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.

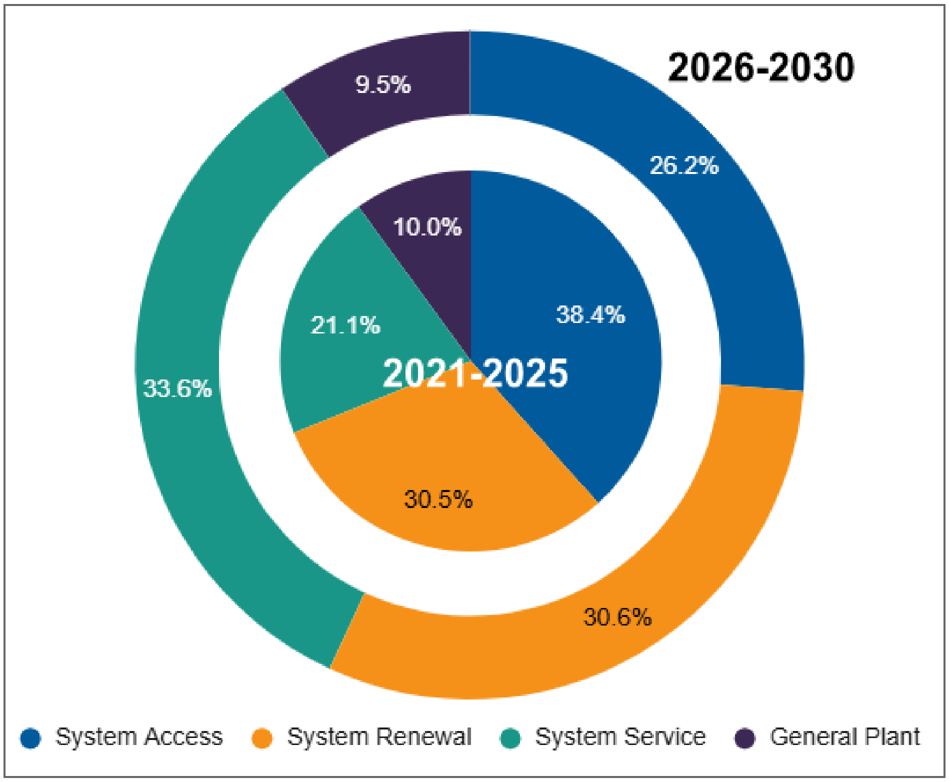
4.2. FORECAST TO HISTORICAL VARIANCE OVERVIEW

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.

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%**

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.

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**

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.

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**

2

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.

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.

[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.

[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.

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:

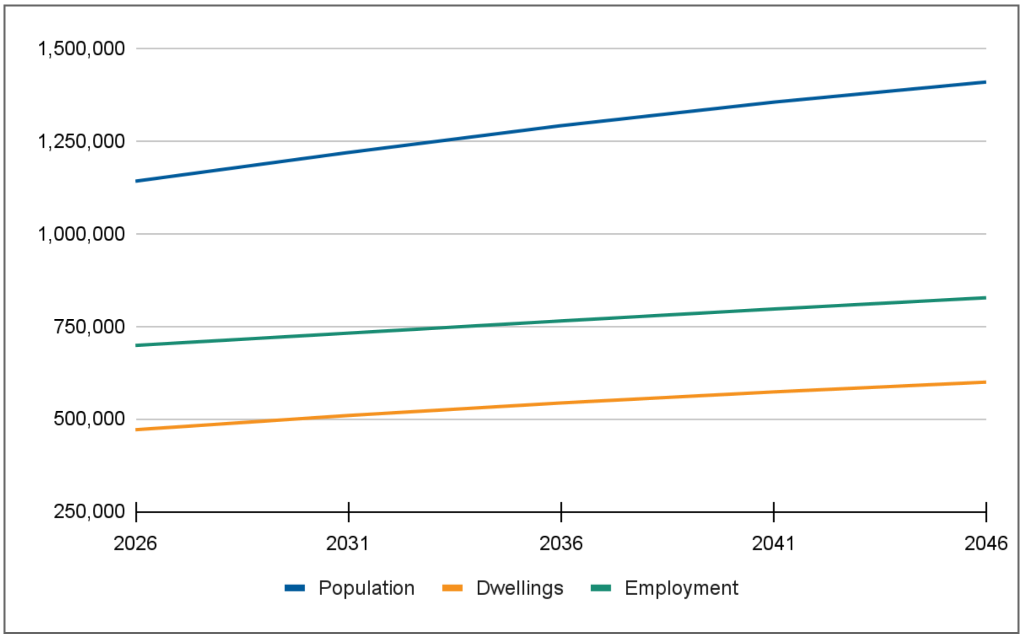
- **Residential Growth:** Driven by forecasted population increases, the resulting expansion of housing and employment opportunities is expected to fuel a rise in residential connection requests. This trend is visually represented in Figure 1, which illustrates the City of Ottawa's population projections[7].
- **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

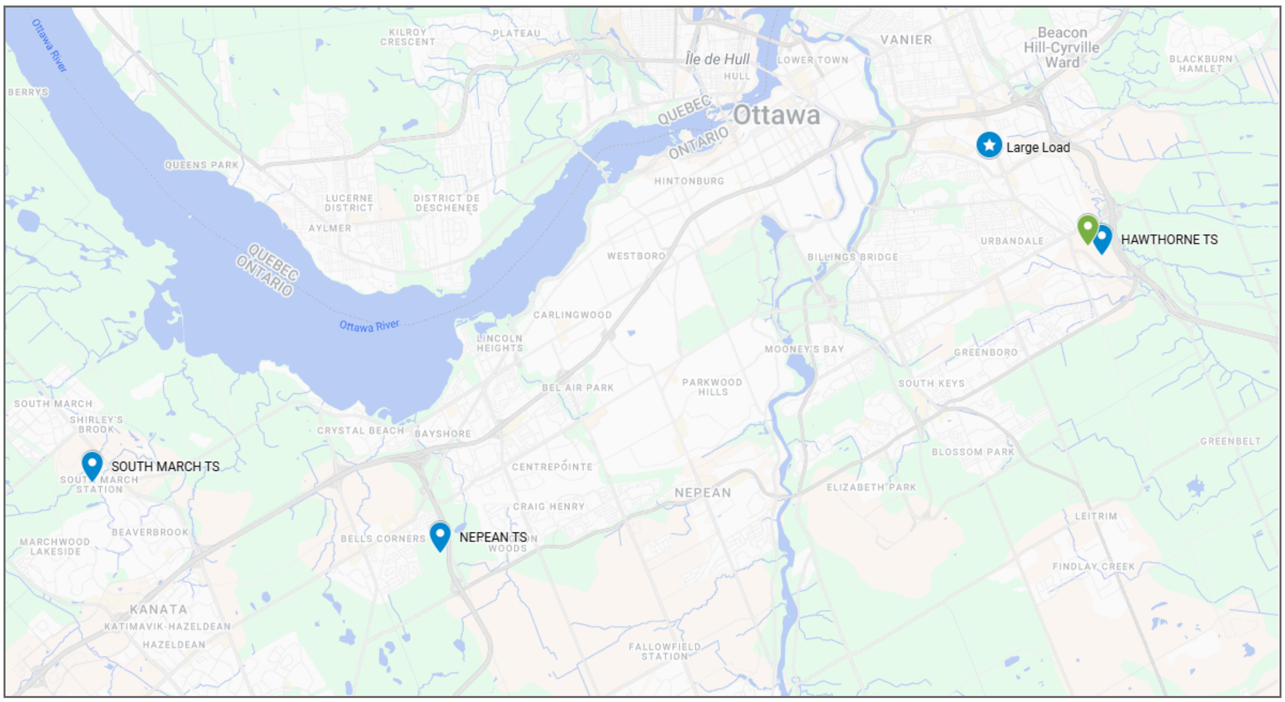
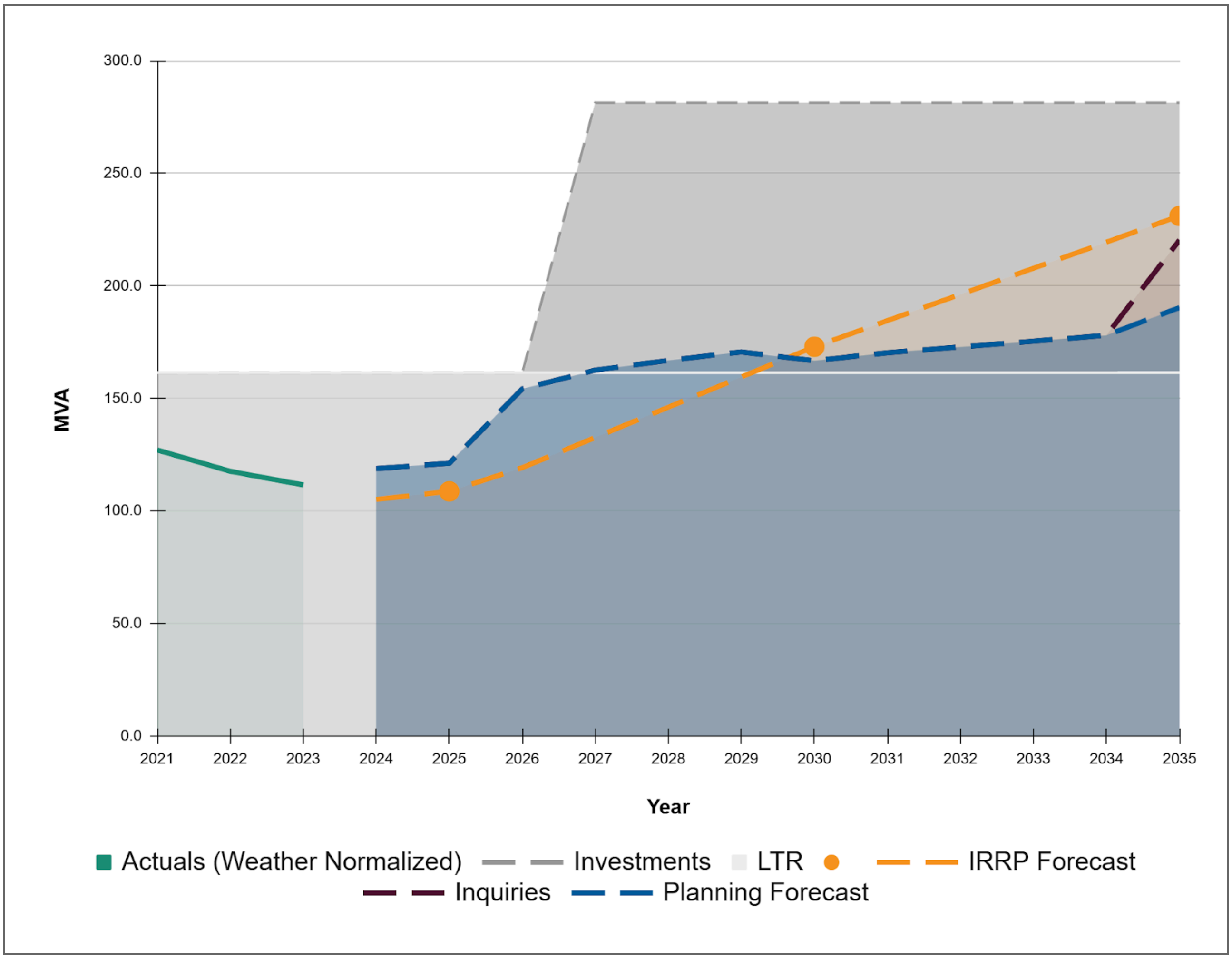


Figure 3 presents the load forecast against planned capacity (LTR), factoring the energization of Hydro Road TS in 2027, which will increase the 44kV Eastern region's capacity to 280 MVA. The figure compares the Integrated Regional Resource Plan IRRP Forecast, Planning Forecast, and the customer load 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.

