to Completion and Risk Mitigation Strategies

Table 16 below summarizes the key risks of the data and system integrations program.

Table 16 - Key Risks of the Data & System Integrations Program and Mitigation Strategies

Risk	Mitigation
Resource availability	Hydro Ottawa will need to ensure appropriate IT, vendor and business resources are available to support technology upgrades and use case automations.
Competing priorities	Hydro Ottawa will prioritize initiatives that could create business risk and/or negatively impact daily operations.

5.7.3. Other Factors

A few factors that may influence database and integration technology upgrades will be determined by:

- Vendor obsolescence timing
- Business resource availability
- New projects with technology dependencies

Data warehouse activities will be influenced by business needs, size and complexity, cost, technology considerations, and business resource availability.

6. GRID TECHNOLOGY

6.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $2.0M (CAPEX)

2026-2030: $4.3M (CAPEX) and $1.5M (OM&A)

Budget Program: Operations Initiatives

Main Driver: Business Operations Support

Secondary Driver: Grid Modernization

Outcomes: Operational Effectiveness

Hydro Ottawa's Grid Technology program is responsible for the management of systems that complement operations processes in System Service, System Renewal, and System Access. To ensure operational excellence and regulatory compliance, investment in technology infrastructure is essential. This commitment encompasses regular application upgrades, system enhancements to optimize performance and functionality, seamless integrations across platforms, and the adoption of emerging technologies to enhance efficiency and security. Key business functionality supported by this program are:

Network Visualization and Asset Register

The Geographical Information System (GIS) is the repository for Hydro Ottawa's electrical distribution network as well as an aggregation point for multiple sources of geographic data including asset location, service territory and ward boundaries, and land registry information such as property data and easement mapping. This system integrates with several key Hydro Ottawa systems including the Customer Care & Billing system for premise information. The electrical distribution network model serves as the foundation on which the Outage Management System (OMS) understands the connectivity of the electrical grid and predicts associations between individual outage reports and the fault locations.

Electrical distribution network model visualization and asset register functionality provided by GIS also supports design efforts considering factors like terrain, land use, and environmental impact.

Data Collection and Analytics

The Planning Historian is used for collecting and storing data related to the operation of the electrical distribution grid. This system is an important tool to allow performance monitoring, analytics, trend identification, and quality assurance of grid performance. It also serves as a key source of data for the asset management business process outlined in Schedule 2-5-4 - Asset Management Process as well as the Enterprise Asset Management system outlined in Section 3 of Attachment 4-1-1(A) - Transition to Cloud Computing.

This system must not only meet operational availability and reliability needs, but also scale substantially between 2026 and 2030, growing from tens of thousands of field devices in 2025 to hundreds of thousands by 2030. This increase in field devices is being driven by the introduction of intelligently-connected sensors to amplify grid observability and improve grid controllability as discussed in Section 2.3.3 of Schedule 2-5-1 - Distribution System Plan Overview as well as in Section 5 of Schedule 2-5-7 - System Renewal Investments.

Network Modeling and Simulation

This system creates detailed models of the electrical distribution network, like topology (representation of lines, transformers, switches, etc.) and electrical characteristics such as impedance, resistance and capacitance. It also provides simulation functionality for steady-state fault analysis and dynamic analysis to understand the grid's response to disturbances and transient events. This tool aids in capacity planning, voltage regulation, and protection coordination.

Additional modules and feature functionality will be required in the 2026-2030 rate period to address the changing needs of load forecasting and effectively respond to the expanding grid capacity requirements as well as increases in connection requests discussed in Section 2.3.1 of Schedule 2-5-1 - Distribution System Plan Overview.

6.2. PERFORMANCE OBJECTIVES AND TARGETS

Hydro Ottawa employs KPIs to measure and monitor its performance. The Grid Technology program is expected to lead to improvements in the KPI metrics detailed in Table 17.

Table 17 - Performance Targets for Grid Technology Program

Performance Outcome	Target
Operational Effectiveness	● Appropriate system architecture design and regular upgrades ensures these systems maintain a 99.0% uptime with a maximum allowable downtime of 8 hours and maximum allowable data loss of 24 hours in the event of a failure. ● Facilitate operational efficiencies through digitization and automation of network modeling, simulation and visualization to enhance overall performance and effectively meeting organizational objectives. ● Enhance data-driven decision-making by consolidating data and leveraging analytics and tools to enhance visibility of grid asset performance and electrical network modeling and simulation.

6.3. PROGRAM DRIVERS AND NEED

6.3.1. Main and Secondary Drivers

Primary Driver:

Business Operations Support; this program supports core business processes such as Distribution Asset Management, System Access, System Renewal, and System Service. Investing in this program will facilitate faster, more accurate planning, design and maintenance of the electrical distribution grid supporting grid modernization objectives of enhanced reliability, adaptive grid flexibility, fortified resilience, and robust security.

Secondary Drivers:

- Scalability and Performance: enhancing data historian and simulation tools to include additional data sources (e.g., smart meters, sensors).

- Support the Enterprise Asset Management System: The Grid Technology systems are key sources of information for the Asset Management System. These systems track the geographic location and key health information of a particular asset.
- Process Automation and Efficiency: Automate manual tasks and streamline workflows, reducing errors and improving productivity.
- Faster Decision-Making: Implementing solutions to automate capacity calculations that will assist the planning process.
- Agility and Innovation: Position Hydro Ottawa to adapt to the energy transformation.
- Risk Mitigation: Stay current with technology and mitigate the risks associated with obsolescence.

6.3.2. Current Issues

The Grid Technology program aims to address the following challenges:

- **Meeting the Energy Transition & Electrification Demands:** The use of spreadsheets to track capacity and calculate offloading and rebalancing of electricity is inefficient and error-prone. It leads to suboptimal resource allocation and missed economic development opportunities due to an inability to respond in a timely fashion to connection requests. Improvements to the Data Collection and Analytics and Network Modeling and Simulation initiatives will eliminate the spreadsheets by incorporating this function within existing systems. This will reduce manual efforts and increase the speed of assessing, and responding to, connection requests.
- **Data Requirements Exceed Current Capacity:** The existing Planning Historian has a limitation on the number of data points it can track. Expanding it for AMI integration is necessary to capture a comprehensive view of grid operations. Upgrades planned to this solution will allow the system to ingest and manage the increase in data volume created by AMI 2.0.
- **Lengthy, Manual Processes:** Systems that support planning and design are fragmented and do not address the evolving needs of the business. This creates a lengthy, manual

process which limits peak load calculations to twice per year (winter and summer) and inhibits Hydro Ottawa's ability to respond to capacity requests in a timely, efficient manner.

- **Technical Obsolescence:** Outdated IT systems can cause disruptions in operations, escalating support costs, and prevent the adoption of new capabilities that deliver operational efficiency to meet the evolving needs of customers.
- **Data Accuracy:** Limited data validation is conducted at present on the electrical connectivity model, which makes future automation solutions challenging. Enhancements to the network visualization system to include automated data validation, as well as additional tools to integrate and automate fragmented systems in this space, will address data accuracy and better inform decision-making.
- **Changing Environment:** Ottawa has experienced several significant weather events over the 2021-2025 rate period. Digitizing and integrating grid capacity information will streamline decision-making in complex restoration scenarios.

6.4. PROGRAM BENEFITS

By consolidating and expanding spatial and asset performance data, and strengthening simulation tools, the utility can enhance grid visibility, improve planning and analysis, and automate tasks. This leads to:

6.4.1. Improved Distribution Model Accuracy

This program aims to improve the design-to-energization process by consolidating and enhancing tools that will reduce manual effort as well as the time between energization in the field and distribution model updates.

6.4.2. System Operation Efficiency and Cost Effectiveness

This program is a set of continuous operational technology platform upgrades and enhancements. Therefore, it is expected that the benefits from the program will increase over time as the upgrades and enhancements are deployed.

Data improvement will help to make better decisions to improve grid reliability and reduce downtime through predictive maintenance and improved operational insights. The integration and automation of these processes is expected to improve data quality and access to advanced planning and simulation capabilities.

6.4.3. Reliable Solutions to Power Advanced Applications

Using the latest software platforms, engineers and designers can rely on accurate information to make data-driven decisions on technical aspects of projects.

The program will ensure that the software infrastructure can support the integration of new technologies, such as smart meters, renewable energy sources, and advanced grid control systems. It will prioritize the security and integrity of all data managed by these software systems, implementing robust cyber security measures to protect against threats.

By improving data accuracy, grid visibility, and predictive capabilities, the program will contribute to a more stable and resilient grid and operational efficiencies. Through data analysis and simulation, the program will help optimize grid performance, reduce costs, and improve efficiency.

6.4.4. Cyber Security

The program will prioritize the security and integrity of all data managed by these software systems, implementing robust cyber security measures to protect against threats.

6.4.5. Economic Development

Energy transition and electrification is an emerging component of economic development within the City of Ottawa. Digitizing and centralizing design and engineering processes will invariably help support streamlined decision-making for those interested in building electrification, EV charging infrastructure, and DERs as well as larger commercial development opportunities such as data centers.

6.5. PROGRAM COSTS

The historical period represents the purchase and installation of the different operation technology software platforms. The future costs are to maintain these platforms using IT best practices for system upgrades and refreshes as well as the targeted implementation of enhancements to provide scalability and enable Hydro Ottawa to respond to the demands of the growing nation's capital.

Table 18 - Grid Technology Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 0.5	$ 0.2	$ 0.4	$ 0.4	$ 0.4	$ 1.1	$ 0.9	$ 1.0	$ 0.6	$ 0.6
OM&A	-	-	-	-	-	$ 0.3	$ 0.3	$ 0.3	$ 0.3	$ 0.3
ANNUAL TOTAL	**$ 0.5**	**$ 0.2**	**$ 0.4**	**$ 0.4**	**$ 0.4**	**$ 1.4**	**$ 1.2**	**$ 1.3**	**$ 0.9**	**$ 0.9**
5-YEAR TOTAL					**$ 2.0**					**$ 5.7**

6.5.1. Cost Factors

The largest singular factor which has driven adjustments to costs is the recent industry adoption of term licensing models in lieu of the standard perpetual licensing models. Term licensing restricts the life of the license to a defined period and bundles additional services such as access to free upgrades which otherwise would have been forecasted separately. Hydro Ottawa has limited control over changing licensing models, but cost optimization is a key component of solution selection and contract renewal negotiation with vendors.

6.6. ALTERNATIVES EVALUATION

6.6.1. Alternatives Considered

Alternative One - Do Nothing: Run to failure and address issues as they arise. Not upgrading can lead to a cascade of negative outcomes that impact various aspects of Hydro Ottawa's business.

- **Increased operations and cyber security risks**: The risk of software failure increases as upgrades are delayed. When failure occurs, downtime is prolonged and can impact Hydro Ottawa's ability to execute key business mandates. Outdated software also leaves vulnerabilities unaddressed, potentially leading to outages, equipment damage, data breaches, and safety hazards. This risk grows exponentially as systems age and vulnerabilities are discovered.
- **Compliance challenges**: Using outdated software may make it difficult to comply with evolving regulatory requirements for grid reliability, cyber security, and data protection, incurring penalties.
- **Inefficient grid operations**: This leads to slower outage response, higher energy losses, difficulty integrating renewable energy sources, and challenges in meeting growing demand, ultimately impacting customer satisfaction and grid reliability.
- **Missed opportunities**: Neglecting upgrades means missing out on new features, functionalities, and improvements that could enhance efficiency, optimize the grid, and support innovation.
- **Increased technical debt**: Delaying regular upgrades and maintenance may provide short term benefits by reducing immediate costs, but it invariably makes future modernization efforts more complex and costly.

Alternative Two - Maintain: Upgrade software when it reaches end-of-life, do not optimize or integrate. While this option addresses supportability and cyber security, it does not position Hydro Ottawa to respond to the energy transformation or enable it to responsibly manage labour or asset costs. The potential outcomes of this alternative include:

- **Improved individual system performance**: Incremental benefits gained through feature enhancements included in upgrades, and maintenance of cyber security posture.
- **Operational inefficiencies**: Several challenges have been outlined related to automation and integration which will not be addressed by this alternative.
- **Reduced ability to leverage data**: Data remains isolated in separate systems, limiting comprehensive analysis, identification of trends, and extraction of valuable insights for

decision-making.

- **Hindered innovation:** This approach restricts Hydro Ottawa's ability to leverage the full potential of its software and data, hindering innovation and the adoption of new technologies like AI and machine learning for grid optimization.
- **Increased complexity and costs in the long run**: Maintaining multiple standalone systems is economically inefficient and it contravenes basic TOGAF principles.

Alternative Three - Accelerated: Adopt a future-focused program that addresses business process inefficiencies caused by disparate or incomplete technical solutions and positions Hydro Ottawa to respond to the energy transformation. This alternative will upgrade solutions to the latest versions, integrate and unify solutions to support planning, design and simulation to improve operational efficiency, security, and overall performance. The potential outcomes of this alternative include:

- **Improved system performance and security**: Newer versions often come with performance enhancements, bug fixes, and new features, improving the efficiency and reliability of individual systems. Upgrading to the latest versions ensures that Hydro Ottawa core software has the latest security patches, minimizing vulnerabilities and strengthening defenses against cyberattacks.
- **Enhanced data accessibility and analysis**: Integrating with GIS allows Hydro Ottawa to leverage spatial context and visualize data from various sources, producing better analysis, informed decision-making, and optimized grid operations.
- **Streamlined workflows**: Consolidating software and moving functionalities to existing systems reduces complexity, eliminates redundancies, and streamlines workflows, leading to improved productivity and reduced manual effort.
- **Increased efficiency and cost savings**: Optimizing processes and automating tasks through integration and consolidation can lead to better resource utilization and cost savings.
- **Improved innovation and agility**: A modernized and integrated software environment

allows for better data analysis, supporting innovation and faster adaptation to changing business needs.

- **Increased Initial investment**: Implementing integration and consolidation projects requires an upfront investment in planning, development, and potentially new software licenses or customization.
- **Temporary disruption**: Integrating and consolidating systems can cause temporary disruptions to operations as employees adjust to new workflows and systems.
- **Change management challenges**: Successfully implementing integration and consolidation requires careful change management to ensure employee buy-in and adoption of new processes.

6.6.2. Evaluation Criteria

System Reliability

This criterion assesses the system's ability to meet service level agreements and provide the required level of availability and ensure potential data loss does not exceed acceptable limits. System upgrades aim to reduce the probability and impact of system failures by addressing aging infrastructure and application versions.

Operational Efficiency

This criterion considers the alternative's ability to position Hydro Ottawa to "do more, more quickly" in response to increasingly complex demands. Incorporating automation reduces manual effort and improves efficiency. Facilitating data analysis and visualization enables informed decision-making and grid optimization.

Enabling The Energy Transition

This criterion assesses the alternative's ability to address the anticipated rise in electrification within the community, including the adoption of electric vehicles, heat pumps, renewables, and light rail transit. Increased densification and other demands on the electricity grid require efficient data-driven decisions.

6.6.3. Preferred Alternative

The preferred alternative is to adopt a responsible but future-focused program which involves the integration and enhancement of Hydro Ottawa software, including simulation tools, data historians for planning, and GIS, along with upgrading and maintaining those systems. This strategy fosters a holistic view of the grid by breaking down data silos and integrating information from various sources, especially leveraging GIS. This creates design efficiencies, improved situational awareness, better-informed decision-making, and optimized grid operations. It enhances efficiency and productivity by streamlining workflows, automating tasks, and fostering collaboration among departments. Finally, upgrading and maintaining these systems ensures that they remain secure and reliable, minimizing vulnerabilities and maximizing uptime.

This approach promotes innovation and adaptability by enabling Hydro Ottawa to leverage the latest technologies and data-driven insights to meet the evolving demands of the energy landscape. By embracing this comprehensive strategy, Hydro Ottawa can achieve cost savings, improve grid reliability, and better serve its customers while positioning itself for a successful future.

6.7. PROGRAM EXECUTION AND RISK MITIGATION

6.7.1. Implementation Plan

The Grid Technology program will be executed between 2026 and 2030. Investments in this program are carefully prioritized to align with business objectives and support distribution engineering and asset management processes. The plan includes:

- **Annual Investments**: Focused on proactive software upgrades, implementation of new capabilities, strengthening system resilience, and optimizing processes.
- **Planned Enhancements**: The program encompasses regular evaluations and updates to key grid operations systems ensuring alignment with evolving business requirements.

Table 19 shows key projects proposed for the 2026-2030 rate period, as a part of the Grid Technology program.

Table 19 - Proposed Projects under the Grid Technology Program

Year	Proposed Projects
2026	• Planning Historian upgrade and integration of AMI data
2027	• Network modeling and simulation feature extension • Digitization of electrical grid planning and design processes
2028	• Network modeling and simulation feature extension • Integration of operational design tools with the geographical information system
2029	• Extension of geographical information system module and integration
2030	• Network simulation enhancement • Extension of grid simulation and modeling capabilities

6.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its Grid Technology program. Table 20 outlines the key risks and corresponding mitigation strategies:

1 **Table 20 - Key Risks of the Grid Technology Program and Mitigation Strategies**

Category	Risk	Mitigation
Business Requirements and schedule	Changing business requirements or schedules can complicate project planning and increase costs.	Maintain flexibility in project designs and budgets. Regularly engage with business to anticipate and adjust for changes, ensuring resource availability and mitigating delays.
Financial Impact	Cost overruns or budget shortfalls may occur due to unexpected expenses. This may be a result of changing software licensing models affecting operating vs. capital investment as well as asset life.	Develop detailed budgets with contingencies and monitor financial performance closely throughout the project lifecycle.
Project Management	Poor project management could lead to delays or inefficiencies.	Utilize experienced project management resources and tools to track progress, manage resources, and maintain timelines.
Resource Availability	Shortages in skilled labor may hinder project progress.	Plan resource needs well in advance and maintain strong relationships with suppliers and contractors to secure reliable access to critical resources.
Rapidly Evolving Technology Landscape	Technology obsolescence, interoperability and security vulnerabilities and new as yet, unknown functionality drive changes to scope, cost and schedule.	Adopt flexible, modular systems to allow for easier upgrades and interoperability. Prioritize cyber security, and develop and regularly maintain a technology roadmap.

7. CONNECTION COST RECOVERY AGREEMENT

7.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $17.0M

2026-2030: $45.9M

Budget Program: CCRA Program

Main Driver: System Investment Support

Secondary Driver: Capacity Constraints

Outcomes: Customer Focus, Operation Effectiveness, Public Policy Responsiveness

The Connection Cost Recovery Agreement (CCRA) program is comprised of capital contributions paid (or to be paid) by Hydro Ottawa to Hydro One, the transmitter, in accordance with cost responsibility requirements under the Transmission System Code, for upgrades on Hydro One's transmission system which will support capacity investments to support Hydro Ottawa customers. The TSC includes an economic evaluation methodology which determines, for the transmission work that is Hydro Ottawa's responsibility, whether expected incremental revenues over the applicable time horizon will be sufficient. To the extent the economic evaluation methodology identifies a shortfall in the expected revenues, Hydro Ottawa is required to pay a capital contribution pursuant to a CCRA with Hydro One.

The CCRA program includes investments for transmission upgrades required to remove equipment limitations and leverage planning capacity in existing Hydro One/Hydro Ottawa owned stations as well as build adequate transmission capacity to supply new stations being planned for energization until 2030. Listed below are the new and ongoing transmission upgrades in which Hydro Ottawa will be required to make a contribution towards the upgrade through a DCF mechanism:

- Hydro Road MTS CCRA - New 44kV station

- Mer Bleue MTS CCRA - New 28kV station in the East 28kV region
- Kanata North MTS CCRA - New 28kV station in the West 28kV(North) region
- Greenbank MTS CCRA - New 28kV station in the South 28kV region
- Cyrville upgrade - Addition of capacity to existing 28kV station and convert station supply from 115kV to 230kV
- Bronson DS upgrade CCRA - Conversion from an existing 4kV to a 13kV station in the Core 13kV region
- Removal of equipment limitations such as cables and breakers and/or transformer replacements at Hydro One owned stations of Carling TS, King Edward TS, Lisgar TS
- Switchgear renewals at Hydro One owned stations- Hinchey TH and Russell TB

In total, Hydro Ottawa plans to invest an estimated $45.9M under the CCRA program in the 2026-2030 rate period compared to a historical spending of $17.0M in the 2021-2025 period. The implementation of the Capacity Upgrades program and the CCRA Program will result in an increase of over 811MVA in station capacity to the Hydro Ottawa distribution system.

7.2. PERFORMANCE OUTCOMES

Table 21 outlines the expected performance outcomes associated with the CCRA program supporting the System Capacity program. It details how these programs are expected to impact operational effectiveness, customer focus, and public policy responsiveness measures.

Table 21 - Performance Outcomes for CCRA Program

OEB Performance Outcomes	Outcome Description
Customer Focus	Hydro Ottawa's Customer Focus objectives are supported by: ● Increasing system capacity by 811MVA through new station construction and associated new distribution circuits, upgrades to limiting station cables, and BESS unit installations. ● Improving DER hosting capacity by installing substation transformers that have been designed to accommodate injection of renewable energy into the grid.
Operational Effectiveness	Hydro Ottawa's reliability objectives are supported by: ● Contributing to the improvement of reliability metrics by increasing capacity, especially in capacity-constrained regions that provide alternate supply options during N-1 contingencies.
Public Policy Responsiveness	Hydro Ottawa's Public Policy Responsiveness objectives by: ● Supporting government initiatives for sustainable energy solutions. ● Enabling electrification by investing in additional capacity and operational flexibility.

7.3. PROGRAM DRIVERS AND NEEDS

7.3.1. Main and Secondary Drivers

Primary Driver: System Capital Investment Support.

The primary driver of the CCRA Program is to provide financial support for system capital investments necessary to upgrade and expand the transmission infrastructure. These investments are crucial for maintaining a reliable and resilient electrical grid capable of meeting the growing demand for electricity in the National Capital Region. By setting aside funds through the CCRA, Hydro Ottawa contributes to large-scale transmission projects that enhance grid capacity and functionality. These projects ensure long-term system reliability, while also accommodating future growth, technological advancements, and the evolving energy needs of the region.

Secondary Driver: Capacity constraint.

The secondary driver of the CCRA Program is to address capacity constraints in the transmission system. As Ottawa's population and energy demand increase, the existing transmission infrastructure may become insufficient to meet peak load requirements. Capacity constraints can lead to inefficiencies, reliability risks, and the potential for outages during high-demand periods. Through the CCRA, Hydro Ottawa helps to finance upgrades that alleviate these constraints, ensuring that the community's electricity needs are met without compromising grid stability or service quality. This proactive capacity management supports economic growth and urban development in the city.

7.3.2. Current Issues

Hydro Ottawa has seen an increase in large load requests, driven by the increasing need for electrification to achieve decarbonization targets. These requests, spanning from 5 MVA to 57 MVA, underscore the growing demand on the distribution system. Please see further details in Section 5.1 of Schedule 2-5-4 - Asset Management Process.

It has become increasingly important to build enough transmission capacity to be able to meet the forecasted load growth. The increase in planned transmission upgrades in the 2026-2030 period will dictate Ottawa's ability to meet the needs of the community.

Hydro Ottawa needs immediate capacity upgrades to address current system limitations and meet growing demand. The need for additional upgrades by 2030 is detailed in Section 9.1 of Schedule 2-5-4 - Asset Management Process, and the projects to address these needs are discussed in Section 2 of Schedule 2-5-8 - System Service Investments. Without these investments, the existing distribution system may not be able to meet future demand or service obligations. These capacity upgrades will also necessitate transmission upgrades to ensure sufficient capacity within the provincial grid.

The investment needed to build enough capacity in the transmission system is discussed by the Integrated Regional Resource Planning working group; more details of which can be found in Section 4 of Schedule 2-5-2 - Coordinated Planning with Third Parties.

7.4. PROGRAM BENEFITS

7.4.1. Operation Efficiency and Cost Effectiveness

The CCRA Program enhances operational efficiency by ensuring timely transmission upgrades that support the observed growth in electricity demand. By addressing capacity constraints proactively, Hydro Ottawa minimizes the risk of system failures caused by overloading and stressing equipment leading to costly emergency repairs, optimizing the overall reliability and efficiency of grid operations. Additionally, investing in infrastructure through the DCF model helps to balance the costs of upgrades with long-term revenue, ensuring cost-effective capital deployment.

7.4.2. Customer

The CCRA program ensures that Hydro Ottawa customers receive reliable and uninterrupted service by preventing outages caused by transmission constraints. By contributing to infrastructure upgrades, the program supports the National Capital Region’s growing electricity demand, maintaining service quality and grid stability. This commitment to meeting customer demand fosters trust and improves customer satisfaction, as residents and businesses can rely on consistent energy availability.

7.4.3. Safety

Transmission system upgrades funded through the CCRA program enhance safety by ensuring that the grid operates within its designed capacity, reducing the risk of overloads or failures that could lead to hazardous conditions, such as fires, equipment damage, or outages. A well-maintained and updated transmission infrastructure ensures the safe delivery of electricity to homes, businesses, and critical institutions.

7.4.4. Coordination and Interoperability

The CCRA Program enhances both coordination and interoperability between Hydro Ottawa, Hydro One, and the broader provincial grid. By facilitating close collaboration on transmission upgrades, the program ensures that infrastructure improvements are aligned with both local and provincial energy strategies. This cooperation optimizes the integration of systems, ensuring smooth energy flow across interconnected networks. Upgrades funded through the CCRA program also ensure that the transmission system remains fully compatible with Ontario's larger grid, preventing bottlenecks and disruptions. By fostering effective coordination and maintaining high levels of interoperability, the program enhances the overall reliability and efficiency of the electricity supply.

7.4.5. Economic Development

By ensuring adequate transmission capacity to meet the community's growing energy needs, the CCRA program directly supports economic development. Reliable energy infrastructure is crucial for attracting businesses, supporting new residential developments, and sustaining the growth of key industries in the region. The program contributes to creating a stable environment for investors and developers, fostering job creation and economic prosperity in the city.

7.4.6. Environment

The CCRA program enables Hydro Ottawa to support transmission upgrades that incorporate environmentally-friendly practices and technologies, such as increased integration of renewable energy sources. By ensuring the grid can handle clean energy inputs and operate more efficiently, the program enables efforts to reduce the carbon footprint of the energy sector. Additionally, by avoiding overloading and inefficiencies, the program helps to reduce energy losses, leading to a more sustainable and eco-friendly electricity system

7.5. PROGRAM COSTS

Table 22 provides the historical, bridge and test year spending in the CCRA program.

Table 22 - CCRA Program Expenditures ($'000 000s)

	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CCRA Payments	$ 16.9	$ (2.3)	$ (3.8)	$ 1.7	$ 4.4	$ 18.0	$ 1.3	$ 8.5	$ 17.1	$ 0.9
TOTAL	**$ 16.9**	**$ (2.3)**	**$ (3.8)**	**$ 1.7**	**$ 4.4**	**$ 18.0**	**$ 1.3**	**$ 8.5**	**$ 17.1**	**$ 0.9**
5-YEAR TOTAL					**$ 17.0**					**$ 45.9**

The annual spend for CCRA payments is expected to average $9.2M over the 2026-2030 rate period, which is an increase from the $3.4M average spend during the 2021-2025 timeframe. The greater spend is primarily driven by the increase in capacity projects required through Hydro Ottawa's System Service Investment Category, as detailed in Section 2 of Schedule 2-5-8 - System Service Investments, leading to additional transmission connection projects and costs.

The following is a list of transmission connections to new stations and Hydro One stations cable upgrades/switchgear renewals:

- **Transmission connections to new stations:**
    - Mer Bleue Station CCRA - New 28kV station in the East 28kV region
    - Hydro Road Station CCRA - New 44kV station in the 44kV region
    - Greenbank Station CCRA - New 28kV station in the South 28kV region
    - New Kanata North Station CCRA - New 28kV station in the West 28kV(North) region
    - New Bronson Station CCRA - Conversion from an existing 4kV to a 13kV station in the Core 13kV region
    - Cyrville MTS upgrade CCRA - New 230kV connection to 28kV station in the East 28kV region
- **Hydro One stations cable upgrades:** Removal of equipment limitations such as cables and breakers and/or transformer replacements at Hydro One owned stations of Carling TS, King Edward TS, Lisgar TS

- Hydro One stations switchgear renewals- Hinchey TH (switchgear), Russell TS (transformer+switchgear)

7.5.1. Cost Factors

Multi-year project considerations: This program will be subject to inflationary increases in costs that may impact Hydro Ottawa's contribution through the DCF mechanism.

Transmission Cost: Due to the transmission upgrade requirements, costs would be determined through the CIA and SIA process. While CCRAs are finalized for each project there may be increases to the cost estimates considered at this time.

Transmission line upgrade Cost: The requirement for the Cyrville MTS, New Kanata North Station, and Greenbank Station transmission line upgrades have been determined through the Integrated Resource Planning Process (IRRP). However, the cost and cost-sharing arrangements for these upgrades have not yet been determined and are therefore not included in the current forecast.

7.6. ALTERNATIVES EVALUATION

7.6.1. Alternatives Considered

Alternative One: Continue with CCRA funding to complete ongoing projects from the 2021-2025 rate period with no additional investments in the 2026-2030 rate period. In this alternative, the investments required would be CCRA payments for four new stations: 44kV Hydro Station, Brian Coburn, Piperville and Kanata North.

This "do nothing" alternative involves Hydro Ottawa opting not to contribute funds towards the CCRA program after 2025, effectively postponing or avoiding the required transmission upgrades. This approach is not recommended, as it would create increasing capacity constraints in the transmission network, risking insufficient supply to meet the National Capital Region's growing electricity demand. Over time, the lack of investment in critical infrastructure could lead to grid instability, potential outages, and an inability to accommodate new developments or economic growth.

Failure to invest in transmission upgrades would jeopardize Hydro Ottawa's ability to meet its service obligations to customers and maintain compliance with regulatory standards. This approach will likely result in most regions' capacity lagging behind growth, leading to station loads exceeding planning ratings and an inability to connect new customers or support service upgrades/new connections due to customer growth and increased demand as the National Capital Region navigates the road to a decarbonized future.

In this alternative, 10 out of 18 planning regions will be operating above the planned capacity by 2035 based on the IRRP forecast. This will impact Hydro Ottawa's system accessibility and hinder the ability to connect new customers, especially with an increase in large load requests driven by decarbonization goals.

Alternative Two: Provide CCRA funding for new projects to build transmission capacity in the 2026-2030 rate period in addition to the ongoing projects from the 2021-2025 rate period. The investments required in this alternative are:

- Six new stations: CCRA Payment for 44kV Hydro Road, Mer Bleue, Piperville, Kanata North, Bronson 13kV, Greenbank Station
- Five Existing Station Upgrades: Cyrville (full station), King Edward (Hydro One-Sec cable), Lisgar (Hydro One-sec cable), Carling (Hydro One-sec cable), Russell (Hydro One-transformer+SWG renewal)

7.6.2. Preferred Alternative

The recommended approach is Alternative Two, which aligns with the proposed station capacity upgrades discussed in Section 2 of Schedule 2-5-8 - System Service Investments. This approach ensures that Hydro Ottawa remains ahead of capacity constraints, enabling necessary system enhancements in collaboration with Hydro One. By investing in the DCF mechanism, Hydro Ottawa can mitigate risks associated with capacity limitations in the transmission system.

This strategy helps Hydro Ottawa to fulfill its service obligations, support future growth, and avoid the operational and financial repercussions of an underfunded grid infrastructure. In this alternative, only one of the 18 planning regions will operate above the planning capacity by 2035 based on the IRRP forecast.

7.7. PROGRAM EXECUTION AND RISK MITIGATIONS

7.7.1. Implementation Plan

The timelines for Capacity Upgrades, outlined in Schedule 2-5-8 - System Service Investments, and System Expansion, outlined in Schedule 2-5-6 - System Access Investments, align with the CCRA program implementation plan. Sections 2.3.2 and 2.6.1 of Schedule 2-5-8 - System Service Investments and Sections 4.3.2 and 4.6.1 of Schedule 2-5-6 - System Access Investments, detail the critical system needs and alternative considerations, respectively, that informed the assessment of CCRA payments to be executed between 2026 and 2030. The proposed projects for the 2026-2030 rate period, requiring payments to Hydro One through the CCRA as part of the Capacity Upgrade program, are listed in Table 23.

Table 23 - Proposed Projects under the Station Renewal Program

Year	Proposed Projects
2026	● Mer Bleue TS CCRA ● Greenbank TS CCRA ● New Kanata North TS CCRA ● Carling TS secondary cable upgrade CCRA ● Hinchey TH switchgear Replace CCRA ● Lisgar TS secondary cable upgrade ● Russell TS transformer replacement CCRA
2027	● Hydro Road TS CCRA
2028	● New Bronson 13kV CCRA ● Cyrville station upgrade CCRA
2029	● King Edward secondary cable upgrade CCRA ● Russell TB Switchgear Renewal CCRA
2030	● Russell TB Switchgear Renewal CCRA

7.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces several risks in managing its CCRA Program. Table 24 identifies the key risks and corresponding mitigation strategies.

Table 24 - Key Risks for the CCRA Program and Mitigation Strategies

Category	Risk	Mitigation
Transmitter	The transmitter may experience construction and design delays due to competing priorities and limited resources, which could affect the timely completion of Hydro One-owned station upgrades. These upgrades are necessary to optimize station capacity, particularly in the Downtown Core.	Hydro Ottawa will collaborate closely with Hydro One, offering the necessary support to ensure project timelines are met. Monthly planning meetings and quarterly project meetings are scheduled throughout the year.
Approval delays	The time required to obtain approval from IESO and other federal and provincial bodies (such as National Capital Commission, etc) for some of the transmission upgrades may impact project timing.	Early coordination with IESO and other federal and provincial bodies to ensure timely submission and approval of requests.

7.8. LEAVE-TO-CONSTRUCT (IF APPLICABLE)

Section 92 of the OEB Act, 1998, pertains to the assessment of the need for and the benefits of proposed energy projects in Ontario. Specifically, it requires that any entity seeking to construct or expand electricity or natural gas facilities must obtain approval from the OEB. In this assessment, the OEB evaluates several factors, including need for the project, economic and environmental impacts, cost-benefit analysis and alternative solutions. The goal is to ensure that any new energy infrastructure is necessary, economically viable, and aligns with the province's energy policies and objectives. For the transmission upgrade projects of the New Kanata North station, Greenbank station, Cyrville upgrade and Bronson 13kV upgrade this assessment will likely be required.

8. INFRASTRUCTURE AND CYBER SECURITY

8.1. PROGRAM SUMMARY

Investment Category: General Plant

Program Costs:

2021-2025: $7.8M (CAPEX)

2026-2030: $12.0M (CAPEX) and $1.0M (OM&A)

Budget Program: Information Technology

Main Driver: Business Operations Support

Secondary Driver: Business growth and scalability, Operational Efficiency, Regulatory Compliance, Technology Advancements, Risk Management

Outcomes: Operational Effectiveness, Customer Focus

As Hydro Ottawa has outlined in Attachment 1-3-4(B) - Digital Strategy, Utilities are experiencing “exponential growth and connectivity of electronics and information technology.” The evolution toward digital solutions creates opportunities for new service offerings and energy integration, but also increases exposure to cyber security risks. Though this migration provides opportunities for Hydro Ottawa’s entire customer base of approximately 364,000 customers to leverage new services, Hydro Ottawa has a duty to ensure that cyber security risks are identified, both on-premise and in the cloud, analyzed and mitigated to ensure that risks are maintained at acceptable levels. The Canadian Centre for Cyber Security (CCCS) has highlighted in their most recent 2024 Update: The Cyber Threat to the Energy Sector, with Mitigation Guidelines, that cybercrime remains the top cyber threat to the energy sector, and state-sponsored actors view the energy sector in Canada as a strategic target, especially in times of geopolitical tension which the sector has been experiencing since 2022 with no signs of dissipating. These ongoing threats as part of the cyber security landscape are evidence of the need for improvements and focus in cyber security. In addition, Hydro Ottawa’s IT infrastructure will require continuous enhancements to ensure it supports these new services and it stays current and relevant to the new demands. It is crucial to avoid being out of vendor support and to minimize the potential threat and risks of the ever-changing threat landscape. The OEB continues to further enhance the Ontario Cyber Security Framework and this will lead to cyber security compliance obligations that have not been present to-date for distribution entities.