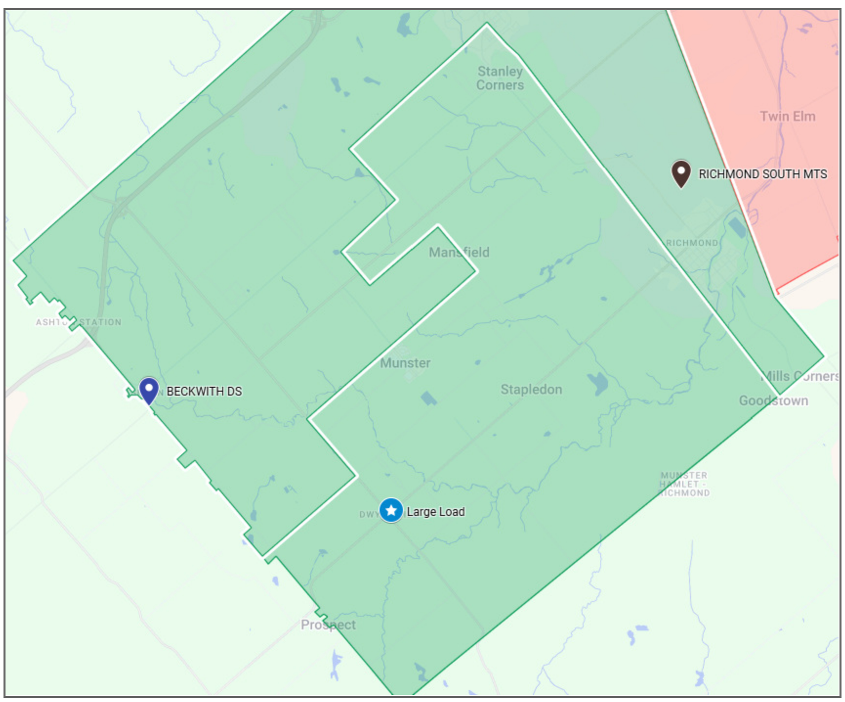
- Due to the size of the ZEB large load request, a 44kV supply option is the only feasible solution in terms of feeder capacity.
- Given the ZEB large load's geographical location, neither Nepean TS nor South March TS are viable connection options. Hawthorne TS, due to its proximity, is the only feasible 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.

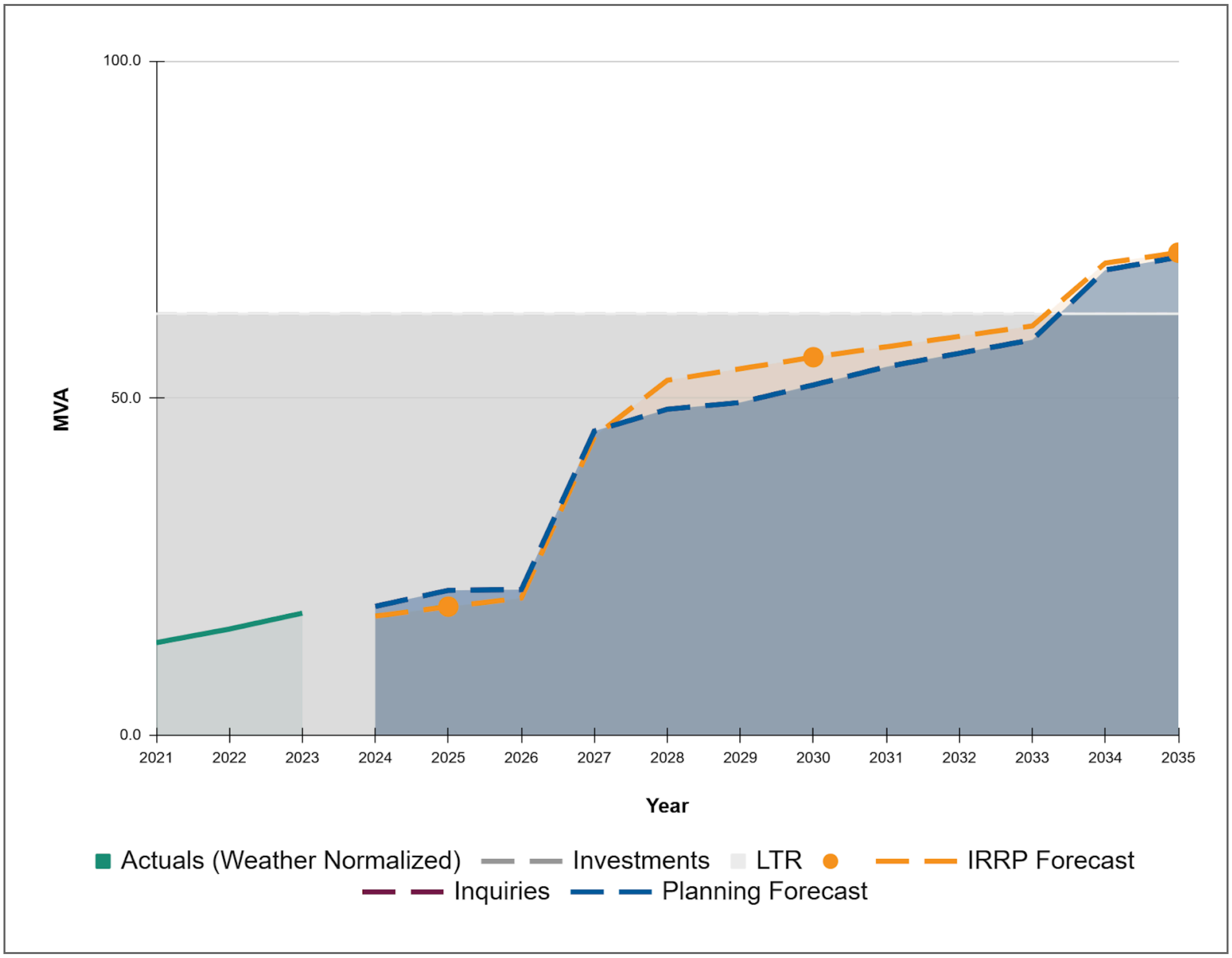
Figure 4 - West 28kV (Southern Region)



[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.

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.

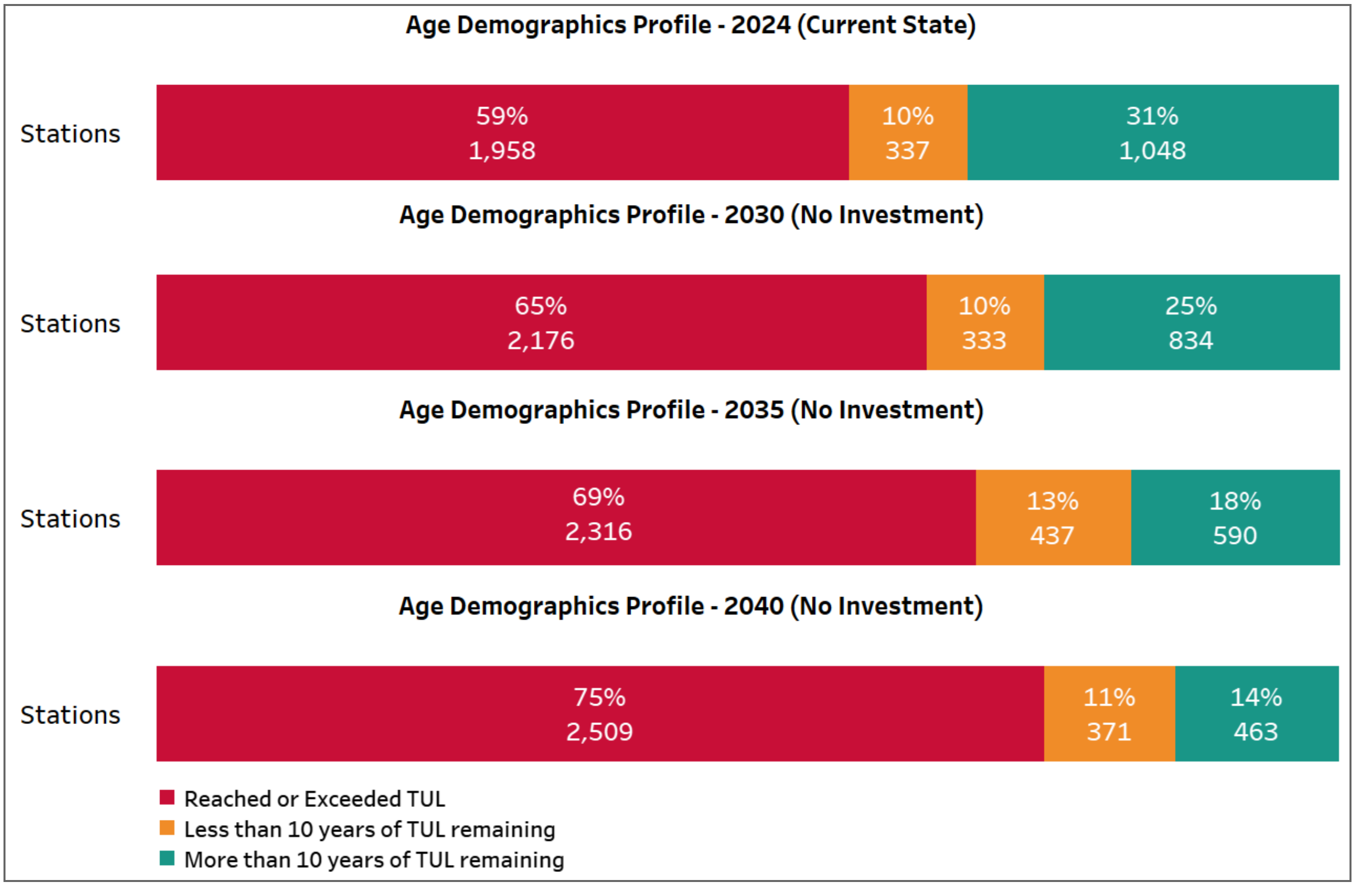
These assets also pose significant safety risks to Hydro Ottawa personnel, contractors, and the public due to the potential for asset failure. Major oil-filled equipment like station transformers can create environmental hazards through oil leaks. Similarly, the failure of Sulfur Hexafluoride (SF_6) 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

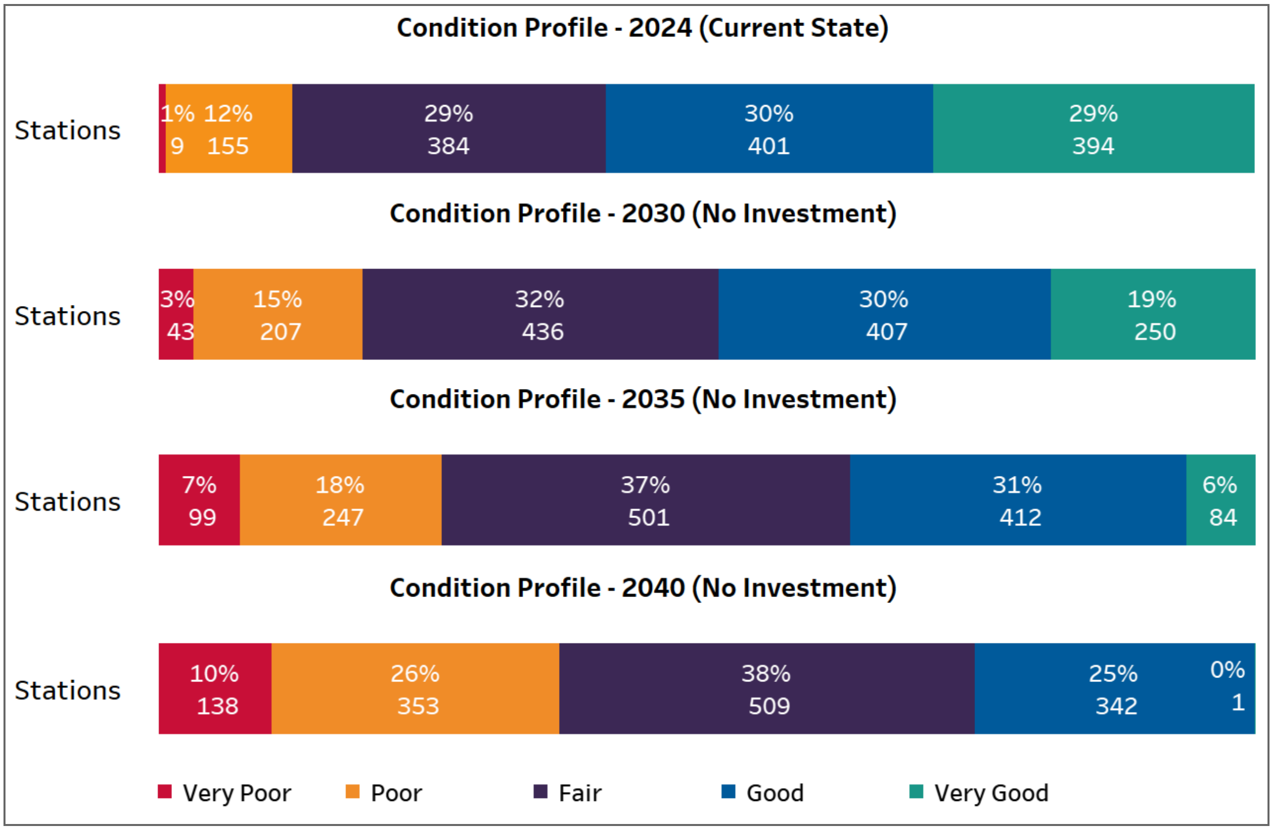
The primary focus of the station renewal program is to mitigate the risks associated with station assets in degraded condition. The age and condition demographics of the major station assets considered within scope of the station asset renewal program are provided in Figures 3 to 14, with the overall 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

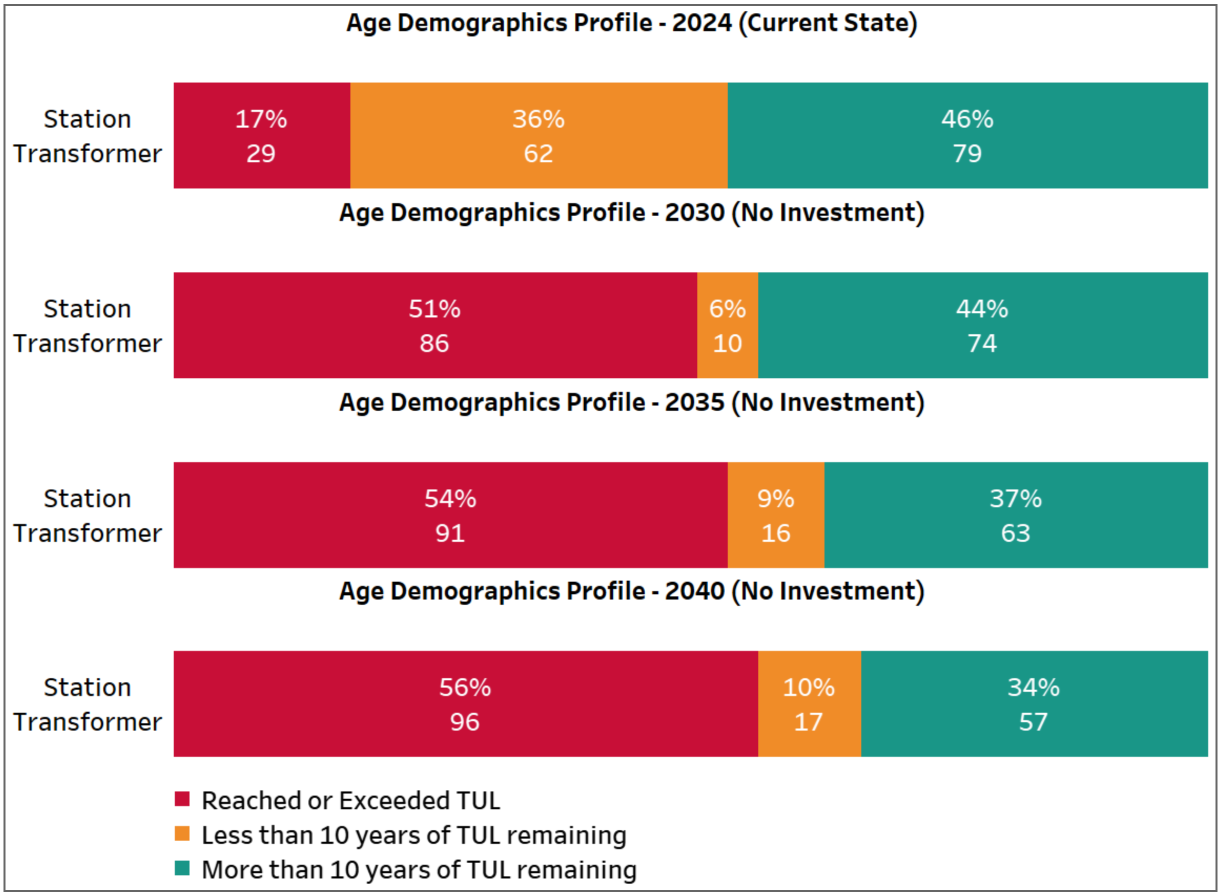
forecasts Hydro Ottawa's end-of-life station assets to increase by about 5% every five years. Likewise, without intervention, the percentage of assets in degraded condition (poor or very poor) will continue to grow at a rate of approximately 8% every 5 years.

The following sub-sections summarize some of the challenges faced by Hydro Ottawa specific to its existing station assets.

2.3.3. Station Transformers

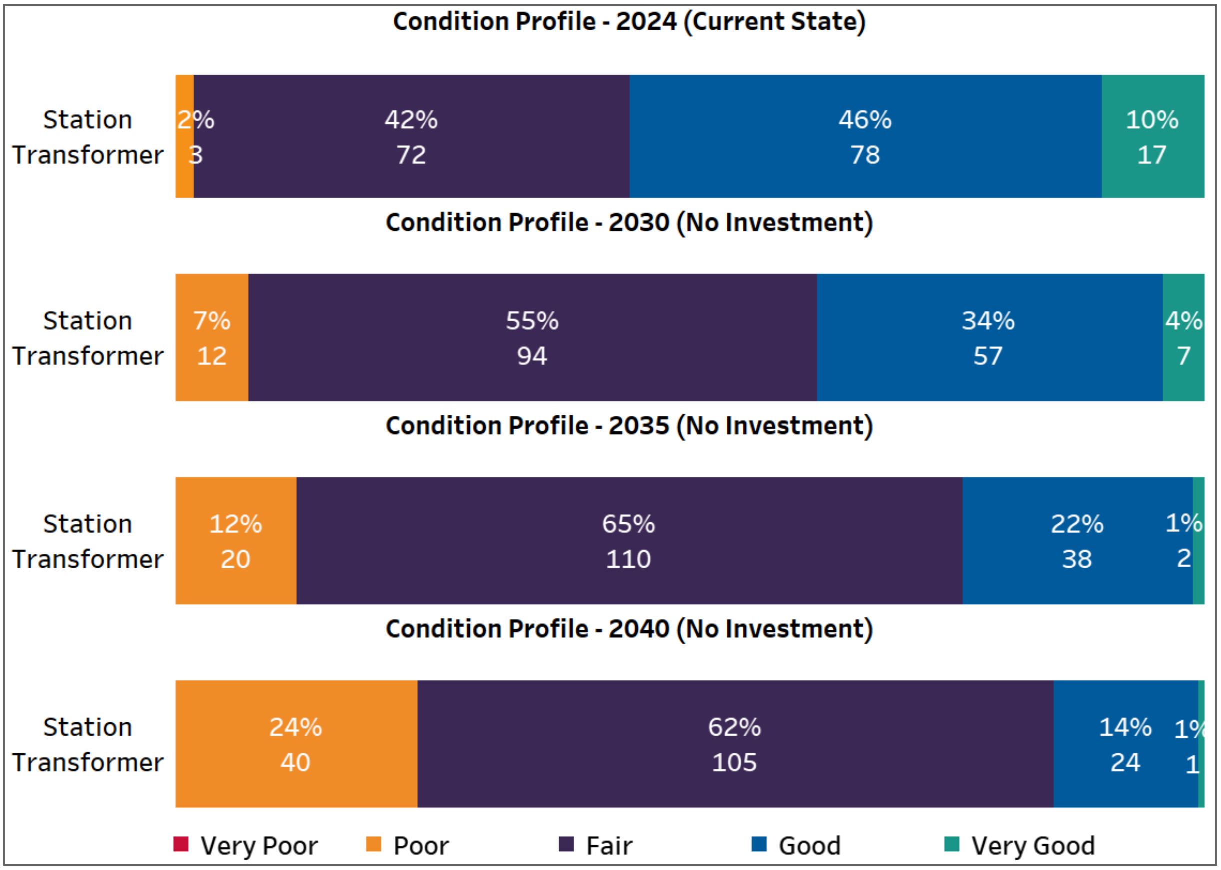
Figures 3 and 4 demonstrate that Hydro Ottawa's station transformers are reaching end of life at a rapid pace, with some degree of deterioration. Specifically, Copperleaf PA forecasts that without intervention the percentage of station transformers that have reached their end of life will increase to 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.

1 **Figure 3 - Age Demographics Profile of Station Transformer**



2

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

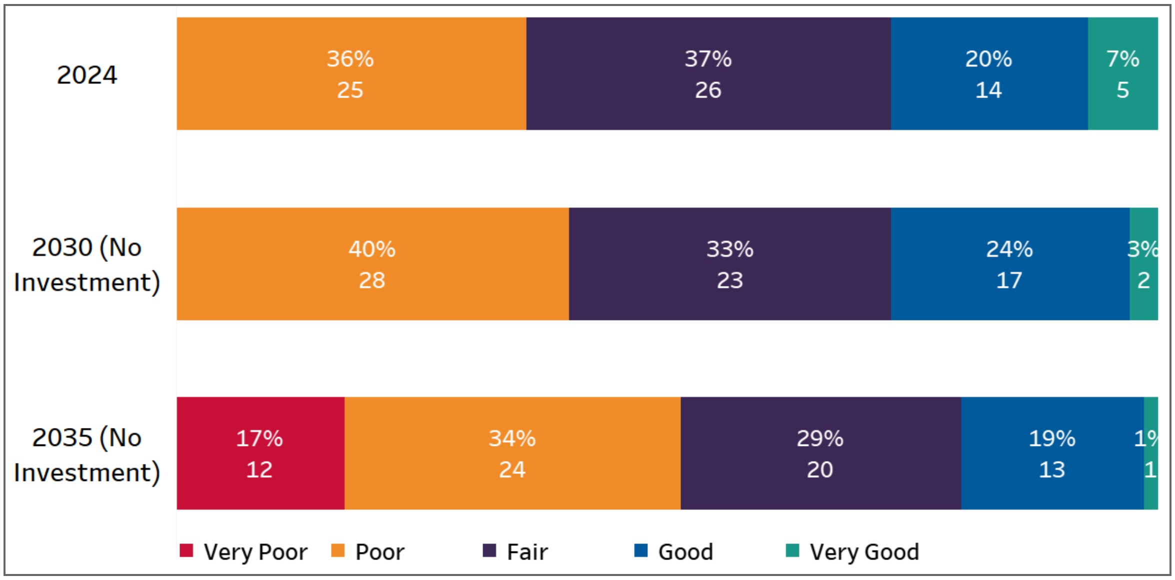
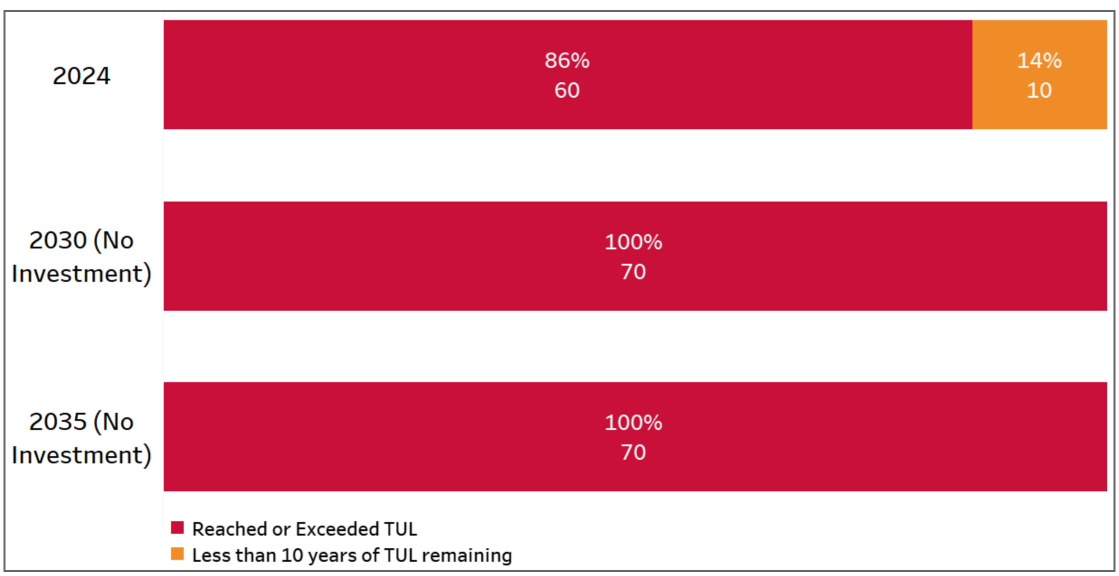


Figure 6 - Age Demographic Profile of Henderson UN, Church AA, Vaughan UG, Carling SM, and Nepean AB