Throughout the rate application cycle, different elements of Hydro's Ottawa IT and OT infrastructure will require either upgrades or transformation including its server virtualization environment, network segmentation, corporate backup system, SAN storage, switching and firewall equipment, meeting rooms technology, wireless infrastructure, data center, corporate telephony, application servers, secure remote access and the monitoring and performance technologies that oversee the network. Employee computing devices such as notebooks, their peripherals as well as mobile devices will further require continuous upgrades. Hydro Ottawa's cyber security technology stack will undergo upgrades and transformation throughout the rate app cycle. Current technology investments pertaining to detectability and preventability capabilities including network traffic analysis, application endpoint control, endpoint detection and response, patch and vulnerability management, networking proxies and email security will also need to go through technology upgrades.

Additionally, as Hydro Ottawa is looking to transform how it monitors and responds to network and cyber security events, investment in predictability-focused solutions will help ensure resilience is at the forefront in its technology footprint to ensure that response and recovery are seamless and meet the business objectives. Continuous investments are planned to unlock efficiencies through automation and orchestration of current processes in order to improve the network and system capabilities. Hydro Ottawa recognizes the industry shift in the energy sector and these investments will help to support customer demands for electrification and grid modernization impacting future Regulatory requirements.

8.2. PERFORMANCE OBJECTIVES AND TARGETS

Enhancing the Infrastructure and Cyber Security programs will help accelerate the performance objectives and targets as shown in Table 25:

Table 25 - Performance Objectives and Targets

Performance Outcome	Target
Operational Effectiveness	• Ensure IT Infrastructure meets business requirements and provides best in class service.
	• Ensure IT infrastructure remains up to date and current and does not fall in end of life support.
	• Ensure cyber security technology stack can detect and protect against threats in real-time and that the residual risk is managed appropriately
	• Strengthen cyber security defenses and safeguard sensitive information from threats and vulnerabilities.
	• Continue to address the changing threat landscape against cybercrime and state sponsored entities due to geopolitical tension.
	• Ensure technology stack is able to recover appropriately to a cyber security event such as ransomware.
	• Improve internal workflows to allow focus on more meaningful work.
Customer Focus	• Protect Hydro Ottawa brand image and reputation.

Establishing KPIs and Key Risk Indicators (KRIs) for the entire program will help manage the risks and contain impacts within acceptable targets. This will further help ensure the overall program objectives are being tracked and measured. Below is a snippet of some KPIs and KRIs examples that could be used to manage overall program and operational effectiveness:

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Figure 1 - Infrastructure and Cyber Security KPIs & KRIs

Operational Effectiveness -KPI & KRIs	Current Month	Q1	Q2	Q3	Q4	Outlook	Trending	Actual	Target
Network and Service Uptime	●	●	●	●	●	●	→		
% of Systems that are Vendor Supported (not EOL)	●	●	●	●	●	●	→		
% of Systems that are Current	●	●	●	●	●	●	→		
Overall Cyber Security Program Health	●	●	●	●	●	●	→		
Corporate Risk (3rd Party Monitoring) Score	●	●	●	●	●	●	→		
CSC Top 20 Maturity Score	●	●	●	●	●	●	→		
Average of Active Critical Risks are < 270 Days	●	●	●	●	●	●	→		
Cyber Insurance Premiums annual increase	●	●	●	●	●	●	→		
Servers Security OS Patched	●	●	●	●	●	●	→		
SCADA OT Assets Patched	●	●	●	●	●	●	→		
% Servers Unresolved Vulnerabilities > 90 Days	●	●	●	●	●	●	→		
% Unpatched Workstations > 90 Days	●	●	●	●	●	●	→		
Mean-Time-to-Patch (3rd Party Apps) is Within SLA	●	●	●	●	●	●	→		
% of Assets with Security Agents Installed	●	●	●	●	●	●	→		
OT Stations Health	●	●	●	●	●	●	→		
Security Health of Public Sites	●	●	●	●	●	●	→		
Corporate Anti-Phishing Campaign CTR	●	●	●	●	●	●	→		
Targeted Anti-Phishing Campaign CTR	●	●	●	●	●	●	→		
% of Completion Awareness Training	●	●	●	●	●	●	→		
% of Contractors Completed Attestation	●	●	●	●	●	●	→		
% of assets monitored (MSSP)	●	●	●	●	●	●	→		
% of use cases implemented (MSSP)	●	●	●	●	●	●	→		
MTTR - ServiceNow Incident Tickets	●	●	●	●	●	●	→		

8.3. PROGRAM DRIVERS AND NEED

8.3.1. Main and Secondary Drivers

Primary Driver: Business operations support

Secondary Drivers:

- Business growth and scalability: Ensure alignment with business initiatives and objectives.
- Operational Efficiency: More automations, orchestration and integrations with other systems, new and modernized functionality.
- Regulatory Compliance: Meet all applicable OEB compliance obligations for cyber security.
- Technology Advancements: Ensure technology continues to drive business services.
- Risk Management: Enhance infrastructure and technology stack to improve reliability, ensure resilience, business continuity and disaster recovery through robust cyber security practices to minimize vulnerabilities, safeguard information and critical assets.

8.3.2. Current Issues

Technical Upgrades

Hydro Ottawa's current IT infrastructure and the various technologies that support it has a traditional lifespan of anywhere from three to five years. It's imperative that throughout this lifecycle, the technologies are running the latest supported iterations, are patched to acceptable levels, and are configured to industry standard baselines with security built-in. They must be continuously monitored to detect anomalies so that any threats can be identified and remediated instantaneously and, ideally, automatically. The threat landscape to the utility sector continues to expand and evolve, as defined by the Canadian Centre for Cyber Security in their National Cyber Threat Assessment 2025-2026 (NCTA)[2], so Hydro Ottawa must ensure that the risk to the attack surface is managed, particularly as new services, connections and integrations are introduced. In order for this to occur, technical upgrades are required to mitigate any threats and risks that target Hydro Ottawa across all business applications. Adversaries will continue to

[2] Canadian Centre for Cyber Security, "National Cyber Threat Assessment 2025-2026", https://www.cyber.gc.ca/sites/default/files/national-cyber-threat-assessment-2025-2026-e.pdf

target systems that are not up to date or running legacy technologies.

IT Infrastructure and Operations

In order to maintain a secure infrastructure, Hydro Ottawa requires funding to:

- Maintain IT and OT infrastructure by keeping it current so that it remains in a supported state, ensuring it continues to deliver on organizational services and aligns to industry standards and best practices.
- Ensure that notebooks, PCs, peripherals, mobile devices are inventoried, tracked, running the necessary software and replaced on an appropriate lifecycle.
- Streamline operations by automating time-consuming manual processes, allowing staff to focus on higher-value activities.

8.4. PROGRAM BENEFITS

8.4.1. Reliability and Aging Infrastructure

Upgrades to the infrastructure and cyber security technology stacks allows Hydro Ottawa to keep pace with technology, mitigate risks and ensure sustained operational excellence.

8.4.2. Cyber Security

As the threat landscape continues to evolve, it's imperative that Hydro Ottawa's infrastructure is able to detect and prevent attacks from occurring.

8.4.3. Regulatory Compliance

Enable Hydro Ottawa to respond and implement Regulatory changes related to cyber security.

8.4.4. Grid Modernization

Upgraded infrastructure to support the demands of grid modernization and increase in data flows and frequency.

8.4.5. Productivity and Innovation

Upgrades will ease adoption of future business requirements.

8.4.6. Digitization and Technology Evolution

Introduce more automation and self-serve options leveraging new technologies such as AI and machine learning.

8.5. PROGRAM COSTS

Table 26 details the historical, bridge and test year spending for the Infrastructure and Cyber Security Program.

Table 26 - Historical, Bridge and Test Year Infrastructure and Cyber Security ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Capital	$ 1.7	$ 2.1	$ 2.4	$ 2.9	$ 1.9	$ 2.6	$ 2.5	$ 2.2	$ 3.7	$ 4.4
OM&A	-	-	-	-	-	$ 0.2	$ 0.2	$ 0.2	$ 0.2	$ 0.2
GROSS SPEND	**$ 1.7**	**$ 2.1**	**$ 2.4**	**$ 2.9**	**$ 1.9**	**$ 2.8**	**$ 2.7**	**$ 2.4**	**$ 4.0**	**$ 4.6**
Capital Contributions	$ (0.5)	$ (0.2)	$ (0.4)	$ (1.1)	$ (1.0)	$ (0.6)	$ (0.8)	$ (0.9)	$ (0.7)	$ (0.5)
NET SPEND	**$ 1.3**	**$ 1.9**	**$ 1.9**	**$ 1.8**	**$ 0.9**	**$ 2.2**	**$ 1.8**	**$ 1.5**	**$ 3.3**	**$ 4.1**
5-YEAR TOTAL					**$ 7.8**					**$ 13.0**

8.5.1. Cost Factors

Hydro Ottawa has received preliminary quotations for the technical upgrades and utilizes knowledge of past projects, vendor agreements, insights and upcoming projects to inform the budget. The increased projected spend in 2029 and 2030 is for hardware upgrades for firewall appliances for both its main and secondary data centres. It's crucial to acknowledge the potential impact of unknown regulatory pressures, which could introduce additional unanticipated development costs.

As the OEB CSF continues to evolve with additional requirements, development costs are expected to increase, but the timing cannot be anticipated. Finally, the scope of projects may expand due to emerging business requirements, change in direction from vendors, which can result in unaccounted for expenses.

8.6. ALTERNATIVES EVALUATION

Infrastructure is at the core of a network and system topology; without an infrastructure, it is not possible to interconnect networks, systems, appliances, applications and users. It is the foundation of technology and is the cornerstone for business applications to operate.

Hydro Ottawa's business objectives and key strategic investment priorities such as Grid Modernization and Enhancing Grid Resilience are fully dependent on a robust and modern infrastructure. In order to achieve this, technology risks must be adequately managed, appropriate funding available, technical resources in place and an ecosystem of partners to collaborate on network design, implementation and maintenance. Throughout the product lifecycle, ensuring seamless operations and continuous improvement is paramount.

Hydro Ottawa recognizes the importance of maintaining its core infrastructure. Given the critical role in supporting all business functions, investing in infrastructure upkeep and enhancements is imperative for sustaining operational efficiency, reducing cyber security risk, and meeting demand from organizational growth.

8.6.1. Alternatives Considered

Alternative One - Do Nothing: Run to failure and address issues as they arise. The consequences of failing to prioritize and invest in the Infrastructure and Cyber Security program could be devastating for the organization. Without adequate funding, Hydro Ottawa could experience increased system failures, service downtime, operational inefficiencies, and cyber security breaches, including threats. Prioritizing funding and investment in system maintenance and enhancements will mitigate these risks, minimizing the chances that Hydro Ottawa will suffer a security breach or IT failure that could have catastrophic consequences for customers' electrical supply.

Alternative Two - Maintain: Perform minimal updates and only when products reach end-of-life. While this alternative addresses the greatest risks for cyber security and obsolescence, it will not allow Hydro Ottawa to keep pace with the growth and transformation of its business, negatively impacting productivity and efficiency.

Alternative Three - Recommended Approach: Implement the program as described in Section 8.1 - Program Summary.

Risks associated with Alternatives One and Two, and their direct impact, are further detailed in Table 27.

1 **Table 27 - Infrastructure and Cyber Security Program Alternatives Risks and Impacts**

Risk Category	Risk	Impact
Operational, Financial, Cyber Security	Delayed Refresh of Assets Driving Risks Associated with Software and Hardware Obsolescence	Increased maintenance costs, decreased system reliability, heightened cyber threats, system failures, data breaches, business disruptions, impacting customer satisfaction and revenue.
Operational, Business	Negatively Impact the Ability of Employees to Support Business Outcomes	Hindered ability to leverage business applications, missed opportunities, operational inefficiencies, decreased competitiveness.
Operational	Decreased Productivity Due to Prolonged Applications/Systems Gaps	Impeded workflow automation, collaboration, decision-making processes, manual workarounds, data discrepancies, project delivery delays, diminished productivity and efficiency.
Financial, Operational	High Unit Cost of Supporting and Servicing Applications	Escalated support costs, increased reliance on reactive measures, strained IT resources, inflated operational expenses, diversion of funds from strategic initiatives towards out of support maintenance costs
Operational, Vendor	Limited Vendor Support	Reduced access to updates, patches, technical assistance, prolonged issue resolution times, exacerbated system vulnerabilities, hindered adaptation to changing business needs.
Cyber Security, Regulatory	Lack of IT Security Controls	Heightened cyber security risks, data breaches, ransomware attacks, regulatory non-compliance, damaged reputation, eroded customer trust, financial losses, legal liabilities.
Operational, Business	Loss of System Integration and Data Consistency	Challenges in system integration, fragmented data silos, hindered communication between systems, reduced visibility, impacted decision-making, reduced business agility.
Financial, Operational	Risk of Project Delays and Cost Overruns	Project delays, cost overruns, missed deadlines, unmet business requirements, stakeholder dissatisfaction, affected project success, and realization of benefits.
Operational, Financial	Compromised Business Continuity and Disaster Recovery	Vulnerability to data loss, prolonged downtime, financial losses due to inadequate system maintenance and disaster recovery mechanisms.
Business, Strategic	Diminished Innovation and Adaptability	Stifled innovation, hindered ability to adapt to market trends, missed opportunities for differentiation and growth, impacted long-term sustainability and relevance.
Operational, Technical	Increased Operational Complexity and Technical Debt	Accumulation of technical debt, hindered system performance, scalability, maintainability, increased future upgrade costs and effort, reduced agility.

8.6.2. Evaluation Criteria

Cyber Security

This criterion assesses the impact of the alternative on Hydro Ottawa's cyber security risks. As the provider of a critical service in the National Capital Region, Hydro Ottawa is a high-risk target for cyber attacks and must ensure that its digital systems have robust threat protection.

Technical Feasibility

This criterion evaluates the alternative's commercial availability, interoperability, and long-term availability. The systems of the Infrastructure and Cyber Security program are integral to the day-to-day operations of Hydro Ottawa and must be capable of evolving alongside the dynamic landscape of the business itself.

Cost Effectiveness

This criterion analyses the impact of the alternative and looks to identify the most cost-effective means of meeting requirements.

Operational Efficiency

This criterion considers the alternative's ability to position Hydro Ottawa to respond to the dynamic needs of its employees and business operations in an efficient manner.

8.6.3. Preferred Alternative

Alternative Three: Implement the program as described in Section 8.1 - Program Summary.

8.7. PROGRAM EXECUTION AND RISK MITIGATIONS

8.7.1. Implementation Plan

Hydro Ottawa's Infrastructure and Cyber Security program will go through technology upgrades and enhancement throughout the rate application period. The intention is to ensure that the infrastructure remains modern, up to date, and supports business deliverables all while ensuring cyber security threats are identified and mitigated with the proper set of detective and protective controls in place.

As many key business initiatives continue to drive innovation and change over the next five years, Hydro Ottawa's infrastructure must be able to support the technological requirements and demand. The Infrastructure and Cyber Security program is focused on implementing these technology upgrades and enhancements. Below is a list of key upgrades and enhancements to be included in this Application:

- Hydro Ottawa will modernize its IT infrastructure by implementing a virtualization environment, migrating workloads to the cloud, increasing data storage capabilities, and updating its corporate telephony system.
- To ensure the network continues to be segmented based on business functions, to support grid modernization, and to reduce the likelihood of risk against malware propagation (i.e. ransomware), it will continue to go through a segmentation effort.
- Smart switching and next generation firewalls will continue to evolve and upgrades of current infrastructure will be required in order to sustain the demand and changing requirements.
- A secondary data centre that is geographically distant from the primary one mitigates the threat of system failure if one centre is compromised by an extreme weather event.
- Managed security information and event management (SIEM) expansion. The intent is to have 100% of the applications to be ingested into Hydro Ottawa's managed SIEM.
- Both detective (identifying threats) and protective (preventing threats) cyber security controls require periodic updates to be productive against the latest threats. Workflows will be automated to increase efficiencies and reduce the mean time between detection and recovery.
- Patch and vulnerability management plays a crucial role in maintaining the security and integrity of IT systems. Effective patch and vulnerability management practices help ensure system stability, reduce security breaches, and enhance overall cyber security posture.

- In the event of a cyber attack, cyber recovery solutions will assist the organization in minimizing the impact and recovery to meet organizational recovery time objectives.
- Zero trust architecture. Hydro Ottawa is adopting a zero trust architecture model and will require appropriate technology to ensure it's implemented correctly.
- Regulatory enhancements as per the Ontario Cyber Security Framework (OCSF).

8.7.2. Risk to Completion and Risk Mitigation Strategies

Table 28 details the key risks and mitigation strategies for the Infrastructure and Cyber Security program.

Table 28 - Key Risks for the Infrastructure and Cyber Security Program and Mitigation Strategies

Risk	Mitigation
Resources	Resources allocation will be performed to ensure Hydro Ottawa delivers on the projects set to complete.
Prioritizing projects	Projects will be prioritized based on upgrade requirements to ensure no services are at end of life.

9. TOOLS REPLACEMENT

9.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $3.2M

2026-2030: $4.9M

Budget Program: Tools Replacement Budget Program

Main Driver: System Investment Support

Secondary Driver: System Maintenance Support

Outcomes: Operational Effectiveness, Financial Performance

This program ensures that frontline crews have access to the necessary tools and equipment to efficiently and effectively execute distribution maintenance and capital programs. It addresses the replacement of aging and worn tools, which are essential for safe and reliable operations. These tools are used by various frontline personnel, including linemen, cable splicers, technicians, and other field staff involved in the construction, maintenance, and repair of the electrical distribution system. The program encompasses a wide range of tools and equipment, falling into the following general categories:

- Safety Equipment: This includes safety devices such as automated external defibrillators (AEDs), gas monitors and detectors, first aid kits, fire extinguishers, fall protection systems such as harnesses and lanyards, rescue equipment and other equipment used to ensure the safety of crews and the public.
- Hand Tools: This category covers a variety of hand tools, both manual and powered, including crimpers, cutters, saws, drills, impact wrenches, and torque wrenches.
- Power Equipment: This includes chainsaws for vegetation management, generators and inverters for providing power on job sites, and hydraulic equipment for heavy-duty tasks.
- Testing and Measurement Equipment: This encompasses various electronic instruments used for testing, regulatory metering validation, and troubleshooting electrical systems, such as multimeters, megger testers, and ground testers.