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

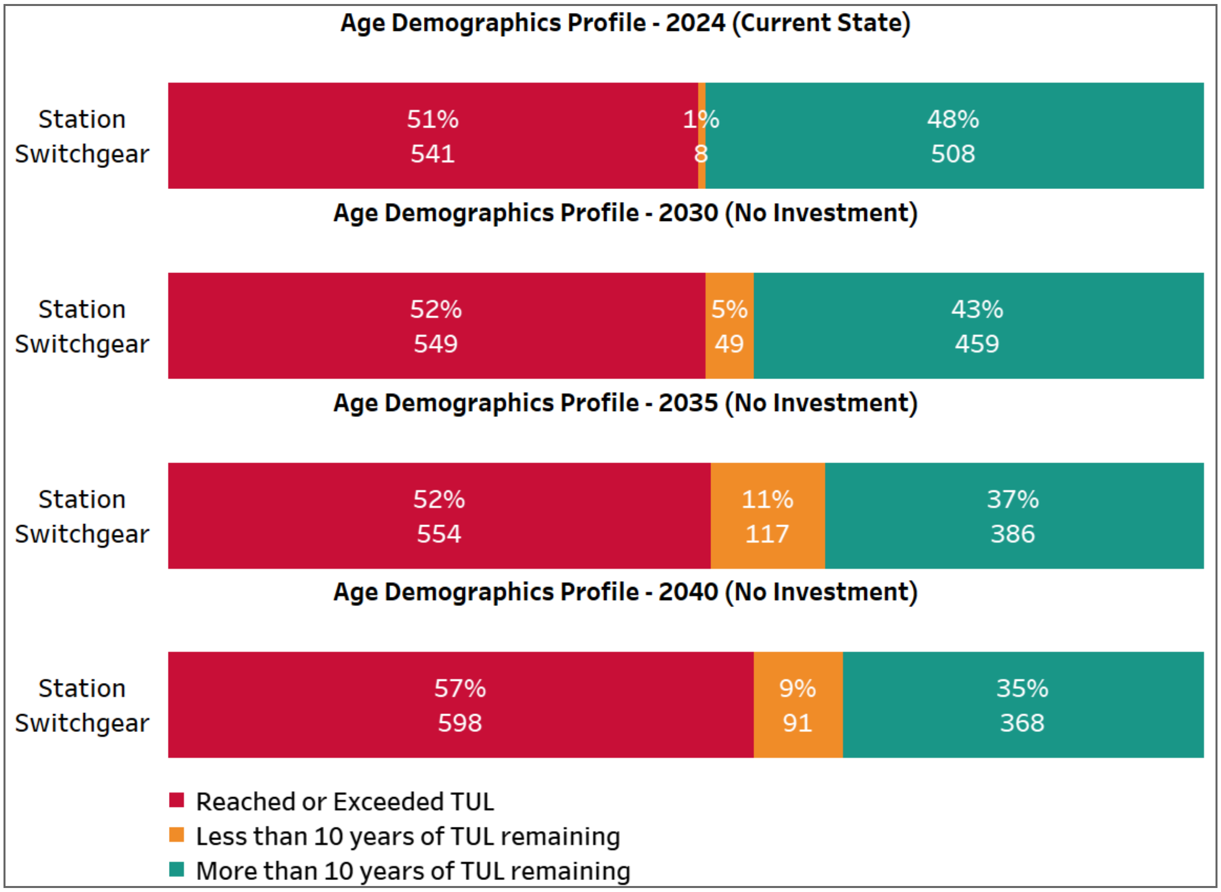
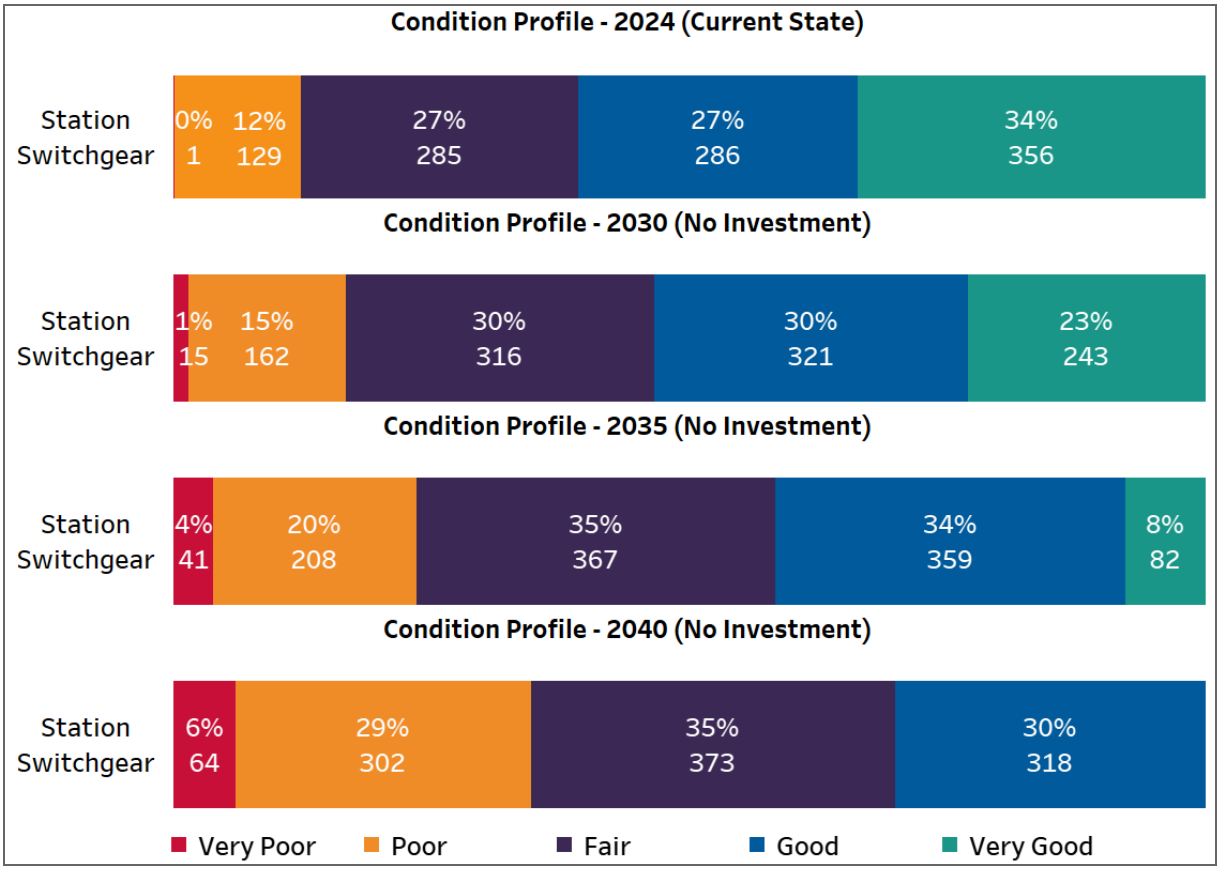


Figure 8 - Condition Profile of Station Switchgear



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

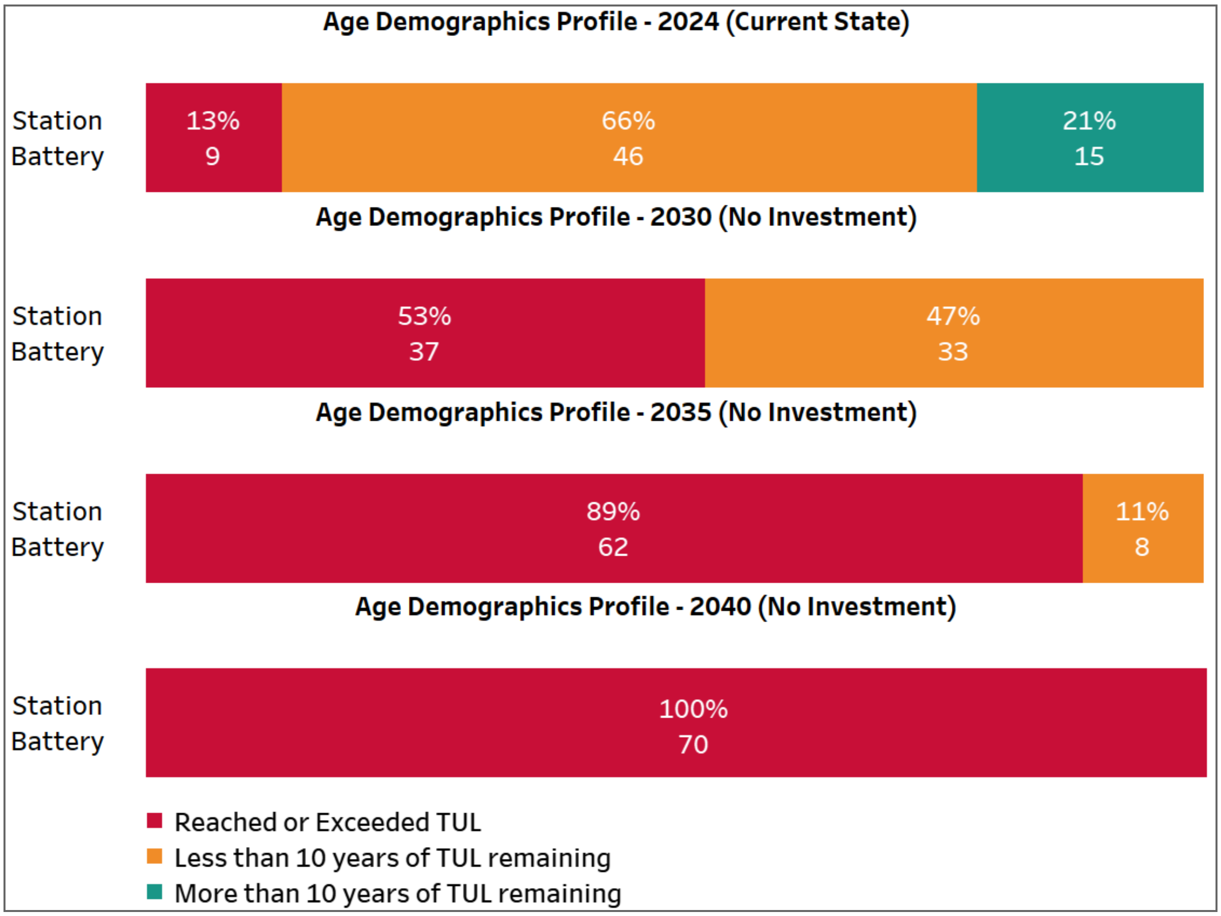
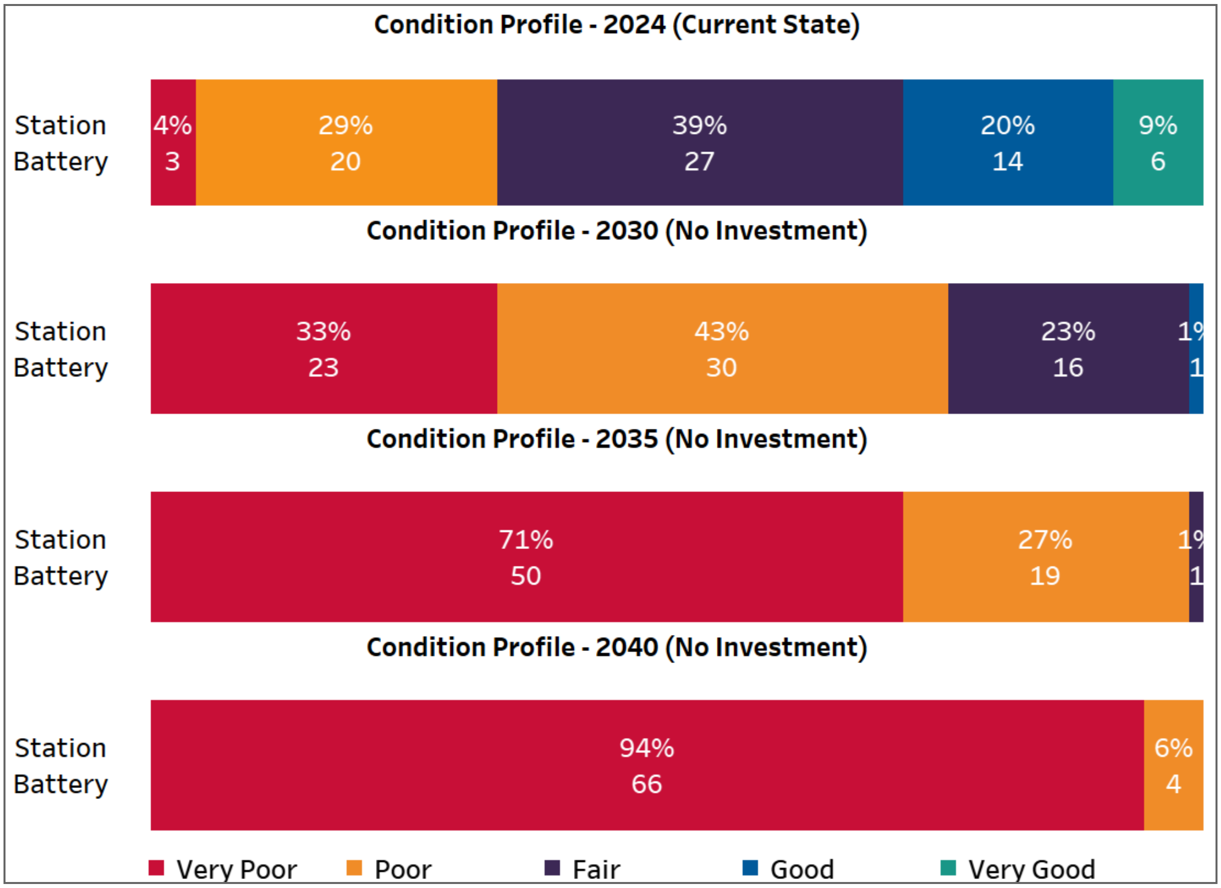


Figure 12 - Condition Profile of Station Batteries

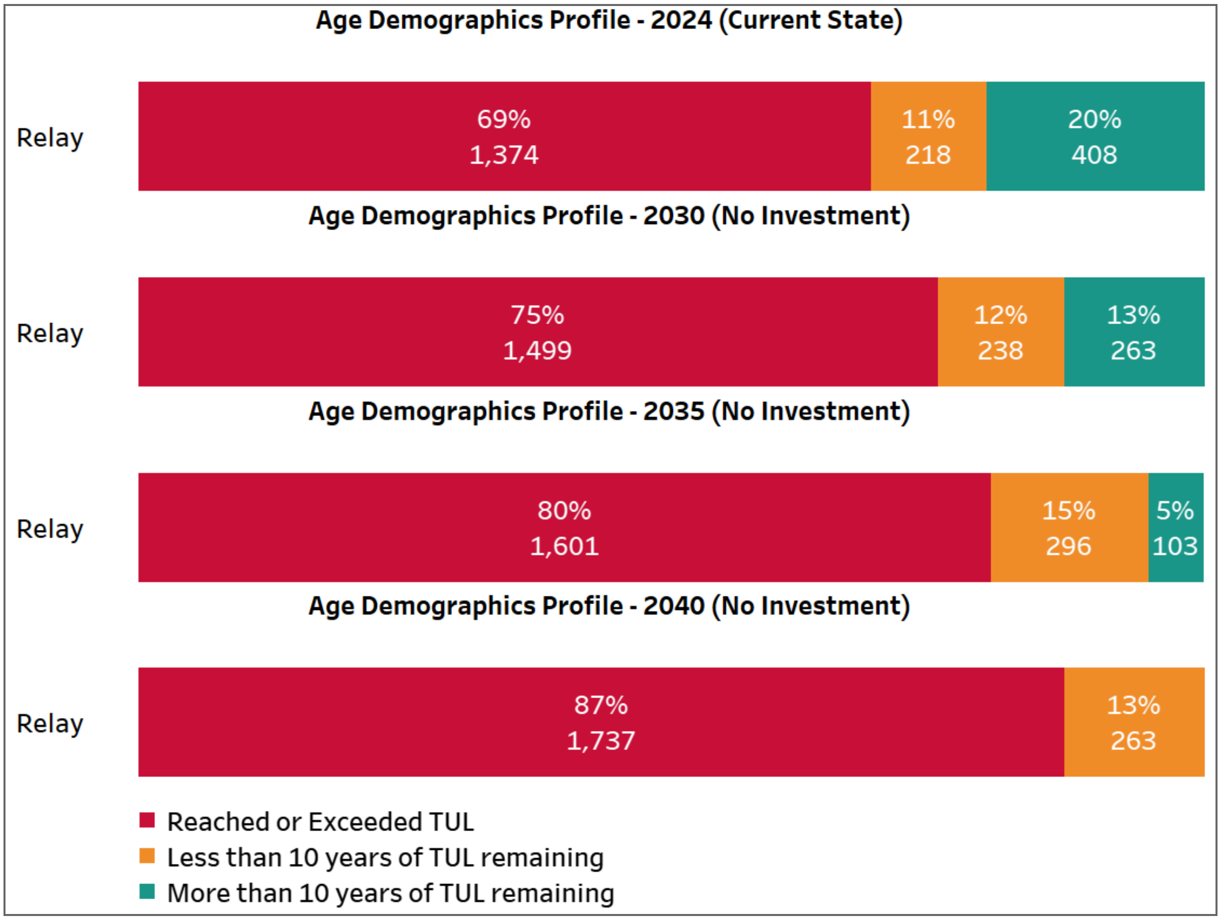


2.3.6. Station P&C

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

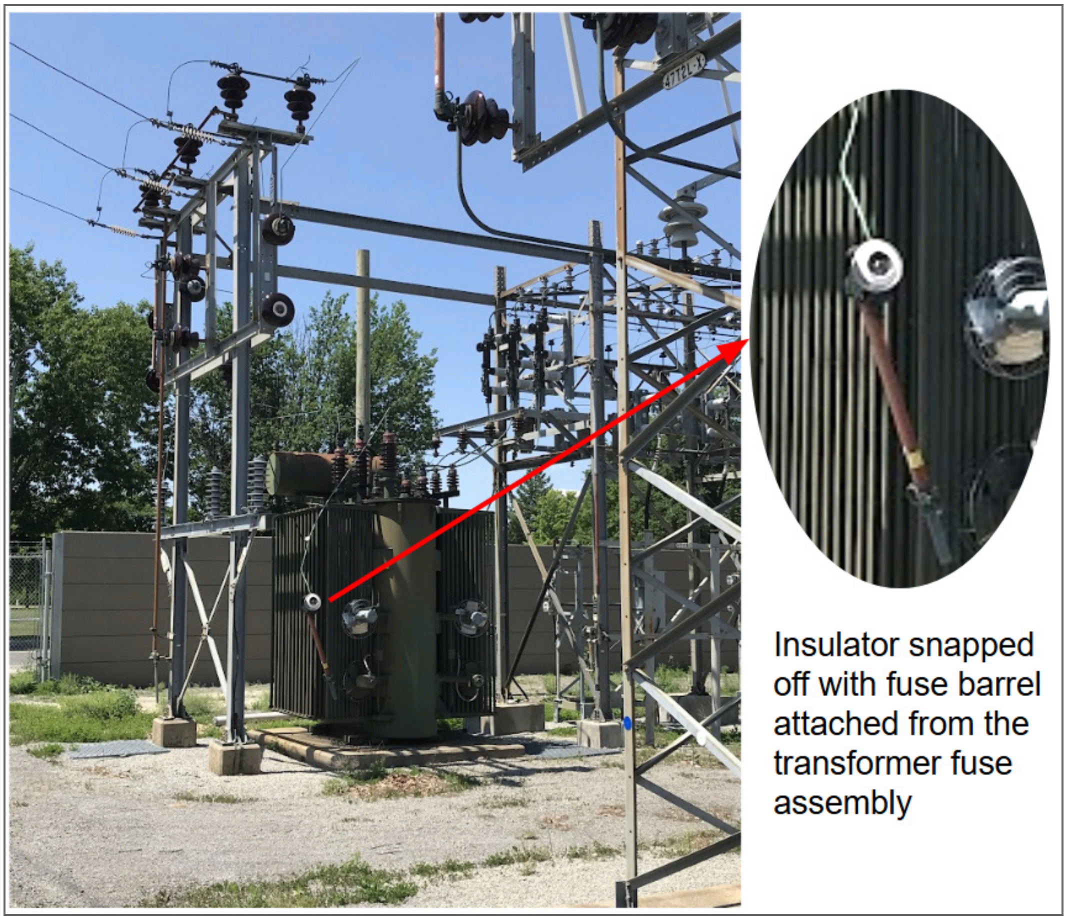
Hydro Ottawa manages transfer trip installations associated with generation connections. Following consultations with customers regarding their projected operational needs and long-term plans, Hydro Ottawa ensures the ongoing compliance of transfer trip installations with present operational requirements, 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

1 **Table 4 - Detailed Unit Replacement and Removal (through EOL voltage conversion)**

2 **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

4 [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

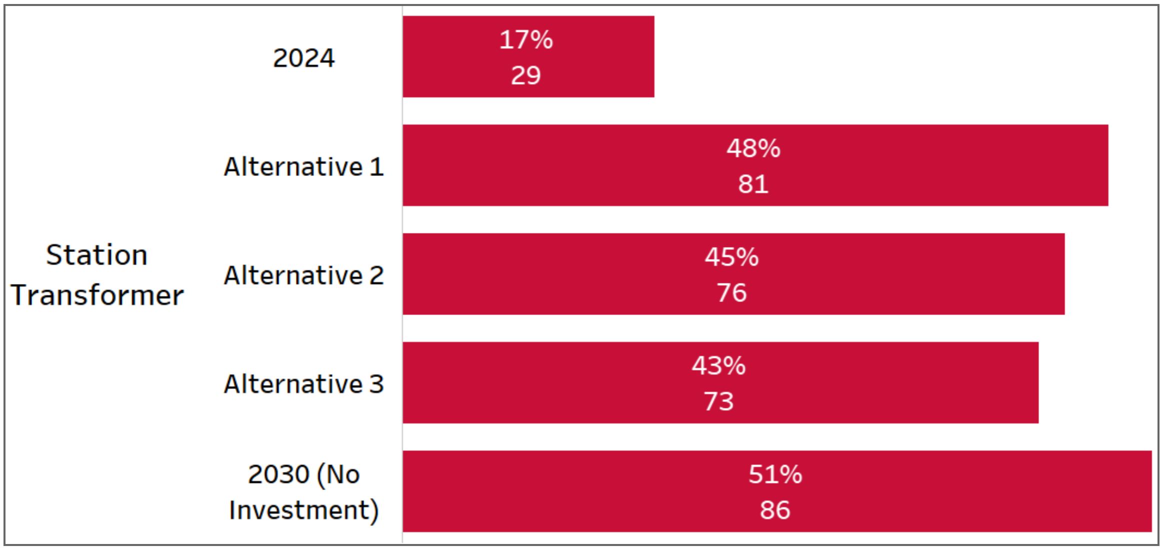


Figure 21 - Number of Station Transformers Projected to Reach a Deteriorated Condition by 2030

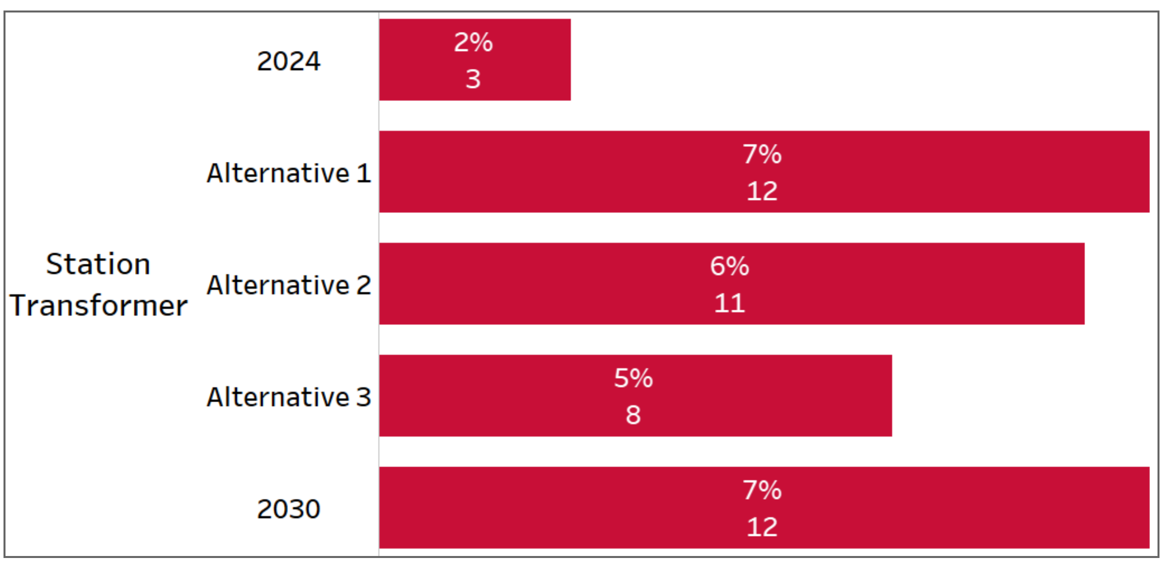


Figure 22 - Number of Station Switchgears Projected to Reach Typical Useful Life by 2030