- Specialized Equipment: This includes tools specific to electrical work, such as hot sticks for working on energized lines, temporary grounds and jumpers for de-energized work, and specialized equipment for working with underground cables and equipment.
- Support Equipment: This category includes items that support field operations, such as hoists for lifting and pulling, ladders for accessing elevated work areas, pumps for removing water, and ground reels for managing grounding cables.

The requested budget for the 2026-2030 rate period represents an increase compared to the 2021-2025 actual spend of $3.2M. While the budget originally approved for 2021-2025 was $2.3M, actual expenditures were $3.2M, primarily due to a higher than anticipated number of tools reaching end-of-life, the purchase of new defibrillators for fleet vehicles, and the Customer Battery Pilot program (initiated during the COVID-19 pandemic). The 2026-2030 budget request of $4.9M reflects the continued need to replace aging tools, increased tool requirements due to anticipated workforce growth and corresponding fleet growth, and the need to maintain a modern and safe tool inventory. For more information on Hydro Ottawa's anticipated workforce growth, please refer to Attachment 4-1-3(C) - Workforce Growth.

Tools are replaced based on a combination of factors, including age, condition, usage, calibration, and safety considerations. Regular inspections are conducted to identify tools that are worn, damaged, or no longer functioning correctly. Some tools have a predetermined lifespan or replacement schedule, but feedback from frontline crews is also considered when determining the need for tool replacement.

Tools are typically stored in centralized tool cribs at various facilities and are distributed to staff as needed. This centralized system allows for better inventory management and ensures that tools are properly maintained and readily available. However, some specialized or frequently used tools may be assigned to individual crews or vehicles for increased efficiency.

9.2. PERFORMANCE OUTCOMES

Table 29 outlines the expected performance outcomes associated with the Tools Replacement program.

Table 29: Performance Targets for Tools Replacement Program

OEB Performance Outcome	Target
Operational Effectiveness	Expenditure on tools supports Hydro Ottawa's overall achievement of operational effectiveness by providing the organization the proper resources required to sustain operations in an effective and efficient manner.
Financial Performance	The tools replacement program serves the overall financial performance of the organization by ensuring expenditures on tools are necessary, responsible, and in support of operational effectiveness.

9.3. PROGRAM DRIVERS AND NEED

9.3.1. Main and Secondary Drivers

Primary Driver: Business operations efficiency drives the need to purchase tools that support the day-to-day business and operations activities. As tool equipment ages, it must be replaced to sustain operations across the business. Tools are used for all critical elements of operations including construction, metering, distribution design, system operations, stations, and health and safety. Outdated or poorly-maintained tools can lead to delays, errors, and safety hazards

Secondary Driver: System maintenance support relies on the availability of appropriate and effective tools. Crews need reliable tools to perform maintenance and repairs quickly and efficiently, minimizing system downtime and service interruptions.

9.3.2. Current Issues

While there are no "program-level" current issues, individual tools are regularly assessed for condition and replaced as needed. This program proactively addresses tool replacement to prevent future issues related to tool availability, performance, and safety. A proactive replacement strategy minimizes disruptions caused by unexpected tool failures.

9.4. PROGRAM BENEFITS

This program ensures that distribution maintenance and capital programs are equipped with the tools necessary to be carried out efficiently, effectively, and safely. This translates to improved service reliability, faster response times, and a safer working environment for crews.

9.5. PROGRAM COSTS

Table 30 details the historical, bridge and test year spending for the Tools Replacement Program.

Table 30 - Tools Replacement Program Expenditures ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Tools Replacement Budget Program	$ 0.7	$ 0.6	$ 0.4	$ 0.9	$ 0.6	$ 0.8	$ 1.0	$ 0.9	$ 0.9	$ 1.3
5-YEAR TOTAL					**$ 3.2**					**$ 4.9**

9.5.1. Cost Factors

The primary factors in determining the future spend for tools replacement was headcount and inflation. Increased operational headcount is outlined in Attachment 4-1-3(C) - Workforce Growth and includes the requirement to outfit both employees and vehicles with the necessary tools to do their job safely.

9.6. ALTERNATIVES EVALUATION

9.6.1. Alternatives Considered

Alternative One - Do Nothing: Run to failure. This approach minimizes upfront capital costs but risks increased downtime, reduced reliability, and potential safety hazards due to aging and poorly maintained tools. It can lead to higher long-term costs due to emergency replacements and lost productivity.

Alternative Two - Planned Replacement: This approach balances cost and performance by proactively replacing tools based on condition, usage, and age. It aims to optimize tool lifespan and minimize disruptions while maintaining a safe and efficient working environment.

Alternative Three - Accelerated Replacement: This approach replaces tools more frequently than necessary, resulting in higher capital expenditures. While it might offer some benefits in terms of tool availability, it does not optimize tool lifespan or minimize overall costs.

9.6.2. Evaluation Criteria

The alternatives were evaluated based on:

Safety: Impact on worker safety.

Reliability: Impact on tool availability and performance.

Cost-effectiveness: Long-term cost of tool ownership, including maintenance, repair, and replacement.

Efficiency: Impact on crew productivity and task completion time.

9.6.3. Preferred Alternative

The preferred alternative is Alternative Two: Planned Replacement. This approach offers the best balance of safety, reliability, and cost-effectiveness. It ensures crews have access to the tools they need to perform their work efficiently and safely, while also managing costs responsibly.

9.7. PROGRAM EXECUTION AND RISK MITIGATION

9.7.1. Implementation Plan

Tools will be purchased and replaced based on condition assessments, this includes regular inspections and testing of tools to identify those needing replacement.

10. BUILDINGS - FACILITIES

10.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $7.0M

2026-2030: $6.6M

Budget Program: Buildings - Facilities, Net Zero - Facilities Capital

Main Driver: System Investment Support

Secondary Driver: Health and Safety, Net Zero Operations

Outcomes: Operational Effectiveness, Financial Performance

Hydro Ottawa's administration facilities are located at Hunt Club Rd. and Bank St. The Hunt Club Rd. location serves as the Head Office and includes a work center for field operations and storage. The Bank St. facility houses a training center, project office space, and a fleet garage and maintenance center.

Investments in these facilities primarily aim to ensure productivity by maintaining safe, functional and efficient workspaces. This includes replacing aging or failing assets that could create hazards, interrupt business, or hinder operational effectiveness. These investments also support strategic objectives, such as accommodating staff growth as noted in Attachment 4-1-3(C) - Workforce Growth and advancing environmental sustainability goals.

The Buildings - Facilities capital program encompasses a range of improvements, including interior upgrades, exterior enhancements, mechanical and electrical renewals, health and safety enhancements, security upgrades and sustainability initiatives. The following sections detail the types of capital work included:

Electrical Systems:

- **Electrical Service Upgrades:** Upgrading electrical panels and systems to accommodate increased power demands from new equipment or building expansions, ensuring safety and preventing overloads.
- **Lighting Retrofits:** Replacing outdated lighting with energy-efficient LEDs to reduce energy consumption and maintenance costs.
- **Emergency Generator Replacements:** Replacing aging generators to ensure reliable backup power during outages.

HVAC Systems:

- **Chiller Replacements:** Replacing aging chillers with more energy-efficient models to reduce energy consumption and operating costs.
- **Boiler Upgrades:** Upgrading or replacing boilers to improve efficiency and reliability.
- **Air Handler Replacement:** Replacing outdated air handlers to improve indoor air quality, reduce noise levels, and enhance overall system performance.
- **Indoor Air Quality Improvements:** Upgrading HVAC systems with advanced filtration.

Plumbing and Piping:

- **Pipe Replacement:** Replacing corroded or leaking pipes to prevent water damage and maintain water quality.
- **Oil Separator:** Replacement and upgrade.
- **Septic:** Replacement and upgrade.
- **Backflow Preventer Installation:** Installing backflow preventers to protect the potable water supply.

Exterior Improvements:

- **Roofing:** Replacement, restoration, and insulation upgrades to improve energy efficiency and prevent leaks.
- **Siding:** Replacement, renewals, and coating to maintain appearance and weather

protection.

- **Windows and Doors:** Replacement with energy-efficient models and upgrades (e.g., storm windows) to reduce energy costs and improve comfort.
- **Hardscaping (Exterior Grounds):** Paving, retaining walls, and fencing for accessibility, safety, and security.
- **Softscaping (Exterior Grounds):** Irrigation and drainage improvements.
- **Foundation:** Restoration and waterproofing to ensure structural integrity.
- **Exterior Walls:** Restoration and insulation upgrades.

Health and Safety:

- **Fire System Upgrades:** Replacing outdated panels and installing new detectors, sprinkler and suppression systems.
- **Emergency Lighting:** Installing or upgrading emergency lighting fixtures.
- **Access Control Systems:** Installations or upgrades to enhance security.
- **Surveillance Systems:** Installing or upgrading cameras and surveillance systems.
- **Intrusion Detection Systems:** Installing or upgrading to detect unauthorized entry.
- **Emergency Communication Systems:** Installing or upgrading mass notification systems.
- **Emergency Power Systems:** Installing or upgrading backup generators and uninterruptible power supplies (UPS).

Interior Improvements:

- **Ergonomic Enhancements:** Providing ergonomic workstations, furniture, and equipment.
- **Accessibility Improvements:** Installing ramps, elevators, handrails, and other accessibility features to ensure buildings are accessible to people with disabilities.
- **Interior capital improvements:** Includes furniture and equipment for new employees.

Table 31 summarizes the age, book value and size of the Administration facilities.

Table 31 - Administration Building Overview

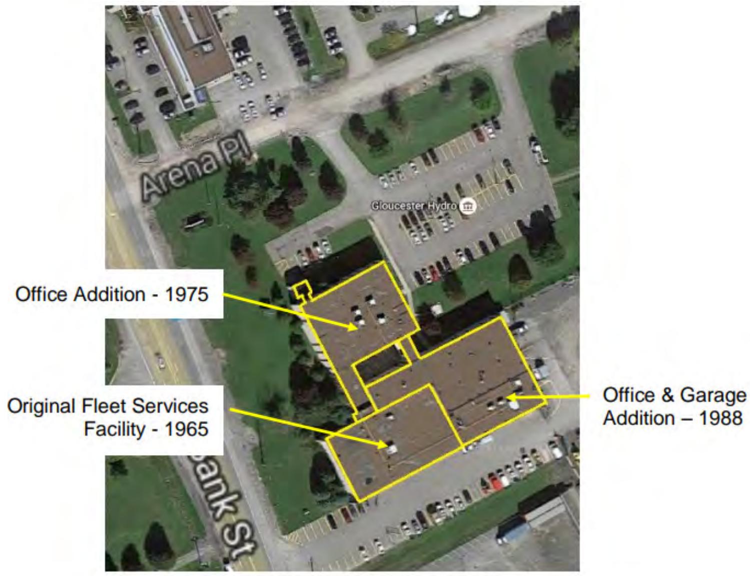
Location	Year Built	Asset Cost	Net Book Value (Dec. 31/23)	Function	Size (sq.ft.)
2711 Hunt Club Rd.	2019	$76.7M	$66.1M	Head Office, Administration, Operations and Storage	185,516
4565 Bank St.	Original Fleet Office - 1965 Office Addition - 1975 Office & Garage addition - 1988	$7.0M*	$4.4M*	Training, Fleet Garage and Storage	101,300

** Excludes disallowed asset value*

See Figures 2 and 3 showing the facilities at 2711 Hunt Club Rd. and 4565 Bank St.

Figure 2 - Head Office and Operations Centre - 2711 Hunt Club Rd.

Figure 3 - Training Centre & Garage - 4565 Bank St



10.2. PERFORMANCE OUTCOMES

Table 32 outlines the expected performance outcomes associated with the Buildings - Facilities Program.

Table 32 - Performance Targets for Buildings - Facilities Program

OEB Performance Outcome	Target
Operational Effectiveness	Provide staff with safe and functional facilities that contribute to a productive and safe work environment. Invest in building improvements and correct deficiencies to address potential safety, compliance and security issues.
Financial Performance	Make optimal decisions regarding capital vs. repair expenditures. Identified expenditures to be within the approved budget amount.
Environment	Reduce greenhouse gas (GHG) emissions related to building operations to support a migration towards the target of achieving net zero emissions.

10.3. PROGRAM DRIVERS AND NEED

10.3.1. Main and Secondary Drivers

Primary Driver: System Investment Support; this program identifies investments required to help ensure that facilities appropriately support the needs of staff to perform work and to protect equipment and materials. Work includes expenditures to remediate poor condition facilities and to address new needs such as growth or expanded work programs.

Secondary Drivers: Provide a safe and efficient work environment that supports OM&A and Capital work programs; Protect the investment in facilities assets by remediating identified deficiencies; Identify opportunities for efficiencies and carbon reduction.

10.3.2. Current Issues

Several key issues are driving the need for capital investment in Hydro Ottawa's facilities:

- Workspace Optimization: While the Hunt Club facility is relatively new and includes space for growth, it requires interior improvements, furniture, and equipment to effectively accommodate planned staff additions and optimize workspace utilization. This includes reconfiguring existing space and purchasing appropriate office furniture and equipment.
- Bank Street Facility Restoration: The Bank Street facility requires building restoration to address issues related to its age. These issues include roofing and foundation as noted in Figures 4 and 5.
- Bank Street Sanitary Sewer Connection: Hydro Ottawa's current sewage holding system at the Bank Street facility is aging, resulting in increasing maintenance costs. Furthermore, the environmental impact of transporting sewage from the facility is not aligned with Hydro Ottawa's sustainability initiatives. The City of Ottawa's planned expansion of the sanitary sewer network in the area presents an opportunity to connect the Bank Street facility to the municipal system, resolving both the maintenance and environmental concerns.

Figure 4 - 4565 Bank St (Water Pooling on Roof)

Figure 5 - 4565 Bank St (Spalling of Concrete Foundation)

10.4. PROGRAM BENEFITS

The benefits associated with expenditures in this program are substantial and contribute directly to Hydro Ottawa's operational effectiveness and employee well-being. These benefits include:

- **Improved Productivity:** Providing safe, functional, and well-configured workspaces enables staff to perform their duties more efficiently. For example, addressing workspace optimization at Hunt Club will ensure that new staff can be integrated seamlessly, minimizing any disruption to ongoing operations. Replacing aging building systems, such as HVAC, reduces downtime and ensures a comfortable working environment, further contributing to productivity.
- **Reduced Risk and Enhanced Safety:** Addressing building deficiencies, such as roof leaks at Bank Street, mitigates safety hazards and prevents costly damage to equipment and materials. Upgrading fire and security systems enhances the safety and security of employees and the facilities themselves.
- **Improved Employee Morale and Retention:** Investing in modern and comfortable workspaces, ergonomic enhancements, and improved indoor air quality contributes to a positive work environment, boosting employee morale and supporting staff retention.
- **Cost Savings:** While the program involves capital expenditures, it also generates long-term cost savings. For instance, replacing aging HVAC systems with more energy-efficient models reduces energy consumption and lowers operating costs. Preventative maintenance and timely replacements can also prevent more costly repairs or replacements down the line.
- **Enhanced Operational Efficiency:** Upgrading building systems, such as electrical service upgrades, supports the efficient operation of equipment and prevents disruptions caused by outdated or inadequate infrastructure. Connecting the Bank Street facility to the city sewer system will eliminate the increasing costs and logistical challenges associated with the aging holding system.

- **Support for Strategic Objectives:** These investments directly support Hydro Ottawa's strategic objectives, including accommodating staff growth and advancing environmental sustainability goals through energy efficiency improvements and reduced environmental impact.

10.5. PROGRAM COSTS

The historical period costs represent infrastructure improvements and sustainability initiatives. Notable examples include a shared access roadway, a new HVAC unit, additional storage, and EV charging stations.

Capital work planned over the 2026-2030 rate period consists primarily of regular replacements and upgrades that are typical for buildings as they age. These general types of expenditures are described above.

Specific capital projects planned for 2026-2030 include:

- Bank Street Exterior Wall Repairs: Repair and repainting of damaged brickwork and concrete to maintain weather protection and structural integrity.
- Bank Street Sanitary Sewer Connection: Connection to the City of Ottawa's expanded sewer network, replacing the aging and costly sewage holding system.
- Hunt Club ERV Floor Re-coating: Re-coating of the ERV (Energy Recovery Ventilator) room floor to protect it from chemical spills and wear.
- Hunt Club Utility Meter Monitoring System: Installation of a utility meter monitoring system to track energy and water usage, supporting conservation efforts.
- Bank Street Roofing Replacement and Repairs: Complete replacement of the aging roof membrane and associated repairs to flashing and insulation.
- Bank Street Fleet Compressor Replacement: Replacement of the aging fleet garage air compressor with a more efficient and reliable unit.

- Bank Street Heat Pump Replacement: Replacing the aging heat pump system with a more efficient and environmentally friendly unit.
- Bank Street Garage Door Repairs and Replacements: Repair and replacement of worn or damaged garage doors to ensure proper operation and security.
- Interior Improvements and Renovations: Reconfiguration of existing workspace and purchase of new furniture and equipment to accommodate additional staff.
- Electrical Service Upgrades: Upgrades to the electrical services at both facilities to support decarbonization and energy efficiency initiatives, including preparing for future systems such as HVAC and EV chargers.

See Table 33 below for costs by Budget Program for historical, bridge and test periods for both buildings combined. Note that the capital contribution in 2023 and 2024 represents grant funding received toward the EV charging stations, reducing the overall cost of this program.