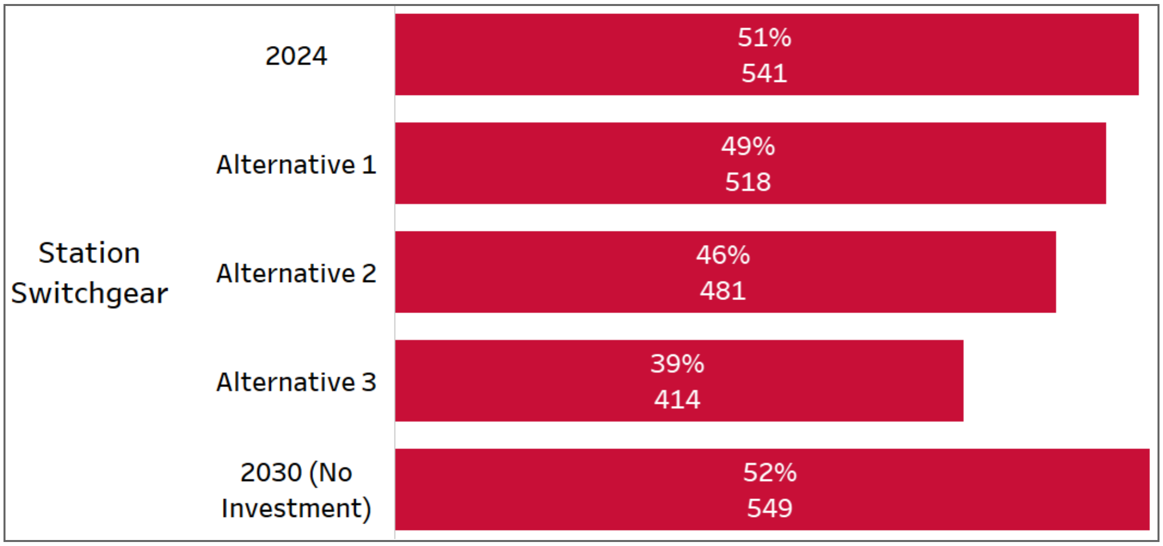


Figure 23 - Number of Station Switchgears Projected to Reach a Deteriorated Condition by 2030

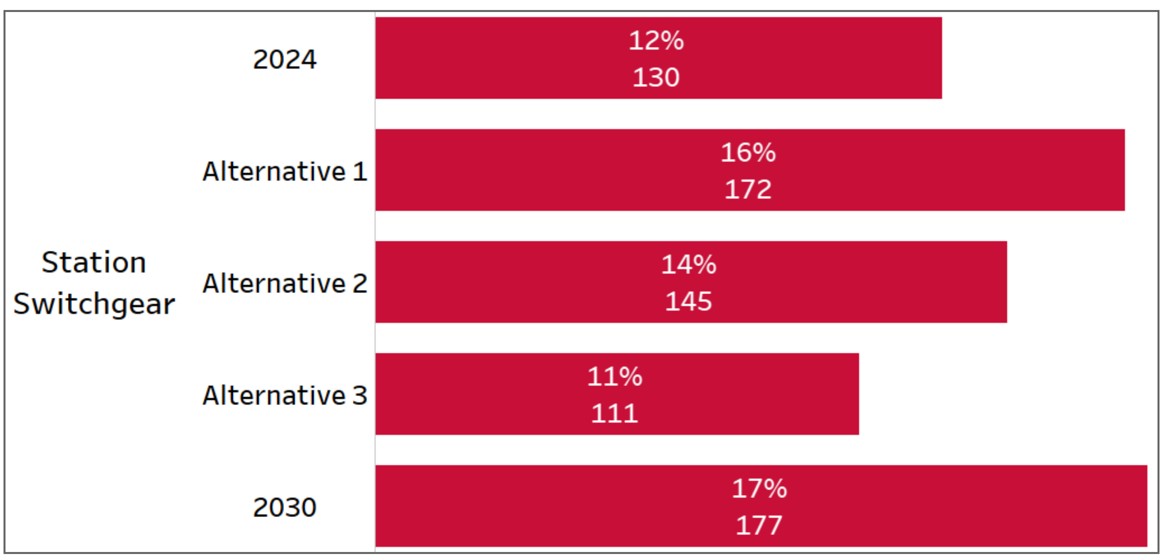


Figure 24 - Number of Station Batteries Projected to Reach Typical Useful Life by 2030

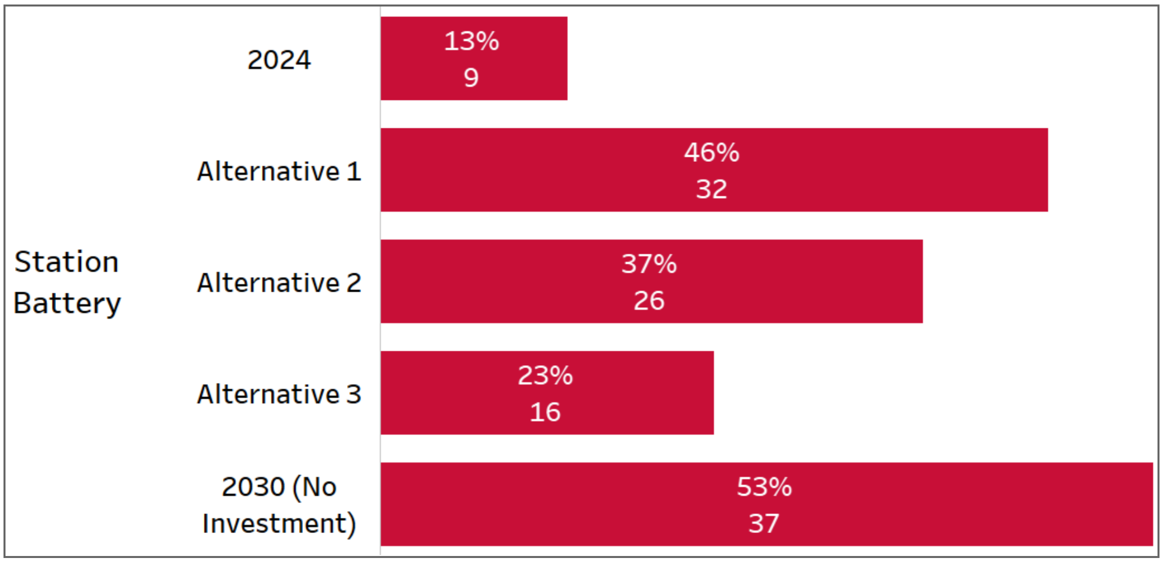


Figure 25 - Number of Station Batteries Projected to Reach a Deteriorated Condition by 2030

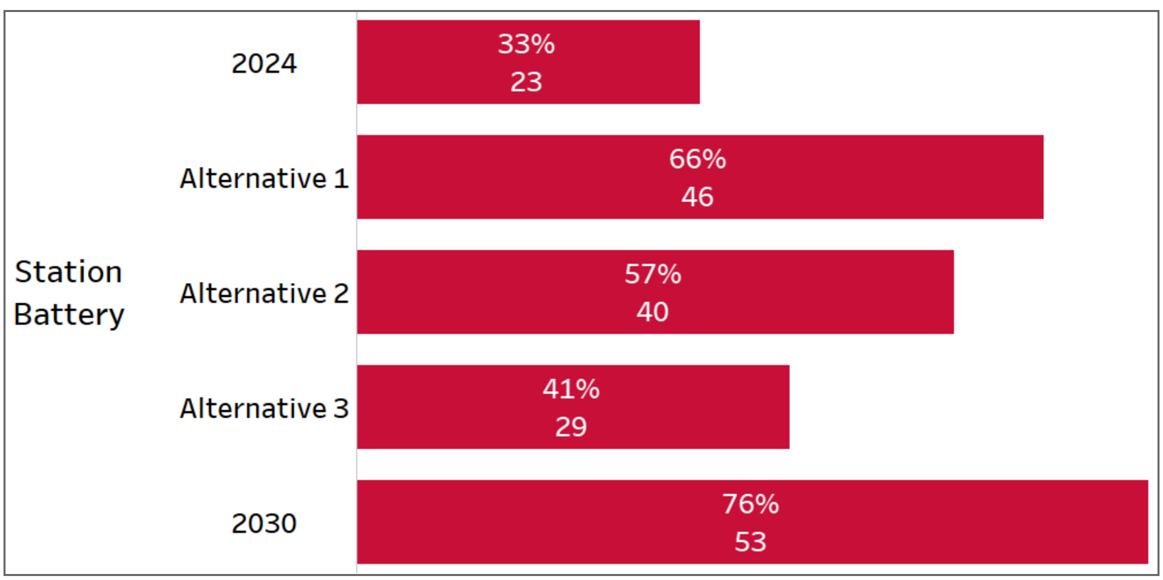
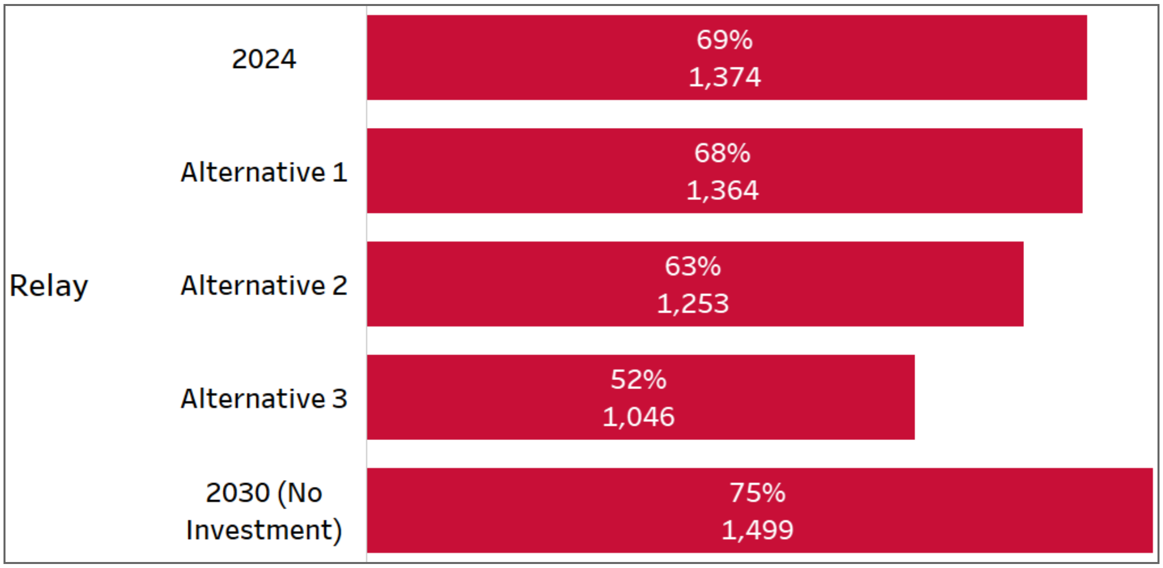


Figure 26 - Number of Station Relays Projected to Reach Typical Useful Life by 2030



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:

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

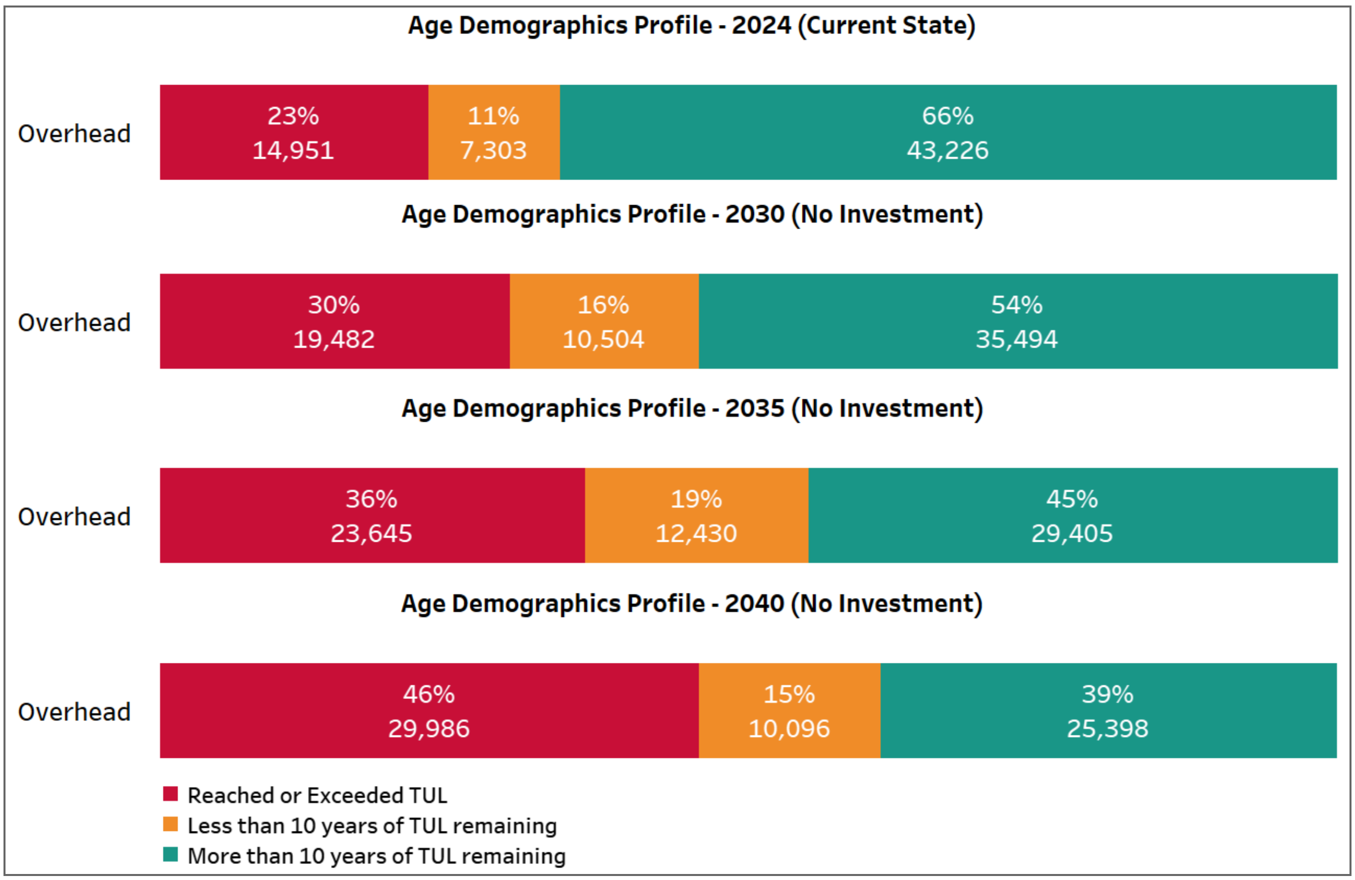
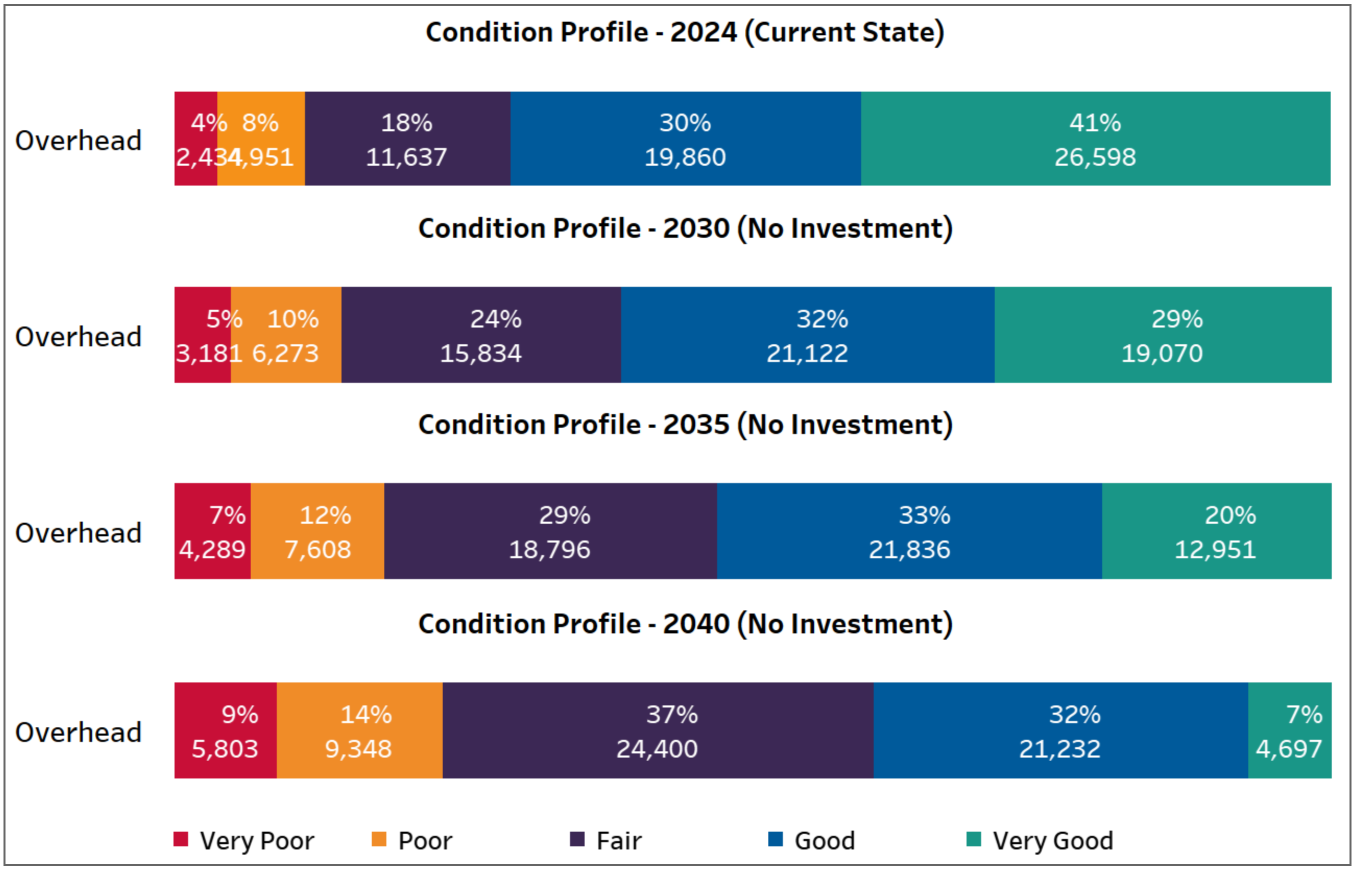


Figure 28 - Overall Condition Profile of OH Distribution Assets



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.

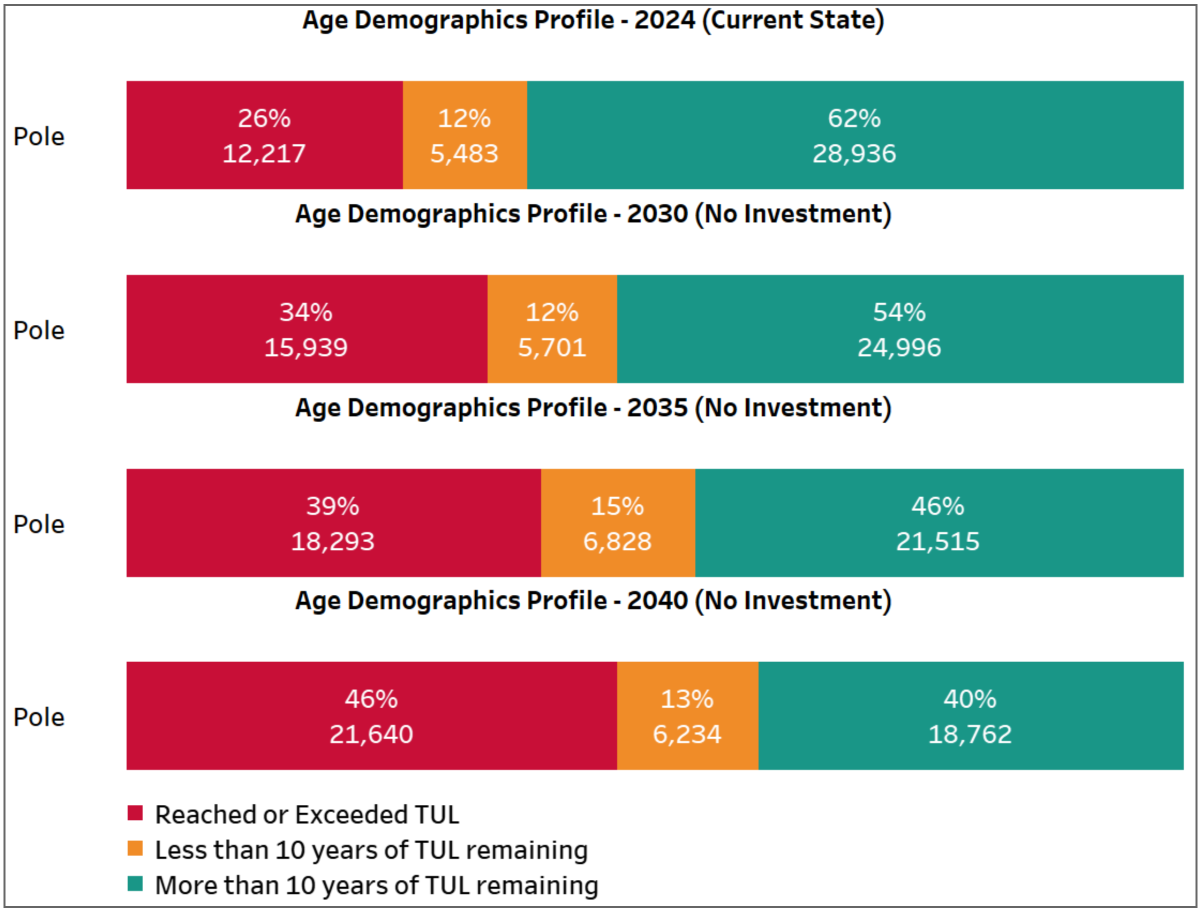
The following sub-sections summarize some of the challenges faced by Hydro Ottawa specific to its existing OH distribution asset categories.

3.3.3. Poles and OH Distribution Transformers

OH Poles

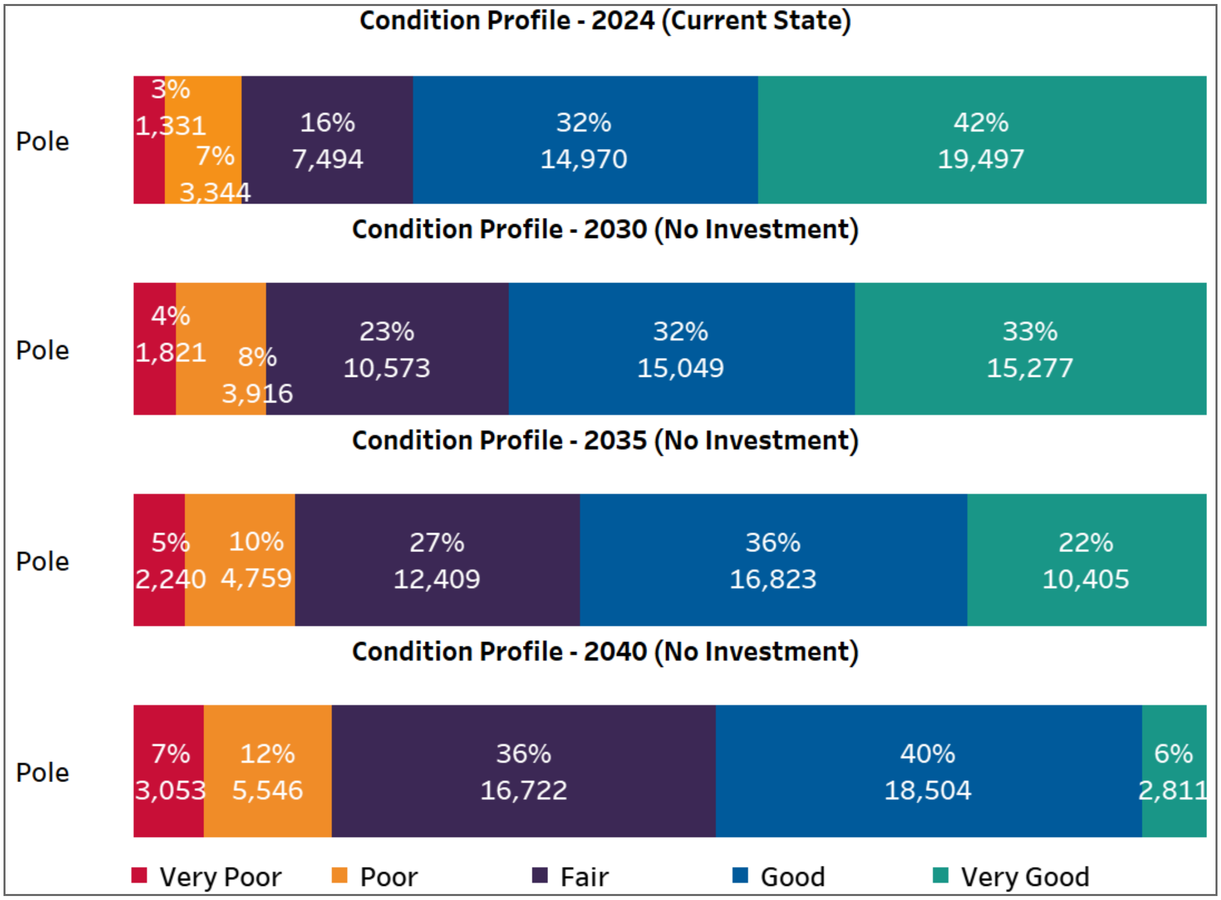
Figures 29 and 30 demonstrate that Hydro Ottawa's poles are reaching end of life and are projected to degrade at a high rate through to 2040. Specifically, Copperleaf PA forecasts that without intervention the percentage of poles that have reached their end of life will continue to grow at a rate of 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.