Table 33 - Buildings - Facilities Program Costs ($'000 000s)

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Buildings - Facilities	$ 0.6	$ 2.1	$ 0.5	$ 0.6	$ 0.5	$ 1.6	$ 1.3	$ 0.7	$ 0.7	$ 0.7
EV Charging Infrastructure	-	-	$ 1.9	$ 1.1	-	-	-	-	-	-
Net Zero - Facilities Capital	-	-	-	-	-	-	-	-	$ 0.5	$ 1.0
GROSS CAPEX	$ 0.6	$ 2.1	$ 2.4	$ 1.7	$ 0.5	$ 1.6	$ 1.3	$ 0.7	$ 1.2	$ 1.7
Capital Contribution	-	-	$ (0.2)	$ (0.1)	-	-	-	-	-	-
NET CAPEX	$ 0.6	$ 2.1	$ 2.2	$ 1.6	$ 0.5	$ 1.6	$ 1.3	$ 0.7	$ 1.2	$ 1.7
5-YEAR TOTAL					**$ 7.0**					**$ 6.6**

Table 34 provides the capital expenditures planned by building in 2026-2030.

Table 34 - Building - Facilities Program Costs by Building 2026-2030 ($'000 000s)

Investment Category		Test Years					Total
		2026	2027	2028	2029	2030	2026-2030
General Plant	Hunt Club	$ 0.7	$ 0.6	$ 0.3	$ 0.4	$ 1.4	**$ 3.4**
General Plant	Bank Street	$ 0.9	$ 0.7	$ 0.4	$ 0.8	$ 0.3	**$ 3.1**
TOTAL		**$ 1.6**	**$ 1.3**	**$ 0.7**	**$ 1.2**	**$ 1.7**	**$ 6.6**

10.5.1. Cost Factors

When making investment decisions for its facilities, Hydro Ottawa takes a long-term view, considering the full life-cycle cost. While regular repairs and maintenance are essential for extending the useful life of a facility, there comes a point where continued repairs become less cost-effective and can even negatively impact operations. A leaky roof, for instance, might be temporarily patched multiple times, but eventually, a full replacement becomes the more prudent investment when considering both financial costs and the potential for business disruption.

10.6. ALTERNATIVES EVALUATION

10.6.1. Alternatives Considered

Alternative One - Reactive Maintenance (Run to failure): This approach minimizes short-term capital expenditures by only addressing facility issues as they arise. While annual repair and maintenance costs may initially appear lower, this strategy risks significant safety hazards, operational disruptions, and higher long-term costs due to emergency repairs and potential legal or regulatory non-compliance. It also leads to a suboptimal and deteriorating work environment, impacting productivity and potentially staff retention.

Alternative Two - Planned Maintenance and Replacement (Balanced Approach): This approach balances ongoing repair and maintenance with the planned replacement of assets nearing the end of their useful life. Regular monitoring of facility conditions allows for proactive interventions, preventing catastrophic failures and minimizing disruptions. This strategy prioritizes safety and ensures a functional work environment while optimizing life-cycle costs.

Alternative Three - Preventative Maintenance and Accelerated Replacement: This approach proactively invests in replacements and upgrades before assets reach the end of their useful life. While this can reduce future risks and maintenance costs and help Hydro Ottawa reach Net-Zero targets faster, it results in higher upfront capital expenditures and may not optimize asset life cycles, potentially increasing costs for customers.

10.6.2. Evaluation Criteria

The alternatives were evaluated based on the following criteria:

- **Safety:** Employee, contractor, and public safety; mitigation of workplace hazards; compliance with applicable regulations.
- **Cost:** Lowest overall life-cycle cost, balancing repair/maintenance expenditures with capital investments to optimize asset service life.
- **Efficiency:** Ability of the workspace to support timely and efficient work execution; minimizing business disruptions due to facility unavailability or inaccessibility; optimizing work productivity.
- **Practicality:** Meeting staff needs without excessive expenditure beyond what is required for effective work performance.
- **Sustainability:** Contribution to environmental sustainability goals, including energy efficiency and reduced environmental impact.

10.6.3. Preferred Alternative

Hydro Ottawa has selected Alternative Two: Planned Maintenance and Replacement, as the preferred approach for the 2026-2030 rate period. This approach provides the best balance between safety, reliability, cost-effectiveness, and environmental sustainability. It mitigates the significant risks associated with Alternative One (reactive maintenance), which could compromise safety, lead to costly emergency repairs, and negatively impact operations. While Alternative Three (accelerated replacement) offers increased reliability, it comes at a significantly higher cost without a commensurate increase in benefits. Alternative Two optimizes lifecycle costs by strategically balancing proactive maintenance with timely capital investments, ensuring a safe and functional work environment while responsibly managing ratepayer funds. This approach is consistent with Hydro Ottawa's overall asset management strategy.

10.7. PROGRAM EXECUTION AND RISK MITIGATION

10.7.1. Implementation Plan

The implementation of the 2026-2030 Buildings - Facilities capital program will be guided by a flexible and adaptive approach that considers the unique nature of each project and prioritizes operational continuity.

Project Identification and Scoping: Capital projects are identified through a variety of channels, including:

- Regular facility inspections and condition assessments: These assessments help identify potential issues and maintenance needs before they become major problems.
- Employee feedback and input: Employees are encouraged to report any concerns or suggestions for improvement related to their workspaces. These are often identified through Hydro Ottawa's Hazard Near Miss reporting.
- Technological advancements: New technologies and building systems are evaluated for their potential to improve efficiency, safety, or sustainability.
- Regulatory requirements: Changes in building codes or environmental regulations may necessitate facility upgrades.

Project Implementation: The specific implementation approach for each project will be determined based on its scope, complexity, and potential impact on operations. Some projects may be executed using in-house resources, while others may require external contractors or specialized expertise. Key considerations during project implementation include:

- Minimizing Disruption: Work will be scheduled to minimize disruption to Hydro Ottawa's operations and ensure the continued safety of employees and the public. This may involve scheduling work during off-hours or implementing temporary measures to maintain access and functionality.

- Lead Times: Adequate lead times will be factored in to account for material procurement, contractor availability, and any necessary permitting or approvals.
- Cost Control: Rigorous cost control measures will be implemented throughout the project lifecycle, including competitive bidding, value engineering, and ongoing monitoring of expenditures.

This flexible and adaptive approach allows Hydro Ottawa to effectively manage its facilities capital program, ensuring that projects are implemented efficiently, cost-effectively, and with minimal disruption to operations.

10.7.2. Risks to Completion and Risk Mitigation Strategies

Hydro Ottawa faces risks in managing its Building - Facilities Program. See Table 35 for key risks and corresponding mitigation strategies:

1 **Table 35 - Key Risks of Buildings - Facilities and Mitigation Strategies**

Category	Risk	Mitigation
Operational	Inability to perform work due to lack of access to or sub-optimal facilities	Proactive maintenance, regular assessments, and contingency planning
Safety	Failure of safety systems and exposure to hazards. Non-compliance with applicable legislation and codes	Regular inspections, employee training, and a strong safety culture
Financial	Required expenditures higher than planned	Accurate budgeting, rigorous cost control, and contingency planning
Environmental	Not meeting environmental legislation or targets	Understanding and adhering to environmental regulations, setting targets, and tracking performance
Project Management	Delays in project timelines	Detailed project planning, effective project management practices, and proactive risk identification
External Risks	Supply chain disruptions: This can affect the availability and cost of materials and equipment	Maintaining relationships with multiple suppliers, exploring alternative materials, and building in buffer time for procurement
External Risks	Changes in regulations or building codes: New regulations or changes to existing ones can impact project scope and costs	Staying informed about regulatory changes and incorporating flexibility into project designs

11. FLEET REPLACEMENT

11.1. PROGRAM SUMMARY

Investment Category: General Plant

Capital Program Costs:

2021-2025: $17.6M

2026-2030: $40.6M

Budget Program: Fleet Replacement, Fleet Additions

Main Driver: System Investment Support

Secondary Driver: Health and Safety, Net Zero Operations

Outcomes: Operational Effectiveness, Financial Performance

The Fleet Program is responsible for the procurement, maintenance, and disposal of fleet assets (vehicles and equipment) required to support Hydro Ottawa's functional and operational needs. The primary objectives of the Fleet Program are to optimize fleet asset usage and lifecycle costs, and to ensure that these assets are available, perform reliably, and are safe.

Hydro Ottawa relies on a diverse fleet of 237[3] vehicles and 44 other units of transportation equipment to support its OM&A and capital work programs. Vehicles are essential for providing efficient and reliable customer service including timely power restoration, efficient distribution system construction and maintenance, and ensuring worker and public safety.

Hydro Ottawa's service territory comprises 662 km^2 of rural service area and 454 km^2 of urban service area. This diverse service territory requires a variety of fleet assets capable of supporting maintenance and construction activities in both overhead and underground distribution line operating environments.

The utility's Fleet Services Unit (Fleet) is responsible for both the maintenance and capital replacement of fleet assets. Fleet, in conjunction with the various distribution operations work

[3] As of September 30, 2024

groups, determines the demand for new vehicles based on the planned OM&A and capital work programs. For existing assets, Fleet conducts ongoing condition assessments to inform maintenance decisions throughout each vehicle's lifecycle. These assessments also play a key role in determining when a vehicle should be replaced. Factors considered in replacement decisions include age, mileage, repair history, and overall condition. Deterioration of fleet assets can negatively impact utility performance in areas such as reliability, productivity, and safety.

A summary of the number of fleet assets in Hydro Ottawa's fleet and their net book value is provided in Table 36.

Table 36 - Hydro Ottawa Fleet Summary (As of September 30, 2024)

Vehicle Category	# of Units	Asset Cost ($'000s)	Net Book Value ($'000s)
Light Duty Vehicles	149	$ 6,324	$ 3,358
Medium Duty Vehicles	29	$ 3,990	$ 2,685
Heavy Duty Vehicles	59	$ 18,029	$ 8,552
Other	44	$ 1,585	$ 829
TOTAL	**281**	**$ 29,929**	**$ 15,425**

Descriptions of the types of vehicles in the above categories are as follows:

- **Light Duty Vehicles:** This category includes pick-up trucks, vans, and small cars used for transporting supervisors and inspection staff. These vehicles support various tasks, such as responding to trouble calls, transporting crews and materials, metering, collections, design work, and safety inspections.

- **Medium Duty Vehicles:** This category encompasses step vans and walk-through body trucks, which serve as mobile workshops for underground splicing and station maintenance. It also includes dump trucks used for transporting compaction materials for pole line work, and flatbed trucks for transporting cable and transformers.

- **Heavy Duty Vehicles:** This category includes specialized vehicles such as bucket trucks, diggers, and cranes. These are used for performing overhead and underground line work, drilling and installing poles, and lifting heavy transformers. Also included are track machines, such as a backyard bucket/digger and a backyard transformer transporter.

- **Other:** This category comprises a range of specialized equipment, including pole trailers, flat deck trailers, underground pulling equipment, and forklifts (both indoor and outdoor) used for material handling. Other units and equipment classified here are typically pulled by heavy- or medium-duty vehicles, or are self-propelled units with their own engine/powerplant, typically used for line work. Examples include stringing/pulling trailers, compressors, backyard carriers, various types of trailers, forklifts, and reel trailers.

Hydro Ottawa's commitment to environmental responsibility is strongly reflected in its fleet strategy, a vital component of the organization's Eight point plan aimed at achieving Net Zero Operations. Hydro Ottawa has made significant strides in greening its fleet, focusing on strategic implementation of available and reliable green technologies. The availability and pricing of fully-electric (EV) vehicles, particularly full-size pick-up trucks and vans, improved considerably during the 2021-2025 rate period, compared to its planning stage. This shift enabled Hydro Ottawa to significantly increase its fleet of low- and non-emitting vehicles, as demonstrated by the substantial growth detailed in Table 37.

Table 37 – Vehicles and Equipment with Green Attributes

Vehicle Category	At May 31, 2020	At Dec 31, 2023	Projected at Dec 31, 2025
Electric	2	22	48
Plug-in Hybrid	0	3	7
Hybrid	8	11	9
Hybrid Equipment	22	24	28
TOTAL	**32**	**60**	**92**

The addition of electric vehicles, consisting of pick-up trucks, cargo vans and SUVs, has allowed Hydro Ottawa's fleet to reduce fuel consumption and these vehicles are successfully getting through their day on a single charge and reducing carbon output. Where EV vehicles are not practical or available, Hydro Ottawa has purchased Hybrid vehicles such as the Toyota Rav 4 and Sienna. These vehicles are tried and tested and are more fuel-efficient than their internal combustion engine counterparts.

Auxiliary hybrid units have been installed on medium and heavy duty vehicles to run all accessories, except for air conditioning, using an inverter and auxiliary batteries. It is no longer necessary for a vehicle to be kept running at a job site, thus reducing idling time and saving fuel. The batteries charge when the vehicle is on the road and when plugged in at night. In addition, what is known as "Cab Comfort" will be added to some new units. This is the inclusion of a Heating and Air Conditioning unit that can be run by the hybrid battery and allows the cab to be heated and cooled without running the diesel engine. Hybrid battery and inverter to power accessories is now standard specification for all new medium duty trucks purchased by Hydro Ottawa.

Fleet has also undertaken a pilot program retrofitting an existing bucket truck with a Hybrid battery pack (Viatec) smart Power Take Off (PTO), capable of operating the boom for several hours a day without operating the diesel engine. This required working with Viatec through numerous testing and adjustments to optimize the total run time of the hybrid boom. Currently, of the units that Viatec has in service, Hydro Ottawa is in the top five in North America for total run time and idle reduction per month (>60 hrs).

Fleet also has units on order that will be fit-up with factory hybrid boom packs to operate the boom without the use of the diesel engine. New heavy-duty vehicles will have an inverter and battery pack to allow operators to run accessories such as emergency lighting and equipment as well as battery charging for battery-operated tools. All of this can be managed without running the truck on diesel fuel.

Hydro Ottawa is committed to the acquisition of vehicles with hybrid technology where there is an operational and financial business case for doing so. In the 2026-2030 rate period, Hydro Ottawa plans on purchasing 14 bucket trucks with plug-in hybrid booms.

While Hydro Ottawa Holding Inc. has set a corporate net-zero target by 2030, the current plan does not include specific funding for significant additions of light-duty or medium-duty electric vehicles (EVs) during the 2026-2030 rate period. The plan does include $2.4M for hybrid boom retrofits. This approach considers several factors. First, Hydro Ottawa is already progressing towards electrification, with an expectation of having 48 fully electric vehicles in its fleet by 2025. Second, the utility anticipates that as EV technologies mature, the cost differential between EVs and their internal combustion engine (ICE) counterparts will continue to decrease. Specifically, advancements in battery technology, increased production volumes, and government incentives are expected to lower EV prices. This could enable Hydro Ottawa to acquire a larger number of fully electric vehicles within the same budget, accelerating the transition of Hydro Ottawa's fleet. At the same time, Hydro Ottawa recognizes the need to maintain some internal combustion engine (ICE) vehicles in its fleet. This is primarily due to the current limitations in backup power solutions for fully electric vehicles, which are critical for power restoration efforts during outages. The significant cost of providing reliable generation backup for a large fully electric fleet remains a key consideration. Hydro Ottawa must also balance these investments with the need to maintain affordable rates for its customers. The utility will continue to monitor developments in backup power technology, such as mobile power stations and improved battery energy density, which could further support the integration of EVs for all applications. For the 2026-2030 period, vehicle acquisitions are budgeted at ICE rates. Finally, looking ahead, the City of Ottawa plans to develop two hydrogen plants by 2036 which will offer a potential pathway for further fleet diversification.

11.2. PERFORMANCE OUTCOMES

Table 38 outlines the expected performance outcomes associated with the Fleet Replacement Program.

Table 38 - Performance Targets for Fleet Replacement Program

OEB Performance Outcome	Target
Operational Effectiveness	• Maintain the percentage of medium- and heavy-duty Fleet vehicles at end-of-life in the 10-15% target range (Refer to additional context on this target below the table). • Provide staff with functional fleet equipment that is available when needed to support OM&A and Capital work programs. • Provide safe fleet equipment in reliable operating condition. • Replace end-of-life fleet prior to critical failure or costly repairs.
Financial Performance	• Manage Fleet operating and capital costs to achieve the lowest overall lifecycle cost. • Monitor and control repair and maintenance costs within budget.
Environment	• Reduce GHG emissions associated with fleet fuel consumption through: ○ Opting for hybrid and electric vehicles while maintaining fleet reliability; ○ Implementing anti-idling technology; and ○ Using GPS reporting to monitor vehicle efficiency. • Safe storage and disposal of automotive fluids.

The proportion of medium and heavy duty fleet vehicles that have reached or exceeded their end of useful life (EOL) is a KPI which is also included in Table 27 of Schedule 2-5-3 - Performance Measurement for Continuous Improvement. The target range is 10% to 15%. This range acknowledges that some vehicles may remain functional and safe beyond their typical lifespan due to condition-based replacement, minimizing maintenance costs and supporting operational efficiency. However, these heavy- and medium-duty vehicles are critical workhorses, representing approximately 80% of the capital expenditures in the 2026-2030 fleet program. Therefore, maintaining the EOL percentage below 15% is crucial. Exceeding this threshold poses a significant risk due to the long lead times required for replacing these specialized vehicles. Unlike light-duty assets, readily available rentals or replacements for equipment like bucket trucks are not typically an option, making fleet availability paramount for uninterrupted operations. A target range of 10-15% is considered optimal to balance cost-effectiveness with the critical need to maintain a reliable fleet.

The current actual as at September 2024 is 23%; however, with the investments in this program, it is expected to be within 14% by the end of 2030.

11.3. PROGRAM DRIVERS AND NEED

11.3.1. Main and Secondary Drivers

Primary Driver: System Investment Support; The primary driver for the Fleet Replacement Program is to ensure the availability of appropriate vehicles and equipment to support OM&A and capital work programs. This involves strategic investment in fleet assets, optimizing lifecycle costs through timely replacements and effective maintenance strategies.

Secondary Driver: Health and Safety, Net Zero Operations; The secondary drivers include ensuring the safety and reliability of vehicles 24/7, and advancing Hydro Ottawa's net-zero objectives by identifying and implementing opportunities for carbon reduction within the fleet. This includes providing safe working conditions for employees and the public.

11.3.2. Current Issues

Hydro Ottawa owns many vehicles that are either already beyond their planned useful life, or will be beyond their planned useful life during the upcoming rate period.

As a vehicle ages, higher operating expenses due to increasing levels of reactive repairs are incurred. The capital replacement program helps to ensure that investments are made at the appropriate level and timing in order to optimize asset maintenance, repair, and capital costs. An appropriately timed vehicle replacement strategy also helps to ensure that the right number of vehicles are available to support system maintenance and capital investment plans. Hydro Ottawa has identified the need to significantly re-invest in Fleet assets, as many vehicles have reached or exceeded the end of their operational service life. These vehicles are subject to increased maintenance and repair expenditures, deteriorating chassis and engine performance, and potentially pose a health and safety hazard to the public and employees. Hydro Ottawa developed its vehicle replacement strategy based on the criteria and process outlined in Section 11.6 - Alternatives Evaluation.

In addition to replacing aging vehicles, the 2026-2030 plan includes additions to the fleet to accommodate the operational needs of a growing workforce. Table 39 identifies the type and number of new vehicles required to support headcount growth.

Table 39 - Vehicles Required for Additional Headcount

Vehicle Type	# New Vehicles
Heavy Duty	14
Medium Duty	11
Light Duty	29
Other	1
TOTAL NEW VEHICLES	**55**

Further information on the number of additional staff and the rationale for the required hiring can be found in Attachment 4-1-3(C) - Workforce Growth. The plan also includes one additional mechanic to support the increasing vehicle and tool requirements.

With respect to the annual trend in expenditures, 2026-2028 have higher expenditure levels than later years due to the hiring of staff and the timing of the need to replace aging and underperforming vehicles in the earlier years of the plan. To ensure continued reliability and prevent potential negative operational impacts, Hydro Ottawa is prioritizing the replacement of a considerable number of its fleet assets that are reaching or have exceeded their expected useful life.

Of Hydro Ottawa's current fleet of 281 vehicles and equipment, 154 (55%) will be at or beyond their replacement criteria age in the 2026-2030 rate period. Of these 154 units, 106 (69%) are planned to be replaced.

11.4. PROGRAM BENEFITS

Hydro Ottawa's capital investments in its vehicle fleet will yield the following benefits:

- Increased fleet reliability
- Optimized fleet lifecycle costs
- Minimized fleet downtime and work execution delays due to unscheduled repairs
- Efficient customer outage responses due to availability of appropriate fleet equipment
- Increased vehicle efficiency, e.g. lower fuel consumption
- Improved garage efficiency by replacing older and poor-condition vehicles that are more costly to maintain with new vehicles
- Reduced environmental impacts such as reductions in greenhouse gases emissions due reduced idling hours
- Increased employee, field crew, and public safety, as newer vehicles are equipped with new technology such as back-up cameras, lane departure warning and other driver safety alerts.

11.5. PROGRAM COSTS

The historical period consists of investments made to replace vehicles including the purchase of some electric or hybrid electric vehicles to replace traditional internal combustion engine (ICE) vehicles. The capital contribution in 2023 shown in Table 40 below represents $100k in electric vehicle governmental rebates; future rebates are unknown and therefore have not been included for the 2026-2030 rate period.

The future costs are focused both on replacing vehicles in poor condition (categorized as Fleet Replacement in Table 40) as well as vehicle additions to support headcount growth (categorized as Fleet Additions in Table 40). During the 2021 to 2025 rate period, there was no headcount growth planned therefore fleet additions were nil. Although additional headcount is being hired in 2024-2025, given lead times for new vehicles, additions to the fleet only occur in 2026. To cover this timing gap, the organization is strategically delaying the disposal of some retiring vehicles, repairing them as needed to serve as temporary replacements or additions, and piloting some sharing programs. In addition, some of the new hires are at the apprentice level and will not require a dedicated vehicle of their own until they are fully licensed.

Table 40 - Fleet Replacement Program Expenditures ($'000 000s)[4]

Budget Program	Historical Years			Bridge Years		Test Years				
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fleet Replacement	$ 1.3	$ 4.7	$ 5.5	$ 3.2	$ 3.0	$ 9.5	$ 6.9	$ 6.5	$ 2.8	$ 0.1
Fleet Additions	-	-	-	-	-	$ 2.6	$ 7.3	$ 4.7	$ 0.3	-
GROSS CAPEX	**$ 1.3**	**$ 4.7**	**$ 5.5**	**$ 3.2**	**$ 3.0**	**$ 12.1**	**$ 14.2**	**$ 11.1**	**$ 3.0**	**$ 0.1**
Capital Contribution	-	-	$ (0.1)	-	-	-	-	-	-	-
NET CAPEX	**$ 1.3**	**$ 4.7**	**$ 5.4**	**$ 3.2**	**$ 3.0**	**$ 12.1**	**$ 14.2**	**$ 11.1**	**$ 3.0**	**$ 0.1**
5-YEAR TOTAL	**$ 17.6**					**$ 40.6**				

Over the 2026-2030 rate period, a total of 140 vehicles at a cost of $40.6M will be purchased in order to replace vehicles at the end of their useful lives and to acquire additional vehicles required to support new work and staff. Table 41 summarizes the total Fleet capital expenditures

[4] Totals may not sum due to rounding.

by year and by vehicle category. While Table 42 (Fleet Replacements) and Table 43 (Fleet Additions) detail the number of vehicles planned in each year by category.

Hydro Ottawa continues to ensure that the utilization of all fleet vehicles is optimized and does not plan on adding new vehicles without assessing the overall need and usage. The numbers presented under the “Total Additions” line in Table 43 represent the total vehicle need based on projected workforce growth, please refer to Attachment 4-1-3(C) - Workforce Growth for further details, rather than the actual number of new vehicles that will be purchased. The “Reduced through Pooling” line reflects Hydro Ottawa's commitment to achieving savings and efficiencies through a pilot vehicle pooling program, which will reduce the total need and therefore the number of actual additions. The bottom line in the table, “Net Additions,” represents the total additions after applying the anticipated reductions achieved through the pooling program. This approach allows Hydro Ottawa to forecast its needs while actively working to minimize them.

The possibility of implementing an expanded vehicle pooling program (some field crews and administrative staff already utilize shared vehicles) has been under evaluation since the move to the new facilities. However, the onset of the COVID-19 pandemic in 2020 understandably led to concerns about shared vehicle use, impacting the feasibility of such a program. Furthermore, the current fleet management software lacked the necessary tools for efficient booking, scheduling, and overall management of a shared vehicle pool. These limitations made it difficult to effectively coordinate vehicle availability and usage.

Hydro Ottawa is scheduled to upgrade its fleet management software in 2025 to address these logistical challenges. This expanded pooling program, particularly in the light-duty category, represents an ambitious target and will necessitate significant change management, including adjustments to work processes, scheduling, and tool storage.

1 **Table 41 - Fleet: Total Capital Expenditures - 2026-2030 ($'000s)[5]**

Vehicle Category	Test Years										Total	
	2026		2027		2028		2029		2030		2026-2030	
	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$
Light Duty	29	$ 1,685	12	$ 710	15	$ 979	12	$ 848	2	$ 135	70	$ 4,358
Medium Duty	7	$ 1,940	7	$ 2,712	2	$ 404	-	-	-	-	16	$ 5,057
Heavy Duty	10	$ 7,153	11	$ 8,400	12	$ 9,297	3	$ 2,166	-	-	36	$ 27,016
Other	6	$ 1,320	10	$ 2,384	2	$ 459	-	-	-	-	18	$ 4,163
TOTAL	**52**	**$ 12,099**	**40**	**$ 14,206**	**31**	**$ 11,138**	**15**	**$ 3,014**	**2**	**$ 135**	**140**	**$ 40,593**

2

3 **Table 42 - Fleet: Capital Expenditure Replacement - 2026-2030 ($'000s)**

Vehicle Category	Test Years										Total	
	2026		2027		2028		2029		2030		2026-2030	
	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$
Light Duty	26	$ 1,502	10	$ 594	12	$ 796	8	$ 591	2	$ 135	58	$ 3,618
Medium Duty	2	$ 333	1	$ 268	2	$ 404	-	-	-	-	5	$ 1,004
Heavy Duty	10	$ 6,322	6	$ 4,117	7	$ 4,809	3	$ 2,166	-	-	26	$ 17,414
Other	6	$ 1,320	9	$ 1,883	2	$ 459	-	-	-	-	17	$ 3,662
TOTAL REPLACEMENTS	**44**	**$ 9,476**	**26**	**$ 6,862**	**23**	**$ 6,467**	**11**	**$ 2,757**	**2**	**$ 135**	**106**	**$ 25,697**

[5] Totals may not sum due to rounding.

Table 43 - Fleet: Capital Expenditure Additions - 2026-2030 ($'000s)[6]

Vehicle Category	Test Years										Total	
	2026		2027		2028		2029		2030		2026-2030	
	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$	# of units	$
Light Duty	20	$ 1,220	2	$ 116	3	$ 184	4	$ 257	-	-	29	$ 1,777
Medium Duty	5	$ 1,608	6	$ 2,445	-	-	-	-	-	-	11	$ 4,052
Heavy Duty	-	-	5	$ 3,410	9	$ 6,617	-	-	-	-	14	$ 10,027
Hybrid Boom price premium		$ 832[7]		$ 873		$ 734		-		-		$ 2,439
Other	-	-	1	$ 501	-	-	-	-	-	-	1	$ 501
TOTAL NEED	**25**	**$ 3,659**	**14**	**$ 7,344**	**12**	**$ 7,535**	**4**	**$ 257**	**-**	**-**	**55**	**$ 18,796**
Reduced through Pooling:												
Light Duty	(17)	$ (1,037)		-		-		-		-	(17)	$ (1,037)
Heavy Duty		-		-	(4)	$ (2,864)		-		-	(4)	$ (2,864)
TOTAL REDUCTIONS	**(17)**	**$ (1,037)**	**-**	**-**	**(4)**	**$ (2,864)**	**-**	**-**	**-**	**-**	**(21)**	**$ (3,901)**
TOTAL ADDITIONS	**8**	**$ 2,622**	**14**	**$ 7,344**	**8**	**$ 4,672**	**4**	**$ 257**	**-**	**-**	**34**	**$ 14,895**

11.5.1. Cost Factors

Inflation

Since 2021, the price of vehicles has increased significantly, between approximately 20% to 40% as noted below, please refer to Schedule 1-2-5 - Impacts of Inflationary Pressure for further details on this period of high inflation. This has had an impact on the cost of vehicles purchased in the 2021-2025 rate period. It is also a contributing factor to the higher fleet replacement costs in the 2026-2030 rate period. Table 44 provides examples of price increases associated with five typical vehicles in Hydro Ottawa's fleet.

[6] Totals may not sum due to rounding.
[7] Although there are no additions to the heavy duty fleet in 2026, this addition of the hybrid boom will be added to the heavy duty replacement but was included here to display the total budgeting of $2.4M on hybrid booms

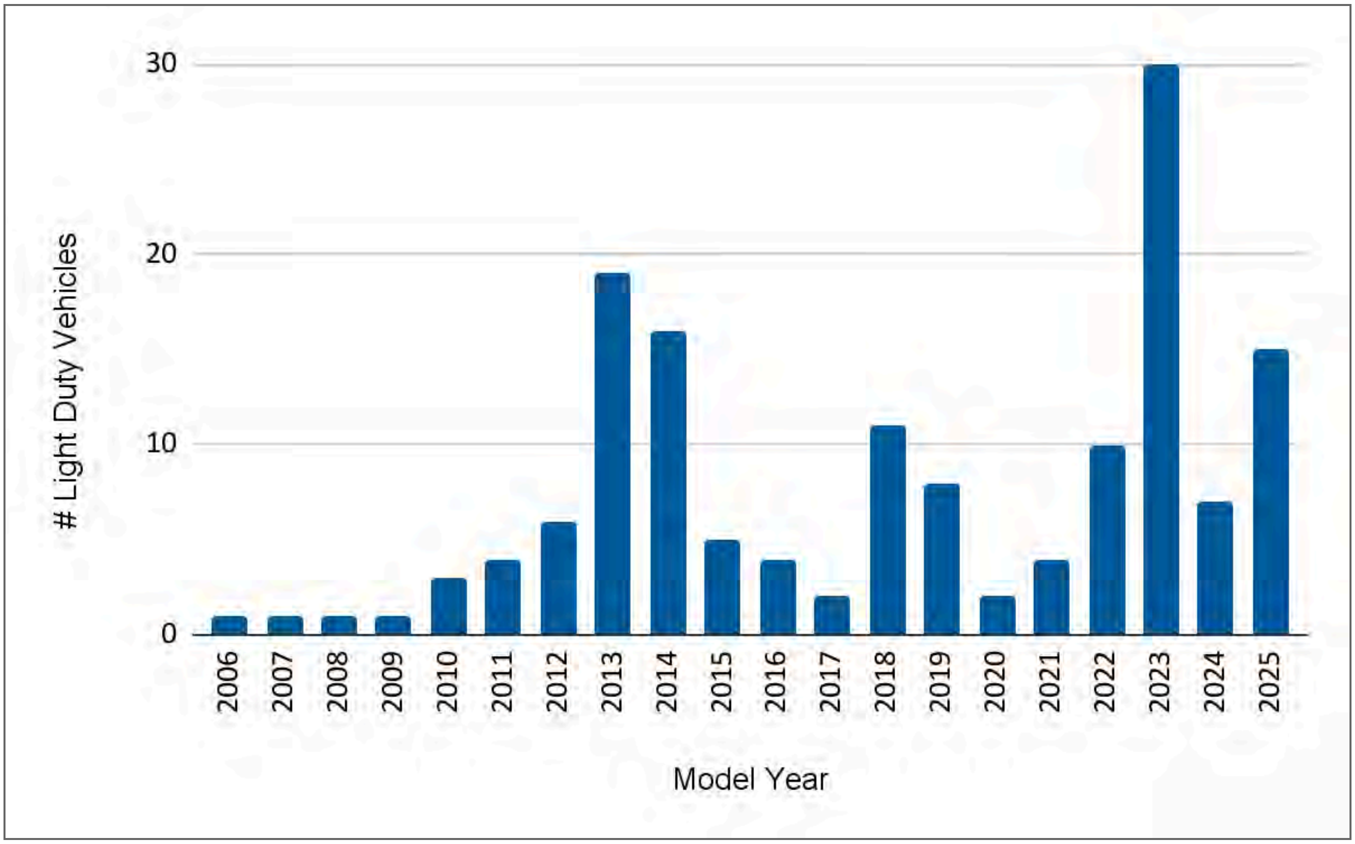
Table 44 - Vehicle Unit Price Increases 2021 vs. 2024

Vehicle Category	Example	2021	2024	% Increase
Light Duty	3/4 Ton Pick-Up	$ 51,485	$ 73,700	43.1%
Light Duty	Cargo Van	$ 38,880	$ 54,846	41.1%
Medium Duty	Step Side Van (excluding interior upfit)	$ 152,900	$ 209,500	37.0%
Heavy Duty	Large RBD	$ 435,201	$ 613,705	41.0%
Heavy Duty	Large Bucket	$ 471,800	$ 582,891	23.5%

Age of Fleet

While vehicle age is not the only criteria for replacement, it is an indication of the need to assess the condition of the vehicle and determine if there is a need for replacement. Figures 6, 7 and 8 illustrate the age distribution of light-, medium- and heavy-duty vehicles.

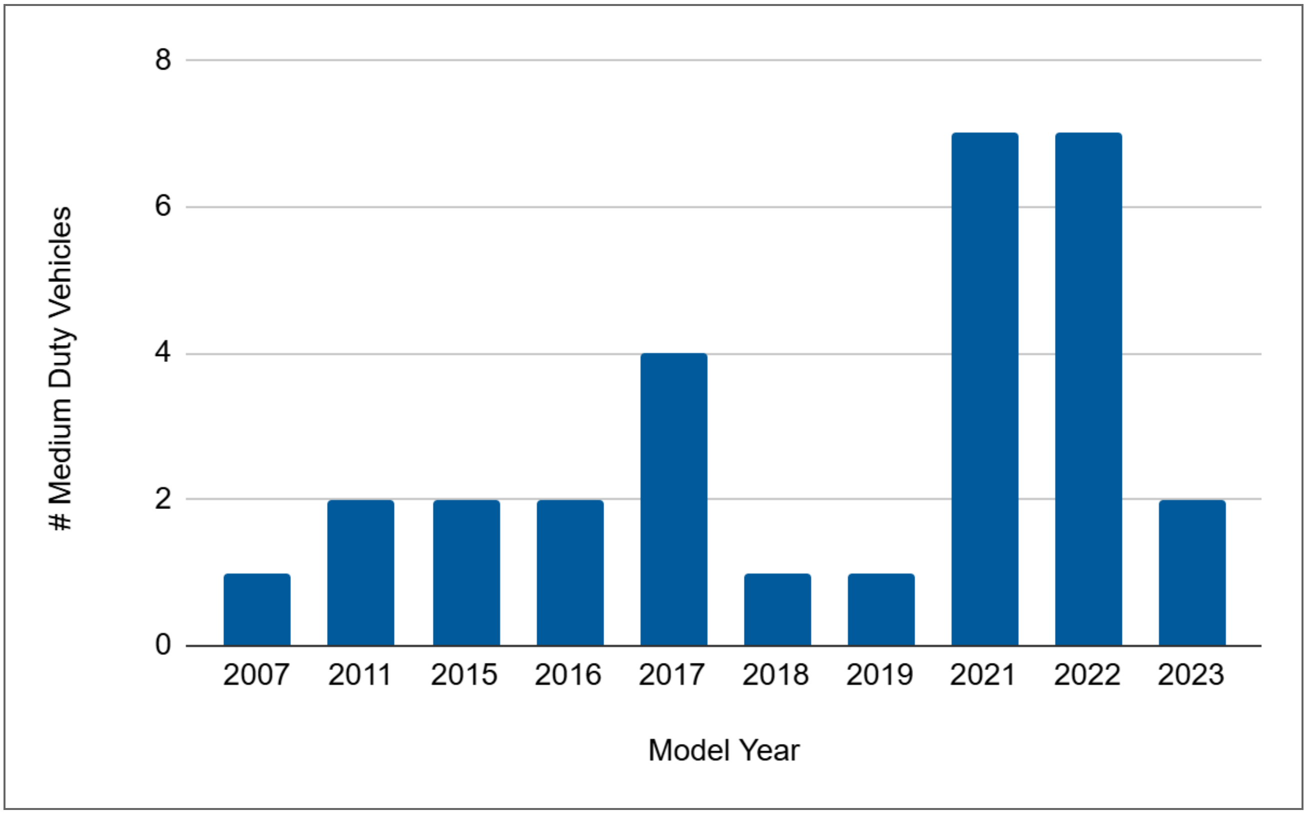
Figure 6 - Number of Light Duty Vehicles by Model Year[8]



Age replacement criteria for light-duty vehicles is between 8-10 years. Based on replacement at the high end of the range, 82 vehicles would require replacement in the 2026-2030 rate period but only 58 of these vehicles are planned to be replaced based on condition assessments.

[8] Fleet projection as of December 31, 2025. No bar indicates no vehicles of that model year.

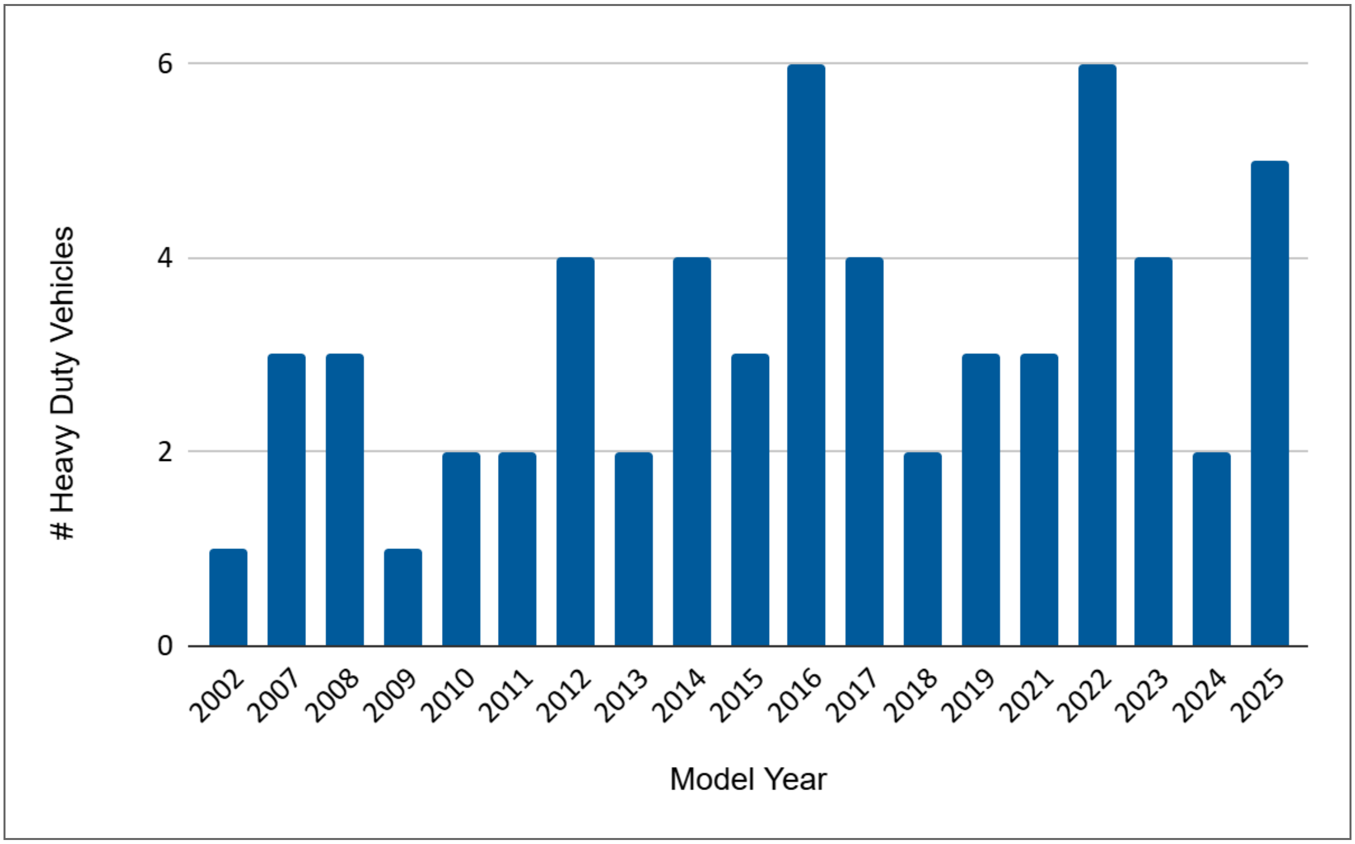
Figure 7 - Number of Medium Duty Vehicles by Model Year[9]



Age replacement criteria range for medium-duty vehicles is between 12-15 years. Based on replacement at the high end of the range, five vehicles would require replacement in the 2026-2030 rate period and all five vehicles are planned to be replaced due to their condition.

[9] Fleet projection as of December 31, 2025. No bar indicates no vehicles of that model year.

Figure 8 - Number of Heavy Duty Vehicles by Model Year[10]



Age replacement criteria range for heavy-duty vehicles is between 12-15 years. Based on replacement at the median of the range, 31 vehicles would require replacement in the 2026-2030 rate period but only 26 vehicles are planned to be replaced based on condition assessments.

[10] Fleet projection as of December 31, 2025. No bar indicates no vehicles of that model year.

11.6. ALTERNATIVES EVALUATION

Hydro Ottawa considered three alternatives in determining its approach to capital investment in Fleet. These alternatives are identified, explained, and evaluated below.

11.6.1. Alternatives Considered

Alternative One - Run to Failure with Minimal Replacement: This approach prioritizes minimizing capital expenditures by extending the life of existing vehicles beyond their target replacement criteria. This requires increased investment in maintenance and repairs, delaying new vehicle procurement until existing units are unsafe or unreliable. While this minimizes short-term capital costs, it carries significant risks, including:

- Increased long-term maintenance costs due to escalating repairs on aging vehicles.
- Higher safety risks due to potential equipment failures and the use of older vehicles.
- Reduced productivity and system reliability due to vehicle downtime and unavailability.
- Potential for higher lifecycle costs due to the inefficiencies of maintaining a fleet of increasingly obsolete vehicles.

Alternative Two - Optimized Replacement and Strategic Additions: This alternative balances the need for reliable equipment with cost optimization. It focuses on replacing priority vehicles that exceed target replacement criteria or fail qualitative assessments, while also strategically adding vehicles to support growth. Key elements include:

- Prioritizing replacements based on condition assessments, lifecycle cost analysis, and operational needs.
- Implementing vehicle pooling and optimizing work schedules to reduce the total number of vehicles required.
- Carefully evaluating new vehicle requests to ensure they are essential and cannot be met through existing resources.
- Continuously assessing vehicle condition and making strategic repair versus replacement decisions.

Alternative Three - Full Replacement: This approach advocates for replacing all vehicles meeting target replacement criteria, and with EV counterparts and hybrid features where available. While this maximizes fleet reliability and availability in the short term and helps Hydro Ottawa meet its Net-Zero targets faster, it has several drawbacks:

- Significantly higher capital expenditures, potentially replacing vehicles before the end of their useful life.
- Suboptimal lifecycle costs due to premature replacements.
- Risk of insufficient charging capacity or back-up power generation to adequately and reliably support a rapidly growing electric fleet, especially if a major weather event causes power outages.
- Based strictly on the replacement age criteria in Section 11.6.2 - Evaluation Criteria, fleet replacement and additions would require a capital funding need of $57M (for 193 vehicles) over the 2026-2030 period.

11.6.2. Evaluation Criteria

The alternatives were evaluated using quantitative criteria, as shown in Table 45 below, and qualitative assessments, including vehicle condition, repair history, mechanic/technician judgment, and operational needs. The quantitative criteria, unchanged from the EB-2019-0261 application, provide a baseline for replacement consideration. It's important to note that meeting a quantitative criterion does not automatically trigger replacement; a comprehensive assessment is always performed.

Table 45 – Quantitative Vehicle Replacement Criteria

Vehicle Description	Age	Km	Engine Hours	PTO Hours
Light Duty				
Automobile (All types)	10	150,000	4,000	N/A
Pick-up Trucks (All types)	10	100,000	5,000	N/A
Vans (Compact)	8	150,000	5,000	N/A
Vans (Cargo)	8	150,000	6,000	N/A
Medium Duty				
Vans (StepSide/Cube/ Walk-through Body)	12	150,000	8,000	N/A
Trucks (Dump)	12	125,000	6,000	N/A
Trucks (Stake / Flatbed)	15	150,000	8,000	N/A
Heavy Duty				
Trucks (Bucket, Radial Boom Derrick (RBD) and Line - includes track units)	12	200,000	10,000	5,000
Trucks (Knuckle Boom / Crane includes track units)	15	200,000	10,000	5,000
Other				
Forklifts (Inside and Outside)	15	N/A	10,000	N/A
Trailers (Pole, Utility, Pulling, Reel)	15	N/A	N/A	N/A

11.6.3. Preferred Alternative

Hydro Ottawa's preferred alternative is Alternative Two. This approach best balances the need for a reliable and efficient fleet with the imperative to manage costs effectively. While Alternative Three offers the highest level of reliability, it comes at a significantly higher cost. Alternative One, while minimizing initial capital outlay, poses substantial risks to safety, reliability, and long-term costs. Alternative Two provides a responsible and sustainable approach to fleet management, optimizing lifecycle costs while ensuring the availability of necessary equipment. The funding requested in this application reflects the balance inherent in Alternative Two, although budgetary constraints required some difficult choices regarding the timing of certain replacements, incorporating some elements of Alternative One to extend the life of some assets where the risk is deemed acceptable. This approach requires careful monitoring and proactive maintenance to mitigate any potential negative impacts.

11.7. PROGRAM EXECUTION AND RISK MITIGATION

11.7.1. Implementation Plan

Hydro Ottawa's Fleet Replacement Program will be implemented through a comprehensive approach encompassing vehicle procurement, advanced fleet management systems, and ongoing utilization analysis.

Vehicle Procurement:

Hydro Ottawa's vehicle procurement process adheres to the utility's Procurement Policy detailed in Attachment 4-2-2(A) - Procurement Policy. Capital replacement needs are identified and open tenders are issued through the Procurement group. This competitive process ensures market flexibility and the opportunity to secure the most favorable pricing and terms. Standardized fleet specifications have been developed for key vehicle models, streamlining procurement and promoting fleet uniformity. These specifications cover critical parameters such as lifting capacity, cab design, turning radius, and boom characteristics. Hydro Ottawa acknowledges the long lead times (up to 24 months) associated with certain specialized vehicles and incorporates this factor into its procurement planning.

Fleet Management and Tracking:

To maximize fleet efficiency and effectiveness, Hydro Ottawa utilizes integrated fleet management and telematics systems.

- **Fleet Management System:** This web-based system (upgrade to cloud-based system scheduled for 2025) provides a comprehensive platform for managing all aspects of fleet operations, including:
    - Asset tracking and capital replacement planning
    - Preventative maintenance scheduling

- Workshop management (workflow planning, scheduling, job assignment)
- Work order management
- Warranty, recall, and campaign tracking
- Operating cost management (fuel, licenses, permits)
- Inventory management (parts supply system)
- Risk management (MVA, safety, compliance)
- Technician records and training plans
- Upgrade to new cloud-based system in 2025 will support comprehensive motor pooling (efficient booking, scheduling, and overall management of a shared vehicle pool)

- This system facilitates proactive maintenance by providing notifications of upcoming service needs (30, 60, and 90 days in advance). This enables efficient scheduling and minimizes vehicle downtime.

- **Telematics System:** This GPS-based system integrates with the fleet management system to provide real-time vehicle location and operational data, including routes, idling time, mileage, engine hours, and driver behavior. Key benefits of the telematics system include:
  - Idle time tracking and reduction
  - Vehicle utilization monitoring and optimization
  - Garage downtime and repair time tracking
  - Real-time engine fault detection
  - Driver behavior monitoring and improvement through driver scorecards (tracking excessive idling, harsh acceleration/braking, speeding, etc.)
  - Accident review and reconstruction

The integration of the fleet management and telematics systems allows for a proactive and data-driven approach to fleet maintenance. Real-time data from the telematics system informs maintenance schedules in the fleet management system, ensuring timely service and minimizing downtime. Operator-reported defects in the telematics system are seamlessly integrated into the fleet management system's repair queue.

Utilization Optimization:

Hydro Ottawa is committed to optimizing vehicle utilization and maximizing the efficiency of its fleet assets. Data from the telematics system is used to analyze utilization patterns across all vehicle classes, identifying opportunities for rationalization, efficiency gains, and asset pooling. While traditional mileage-based utilization metrics are not directly applicable to Hydro Ottawa's diverse operations (which include 24/7 availability, specialized equipment with high boom hours but low mileage, and crew/material transport), the utility considers these factors in its comprehensive analysis.

A key strategy for optimizing utilization is asset pooling. Hydro Ottawa actively seeks opportunities to share vehicles amongst different work groups and departments The consolidation of operations into centralized facilities in 2019 has further facilitated asset pooling and improved overall fleet utilization by reducing travel time to job sites and enabling better coordination of vehicle deployment. Assigning vehicles to specific groups and positions also supports this initiative, clarifying responsibilities and streamlining the sharing process. For example, light-duty vehicles (pickups, vans, cars) are frequently shared between teams with complementary schedules, maximizing their usage. However, to further maximize vehicle sharing, the scheduled upgrade to the fleet management software in 2025 will bring about an expanded pooling program and address prior limitations due to the current fleet management software. This approach is expected to reduce the overall number of vehicles required, minimizing capital expenditures and operational costs.

Analysis of usage patterns for all vehicle types helps identify low-utilization units for potential removal or redeployment, further contributing to cost savings and efficiency gains. The planned reductions in vehicle additions through pooling, as detailed in Table 43, demonstrate Hydro Ottawa's commitment to this important initiative.

11.7.2. Risks to Completion and Risk Mitigation Strategies

Table 46 outlines the key risks associated with the Fleet Replacement Program and the corresponding mitigation strategies.

Table 46 - Key Risks of Fleet Replacement and Mitigation Strategies

Category	Risk	Mitigation
Safety	Employee and public safety issues related to fleet deterioration	• Compliance with applicable codes, standards and regulations • Management supervision, risk assessments and reporting • Proactive replacement of vehicles based on condition and usage, not just age • Training programs focusing on safe operation
Operational	Fleet assets not available when needed to support OM&A and Capital programs	• Scheduled maintenance and inspection of all fleet vehicles and equipment • Advanced ordering prior to need (accommodating lead times) • Competitive procurement process • Contractual agreement with vendors regarding delivery dates • Regular review of fleet utilization data to optimize fleet size and composition
Financial	Higher fleet life-cycle costs due to failure to replace end of life fleet	• Fleet management system and proactive assessment of vehicle condition and replacement

CAPITALIZATION POLICY

In accordance with section 2.2.9 of the *Chapter 2 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications,* as dated on December 9, 2024, Hydro Ottawa's Capitalization Policy is provided in this Schedule as Attachment 2-6-1(A) - Capitalization Policy. Hydro Ottawa converted to International Financial Reporting Standards effective January 1, 2015. No changes have been made to Hydro Ottawa's capitalization policy since its last rebasing application.[1]

[1] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020).

HYDRO OTTAWA CORPORATE POLICY

Subject: Capitalization		
Category: Finance		**Policy Number**: POL-Fi-013.01
Administrator: Director, Finance	**Owner:** Chief Financial Officer	**Approver:** President and Chief Executive Officer

1. PURPOSE

The purpose of this policy is to define the criteria for acquisition, capitalization, transfer and retirement of Hydro Ottawa capital assets.

2. SCOPE

This policy applies to Hydro Ottawa.

3. DEFINITIONS

Capital assets include tangible and intangible assets, exclusive of goodwill

Commissioned or energized, in the context of this policy, is when a capital asset is placed into service or when the enhancement or betterment to an existing capital asset is complete

Directly Attributable Costs are costs that bring the asset to the location and condition intended for use, and include direct labour, inventory, outside services, non-stock materials and specific burdens

Enhancement or Betterment is an expenditure that contributes towards improving an asset's productivity or output or useful life

Goodwill, as defined by IAS 38, is the difference between the purchase price of an asset and the net amount of the acquired asset and assumed liability

Grouped Assets are asset purchases that are pooled into a single capital asset category as, by their nature, it would be impractical to identify individual units. These grouped assets are managed as a single asset for the purposes of depreciation

Hydro Ottawa refers to Hydro Ottawa Holding Inc. and its affiliates

IAS refers to International Accounting Standards

IAS 16 refers to the International Accounting Standard titled Property, Plant and Equipment

IAS 23 refers to the International Accounting Standard titled Borrowing Costs

IAS 38 refers to the International Accounting Standard titled Intangible Assets

IASB refers to the International Accounting Standards Board

IFRS refers to International Financial Reporting Standards

Intangible Assets, as defined by IAS 38, are identifiable non-monetary assets without physical substance

OM&A refers to operating, maintenance and administrative expenses

PP&E refers to Property, Plant and Equipment or Tangible Assets

Readily Identifiable Assets are discrete capital assets that are easily identifiable, so the asset can be individually recorded and depreciated

Residual Value is the estimated amount that an entity would currently obtain from disposal of the asset, after deducting the estimated costs of disposal, if the asset were already of the age and in the condition expected at the end of its useful life

Tangible Assets, as defined by IAS 16, include PP&E that are used on a continuing basis in the production or supply of goods and services and are not intended for sale in the ordinary course of business

4. POLICY DIRECTIVES

a) Hydro Ottawa will capitalize assets based on the standards established by the IASB under IAS 16 and IAS 38 whereby qualifying expenditures have to meet the following criteria:
   i. It is probable that further economic benefits associated with the item, for more than one year, will flow to the entity; and
   ii. the cost of the item can be measured reliably.

b) Capital asset are recorded using the cost method, whereby the cost of a capital asset comprises:
   i. its purchase price, including import duties and non-refundable purchase taxes, after deducting trade discounts and rebates.

ii. any costs directly attributable to bringing the asset to the location and condition necessary for it to be capable of operating in the manner intended by management. This shall include borrowing costs, in accordance with IAS 23, to finance capital projects with a duration greater than six months and accumulated cost is in excess of $100,000.
iii. the initial estimate of the costs of dismantling and removing the item and restoring the site on which it is located, the obligation for which an entity incurs when the item is acquired or as a consequence of having used the item during a particular period for purposes other than to produce inventories during that period.

c) Contributed plant that meets the definition of a capital asset is measured at fair value.
d) The following cost allocation rates included in directly attributable costs are based on management's best estimates of the applicable cost allocation determinants:
   i. Direct Labour - The hourly rate recovers direct labour and benefits costs. It will be applied to all direct labour hours through timesheet reporting.
   ii. Vehicle and Equipment - Vehicle and equipment hourly rates capture the directly attributable costs associated with fleet usage. Individual rates are developed for major vehicle classifications based on expected utilization. Charges will be accomplished through vehicles timesheet reporting.
   iii. Supervision Burden - The supervision burden rate recovers the directly attributable costs associated with the supervision of internal labour and outside services.
   iv. Engineering Burden - The engineering burden rate recovers the directly attributable engineering costs. It will be applied to Distribution Capital projects where applicable.
   v. Supply Chain Burden - The supply chain burden rate recovers the directly attributable procurement and warehouse costs.
   vi. These rates are reviewed and monitored on an annual basis. Material adjustments for over or under recoveries will also be recorded at the end of the fiscal year.
e) Subsequent enhancement or betterment costs which are incurred after the original asset is available for use will be capitalized based on the same criteria as the initial capital investment.
f) The materiality value for capitalizing newly acquired readily identifiable assets or additions to existing assets will be $500.
g) The materiality value for capitalizing grouped assets will be $1,000.
h) Equipment such as switchgear, transformers and meters that are reserved for emergency (capital spares) should be accounted as capital assets otherwise these items will be accounted for as inventory.
i) Depreciation of capital assets is based on the straight-line method in accordance with IAS 16 and 38. The useful lives of assets are reviewed annually.
j) Costs that are incurred to maintain the existing service potential of capital assets should be considered repairs and will be recognized in the profit or loss in the period in which they occur.
k) Hydro Ottawa may incur expenditures for amounts paid to other distributors or transmitters for capital projects. These expenditures, once available for use, should be recorded as Intangible Assets – Capital Contributions Paid.
l) Customer contributions associated with capital projects will be treated as deferred revenue and amortized to income over the life of the assets to which they relate.
m) When assets are retired from service, the capital cost and accumulated depreciation will be removed from Hydro Ottawa's financial statements with any gain or loss (after salvage proceeds, if applicable) charged to OM&A in the period in which the decommissioning occurs.

5. RELATED POLICIES, PROCEDURES AND REFERENCE DOCUMENTS

Hydro Ottawa Code of Business Conduct

6. EXCLUSIONS

There are no exclusions from this policy

7. ADDITIONAL POLICY ELEMENTS

There are no additional policy elements

8. COMPLIANCE

Employees must report incidents of non-compliance relating to this policy in a timely manner to the Policy Owner.

All instances of non-compliance shall be addressed immediately and may result in progressive disciplinary action. All members of the work group who had prior knowledge of the non-compliance may also be subject to progressive discipline. Repeat instances of non-compliance, or those that appear to be of a serious nature, must be immediately reported directly to the Director, Finance.

9. APPROVAL HISTORY

Revision	Effective Date	Description of Changes	Policy Owner:	Approved by:
.00	January 2015	Supersedes Policy FIN5-001-02 published on January 1, 2009	G. Simpson, Chief Financial Officer	B. Conrad, President and CEO
.01	October 2019	Minor updates to wording to match IFRS Standards and clause added regarding CCRA payments	DocuSigned by: Geoff Simpson 43DC885CF33E43F... G. Simpson, Chief Financial Officer	DocuSigned by: Bryce Conrad 8EDB4595749C4E3... B. Conrad, President and CEO

Scheduled Re-affirmation Date: **October 2022**	Responsibility: **Chief Financial Officer**

Signatures on original only; original retained by Chief Financial Officer Division

10. POLICY EXCEPTIONS

Exceptions to the above directives and/or changes to this policy must receive written pre-authorization from the President and CEO. For clarification on any aspect of this policy, contact the Director of Finance.

CAPITALIZATION OF OVERHEAD

Effective January 1, 2012, Hydro Ottawa revised its capitalization methodology used to apply overhead costs to property, plant, and equipment and intangible assets to be in accordance with International Financial Reporting Standards (IFRS). Under IFRS, International Accounting Standard 16 – *Property, Plant and Equipment* (IAS 16) and International Accounting Standard 38 – *Intangible Assets* (IAS 38) prohibit the capitalization of administration and other general overhead costs. As a result, the amount of capitalized overhead was significantly reduced as many of the costs that were capitalized prior to the revision of the policy were considered administrative or other general overhead. There have been no changes to Hydro Ottawa's capitalization of overhead since January 1, 2012 (and thus there have likewise been no changes since the utility's last rebasing application).

Hydro Ottawa applies overhead costs to capital through three separate burden rates: Supervision burden, Engineering burden, and Supply Chain burden. The use of multiple burden rates allows overhead costs to be applied more precisely to the particular projects that are associated with the various types of overhead costs. Please refer to Attachment 2-6-1(A) - Capitalization Policy for Hydro Ottawa's capitalization policy.

As shown in Attachment 2-6-2(A) - OEB Appendix 2-D - Overhead Expenses, the overhead costs capitalized (including labour and fleet) from 2021-2026 are in the range of 19 - 26%.

Attachment 2-6-2(A) - OEB Appendix 2-D - Overhead Expense

(Refer to the attachment in Excel format)

DEPRECIATION, AMORTIZATION DISPOSAL

1. INTRODUCTION

In accordance with section 2.2.4 of the *Chapter 2 Filing Requirements for Electricity Distribution Rate Applications - 2025 Edition for 2026 Rate Applications,* dated December 9, 2024, this Schedule demonstrates that Hydro Ottawa's proposed levels of depreciation and amortization expenses appropriately reflect the useful lives of the utility's assets and the OEB's accounting policies.

2. ANNUAL DEPRECIATION AND AMORTIZATION

In Tables 1 and 2 below, Hydro Ottawa provides details for depreciation by asset group for the Historical Years 2021-2023, Bridge Years 2024-2025, and 2026-2030 Test Years.

Table 1 – Depreciation Expense - Historical & Bridge Years ($'000s)

Asset Group	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Land and Buildings	$ 3,448	$ 3,548	$ 3,620	$ 3,918	$ 3,974
TS Primary Above 50	$ 4,005	$ 4,575	$ 4,659	$ 4,720	$ 4,785
Distribution Stations	$ 4,045	$ 4,012	$ 4,124	$ 4,283	$ 4,286
Poles, Wires	$ 21,508	$ 23,557	$ 25,543	$ 27,961	$ 30,443
Line Transformers	$ 3,461	$ 3,742	$ 4,036	$ 4,337	$ 4,651
Services and Meters	$ 6,622	$ 5,969	$ 5,593	$ 5,592	$ 5,949
General Plant	$ 1,796	$ 2,684	$ 2,703	$ 2,639	$ 2,691
Equipment	$ 3,111	$ 3,101	$ 3,369	$ 3,396	$ 3,344
IT Assets	$ 7,645	$ 8,120	$ 8,408	$ 9,845	$ 11,177
Other Distribution Assets	$ 1,434	$ 1,602	$ 1,562	$ 1,408	$ 1,450
Sub-Total	**$ 57,074**	**$ 60,911**	**$ 63,616**	**$ 68,097**	**$ 72,750**
Contributions and Grants	$ (6,383)	$ (7,124)	$ (7,955)	$ (9,309)	$ (10,815)
TOTAL	**$ 50,690**	**$ 53,786**	**$ 55,661**	**$ 58,788**	**$ 61,936**

Table 2 – Depreciation Expense - Test Years ($'000s)

Asset Group	Test Years				
	2026	2027	2028	2029	2030
Land and Buildings	$ 4,164	$ 4,393	$ 4,778	$ 4,979	$ 5,118
TS Primary Above 50	$ 5,368	$ 6,598	$ 8,654	$ 9,047	$ 9,065
Distribution Stations	$ 4,473	$ 4,719	$ 5,237	$ 5,247	$ 5,156
Poles, Wires	$ 33,263	$ 36,958	$ 40,935	$ 44,460	$ 48,261
Line Transformers	$ 5,008	$ 5,392	$ 5,782	$ 6,169	$ 6,605
Services and Meters	$ 6,614	$ 7,648	$ 9,006	$ 10,486	$ 12,135
General Plant	$ 2,826	$ 3,028	$ 3,292	$ 3,213	$ 3,498
Equipment	$ 3,252	$ 4,671	$ 6,131	$ 7,240	$ 8,120
IT Assets	$ 12,910	$ 14,145	$ 12,451	$ 13,021	$ 13,367
Other Distribution Assets	$ 1,590	$ 1,845	$ 2,042	$ 2,035	$ 2,170
Sub-Total	**$ 79,467**	**$ 89,396**	**$ 98,308**	**$ 105,897**	**$ 113,493**
Contributions and Grants	$ (12,262)	$ (14,005)	$ (16,052)	$ (17,533)	$ (19,083)
TOTAL	**$ 67,205**	**$ 75,392**	**$ 82,256**	**$ 88,364**	**$ 94,410**

For detailed depreciation and amortization expenses, please see the following Excel Attachments:

- Attachment 2-7-1(A) - OEB Appendix 2-BB - Service Life Comparison
- Attachment 2-7-1(B) - OEB Appendix 2-C - 2021-2025 Depreciation and Amortization Expense
- Attachment 2-7-1(C) - OEB Appendix 2-C- 2026-2030 Depreciation and Amortization Expense

3. DISPOSITIONS BY ASSET GROUP

In Tables 3 and 4 below, Hydro Ottawa provides details of amortization related to disposals by asset group for the Historical Years (2021-2023), Bridge Years (2023 and 2024), and Test Years (2026-2030).

Table 3 – Disposals - Historical Years ($'000s)[1]

Asset Group	Historical Years			Bridge Years	
	2021	2022	2023	2024	2025
Land and Buildings	$ (12)	$ (1)	-	-	-
TS Primary Above 50	$ (85)	$ (483)	$ (12)	$ (36)	$ (35)
Distribution Stations	$ (139)	$ (139)	$ (76)	$ (76)	$ (72)
Poles, Wires	$ (41)	$ (187)	$ (147)	$ (146)	$ (139)
Line Transformers	$ (247)	$ (189)	$ (155)	$ (206)	$ (196)
Services and Meters	$ (293)	$ (161)	$ (337)	$ (250)	$ (239)
General Plant	-	-	-	-	-
Equipment	$ (160)	$ (864)	$ (528)	$ (460)	$ (438)
IT Assets	-	-	-	-	-
Other Distribution Assets	-	-	-	$ (3)	$ (3)
Sub-Total	**$ (976)**	**$ (2,025)**	**$ (1,255)**	**$ (1,176)**	**$ (1,122)**
Contributions and Grants	-	-	-	-	-
TOTAL	**$ (976)**	**$ (2,025)**	**$ (1,255)**	**$ (1,176)**	**$ (1,122)**

[1] Totals may not sum due to rounding.

Table 4 – Disposals - Test Years ($'000s)[2]

Asset Group	Test Years				
	2026	2027	2028	2029	2030
Land and Buildings	-	-	-	-	-
TS Primary Above 50	$ (34)	$ (34)	$ (34)	$ (34)	$ (34)
Distribution Stations	$ (71)	$ (71)	$ (71)	$ (71)	$ (71)
Poles, Wires	$ (136)	$ (136)	$ (136)	$ (136)	$ (136)
Line Transformers	$ (192)	$ (192)	$ (192)	$ (192)	$ (192)
Services and Meters	$ (1,299)	$ (3,211)	$ (3,726)	$ (4,665)	$ (5,650)
General Plant	-	-	-	-	-
Equipment	$ (430)	$ (430)	$ (430)	$ (430)	$ (430)
IT Assets	-	-	-	-	-
Other Distribution Assets	$ (3)	$ (3)	$ (3)	$ (3)	$ (3)
Sub-Total	**$ (2,166)**	**$ (4,077)**	**$ (4,593)**	**$ (5,532)**	**$ (6,516)**
Contributions and Grants	-	-	-	-	-
TOTAL	**$ (2,166)**	**$ (4,077)**	**$ (4,593)**	**$ (5,532)**	**$ (6,516)**

4. DEPRECIATION AND AMORTIZATION RATES

Table 5 below provides detailed rates of depreciation and amortization by Uniform System of Accounts (USofA). Depreciation and amortization rates remain unchanged between the Historical/Bridge Years and the Test Years for all Accounts.

[2] Totals may not sum due to rounding.

Table 5 – Property, Plant, and Equipment Depreciation Rates 2021-2030[3]

USofA		Depreciation Rate
1609	Capital Contributions Paid*	2.20%
1611	Computer Software	10% - 20%
1612	Land Rights*	2%
1805	Land	N/A
1808	Buildings	1.3% - 3.3%
1815	Transformer Station Equip. >50 kV	2.2% - 6.7%
1820	Distribution Station Equip. <50 kV	2.2% - 6.7%
1825	Storage Battery Equipment	5% - 10%
1830	Poles, Towers & Fixtures	2.20%
1835	Overhead Conductors & Devices	2.2% - 4%
1840	Underground Conduit	2.50%
1845	Underground Conductors & Devices	1.7% - 4%
1850	Line Transformers	2.90%
1855	Services (Overhead & Underground)	2.20%
1860	Meters	6.70%
1905	Land	N/A
1908	Buildings & Fixtures	1.3% - 5%
1915	Office Furniture & Equipment	10%
1920	Computer Equipment - Hardware	10% - 25%
1930	Transportation Equipment	6.7% - 12.5%
1935	Stores Equipment	10%
1940	Tools, Shop & Garage Equipment	10%
1945	Measurement & Testing Equipment	10%
1950	Power Operated Equipment	6.7% - 8.3%
1955	Communications Equipment	4% - 12.5%
1960	Miscellaneous Equipment*	10%
1970	Load Mgmt Controls Customer Premises*	10%
1975	Load Mgmt Controls Utility Premises*	10%
1980	System Supervisor Equipment	6.70%

[3] USofAs in this table with an asterisk (*) are not included in the Kintectrics study referenced in this Schedule.

The useful lives of Hydro Ottawa's assets and components have been determined based on experience, professional judgement, failure data, and local conditions. Some useful lives differ when compared to the useful life range noted in the Kinectrics Report.[4] However, the useful lives of Hydro Ottawa's assets have been approved in previous rate applications. The utility has therefore continued to depreciate its fixed assets using the same methodology and useful lives as in prior years.

For further details on the useful lives of Hydro Ottawa's assets, please reference Attachment 2-7-1(A) - OEB Appendix 2-BB - Service Life Comparison.

There are variances between the depreciation and amortization calculated using the formulas in the annual Appendix 2-C[5] and those presented in the annual Appendix 2-BA.[6] Hydro Ottawa uses the half-year rule for calculating depreciation/amortization in the year that capital additions are added to the rate base, for both actual and budgeted pooled assets. However, in the case of discrete material assets (e.g. a station, major investment in IT assets, and so forth), the actual or forecasted in-service month would be used to calculate the depreciation/amortization. This is consistent with Hydro Ottawa's historical practices for these types of assets, for both rate application and financial reporting purposes.

Hydro Ottawa uses its financial system to calculate depreciation and amortization expense on assets that are already in service, and uses a depreciation forecast model to calculate depreciation and amortization on budgeted capital additions. Both the financial system and forecast model incorporate actual in-service dates of discrete material assets in the calculation. Hydro Ottawa proposes to continue this method of calculating depreciation for the 2026-2030 period.

[4] Kinectrics Inc., *Asset Depreciation Study for Use by Electricity Distributors*, EB-2010-0178 (July 8, 2010).
[5] The OEB's Appendix 2-C for the years 2021-2030 can be found in Attachments 2-7-1(B) and (C), respectively.
[6] The OEB's Appendix 2-BA for the years 2021-2030 can be found in Attachments 2-2-1(A) and (B), respectively.

5. NET GAIN/LOSS ON DISPOSITION

In Hydro Ottawa's last rebasing application,[7] the OEB approved the establishment of USofA 4362 Loss from Retirement of Utility and Other Property to record the difference between the forecast and actual loss on the disposal of fixed assets related to retirement of assets or damages to plant. Table 6 provides the balance in USofA 4362 for the Historical Years (2021-2023) and Bridge Years (2024 and 2025).

Table 6 – Loss from Retirement of Utility and Other Property ($'000s)

UsofA	Net (Gain)/Loss	Historical Years			Bridge Years		TOTAL
		2021	2022	2023	2024	2025	2021-2025
4362	OEB Approved	$ 389	$ 751	$ 323	$ 336	$ 445	$ 2,243
4362	Actual (gain)/loss	$ (202)	$ 1,234	$ (897)	$ (368)	$ (273)	$ (506)
1508	**Variance**	**$ (590)**	**$ 483**	**$ (1,220)**	**$ (704)**	**$ (718)**	**$ (2,749)**

The increased loss in 2022 is as a result of the Derecho and the higher number of assets that were derecognized during this storm.

Hydro Ottawa is seeking the continuance of the net gain/loss on fixed assets variance account in Schedule 9-1-3 - Group 2 Accounts and Schedule 6-3-5 - Other Income & Deductions. Table 7 provides the annual forecast amounts for the 2026-2030 Test Years.

Table 7 – Loss from Retirement of Utility and Other Property ($'000s)

Net (Gain)/Loss	Test Years					TOTAL
	2026	2027	2028	2029	2030	2026-2030
Forecast	$ 167	$ 636	$ 596	$ 609	$ 576	**$ 2,583**

[7] Hydro Ottawa Limited, *2021-2025 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2019-0261 (February 10, 2020).

Attachment 2-7-1(A) - OEB Appendix 2-BB - Service Life Comparison

(Refer to the attachment in Excel format)

Attachment 2-7-1(B) - OEB Appendix 2-C - 2021 Depreciation and Amortization Expense

(Refer to the attachment in Excel format)

Attachment 2-7-1(C) - OEB Appendix 2-C - 2022 Depreciation and Amortization Expense

(Refer to the attachment in Excel format)