1 **Figure 29 - Age Demographics Profile of Poles**



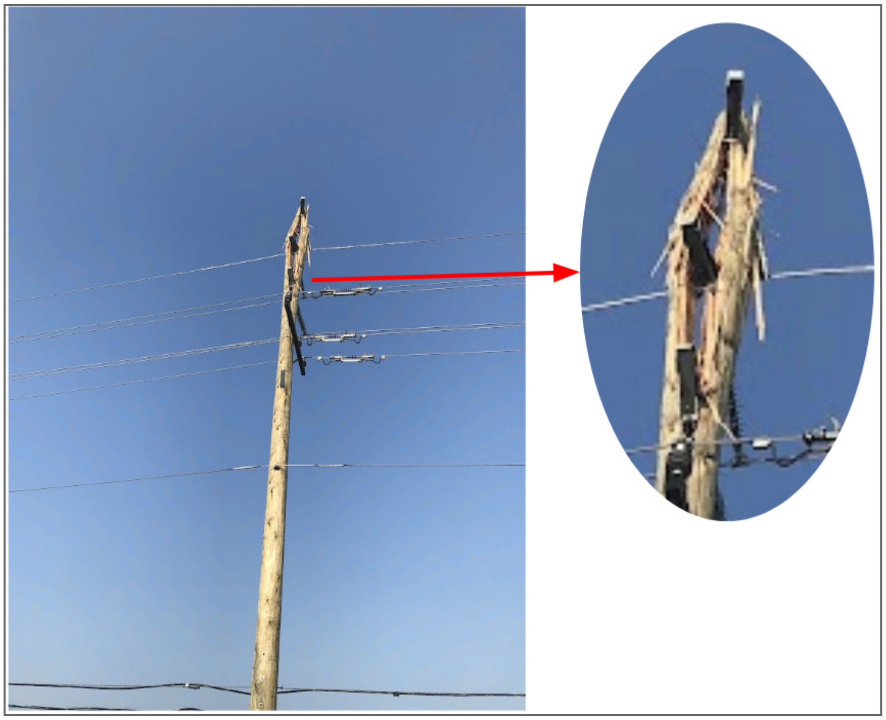
2

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

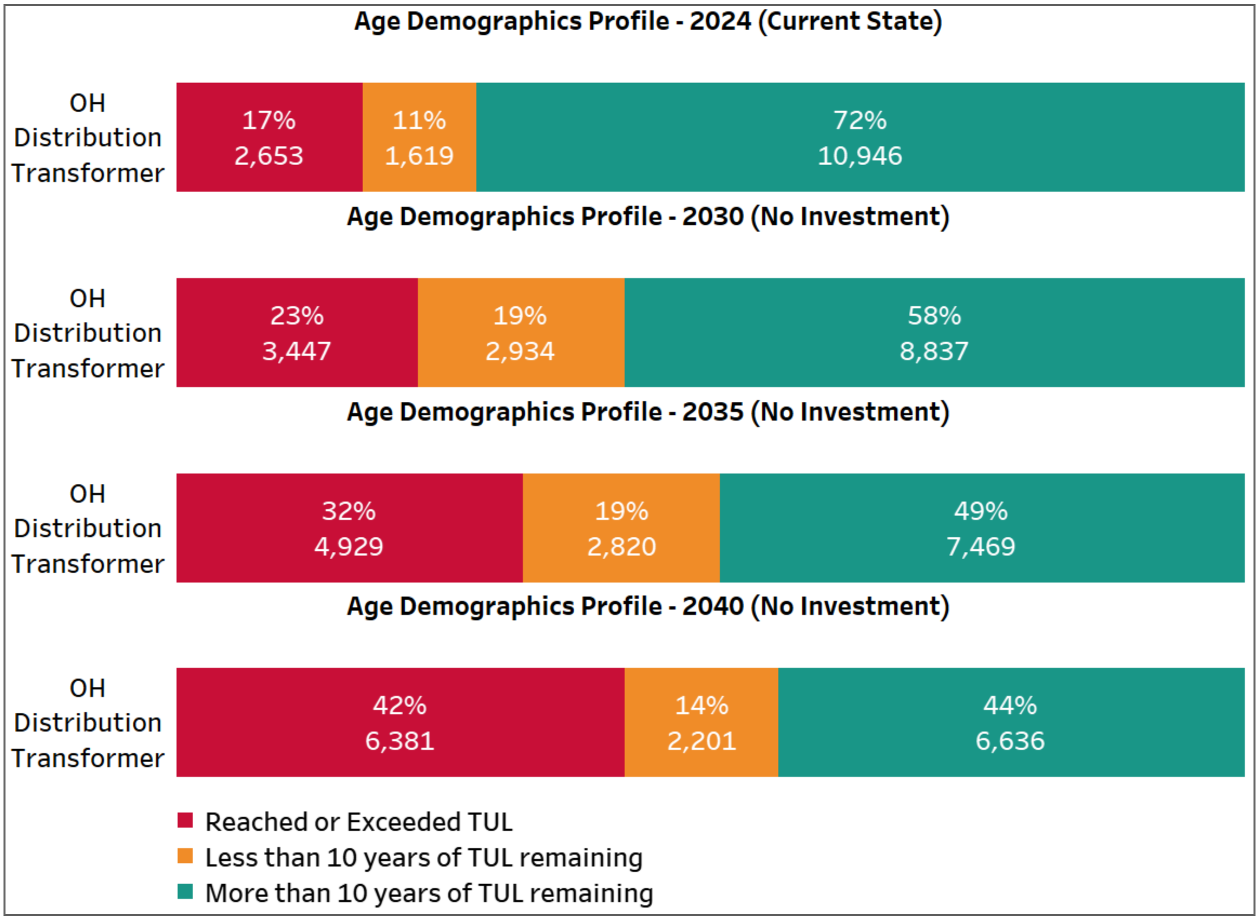
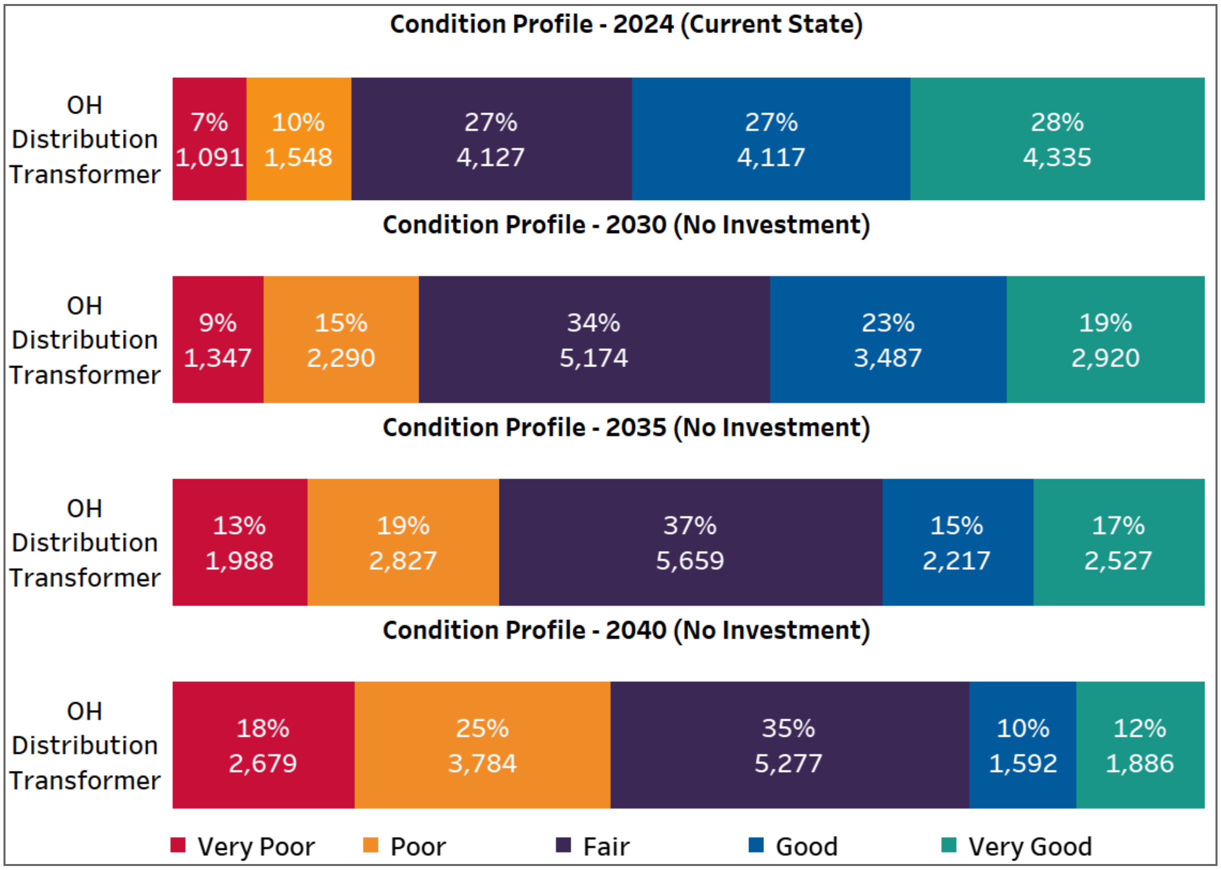


Figure 33 - Condition Profile of OH Transformers



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.

Figure 34 - Age Demographics Profile of OH Switches

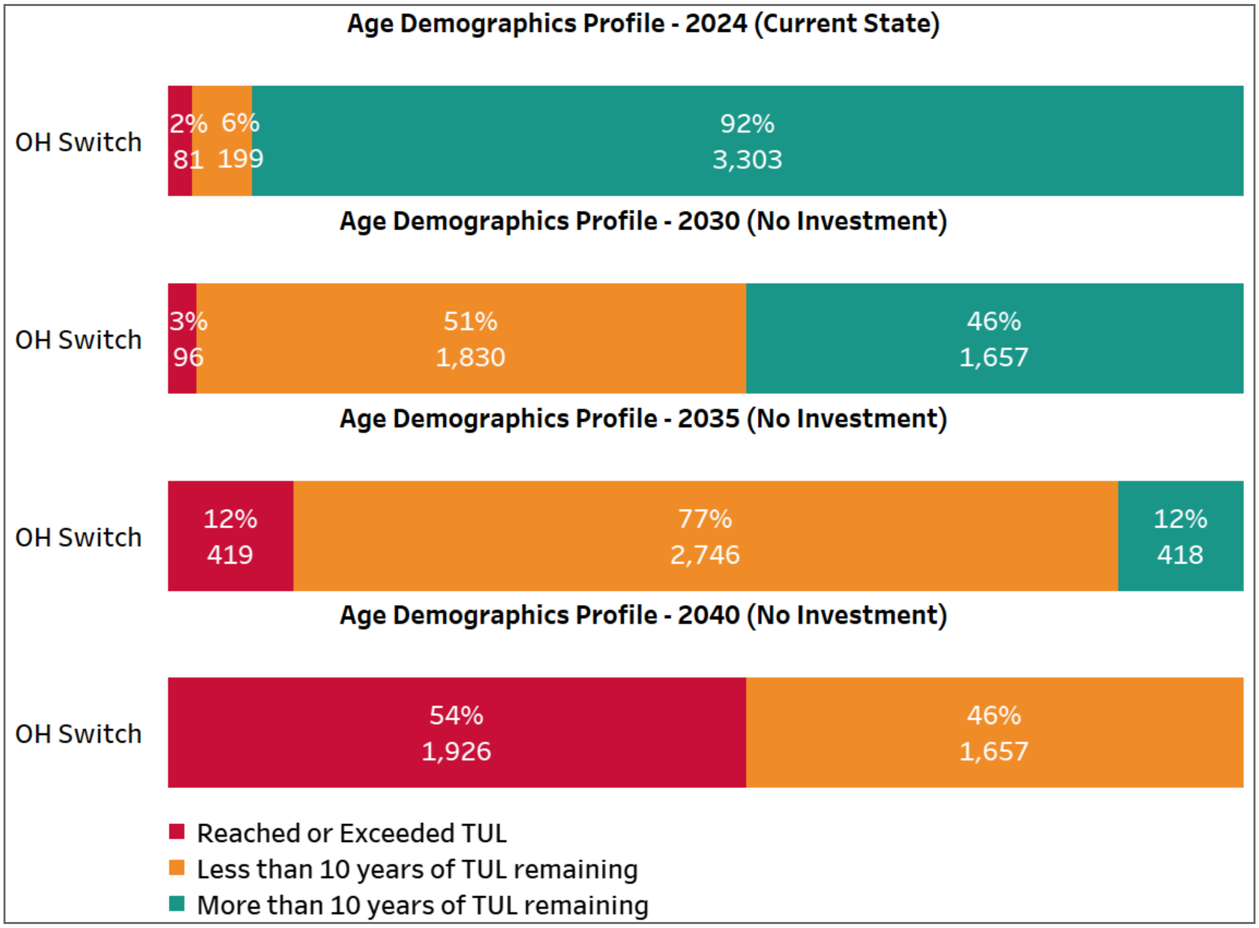
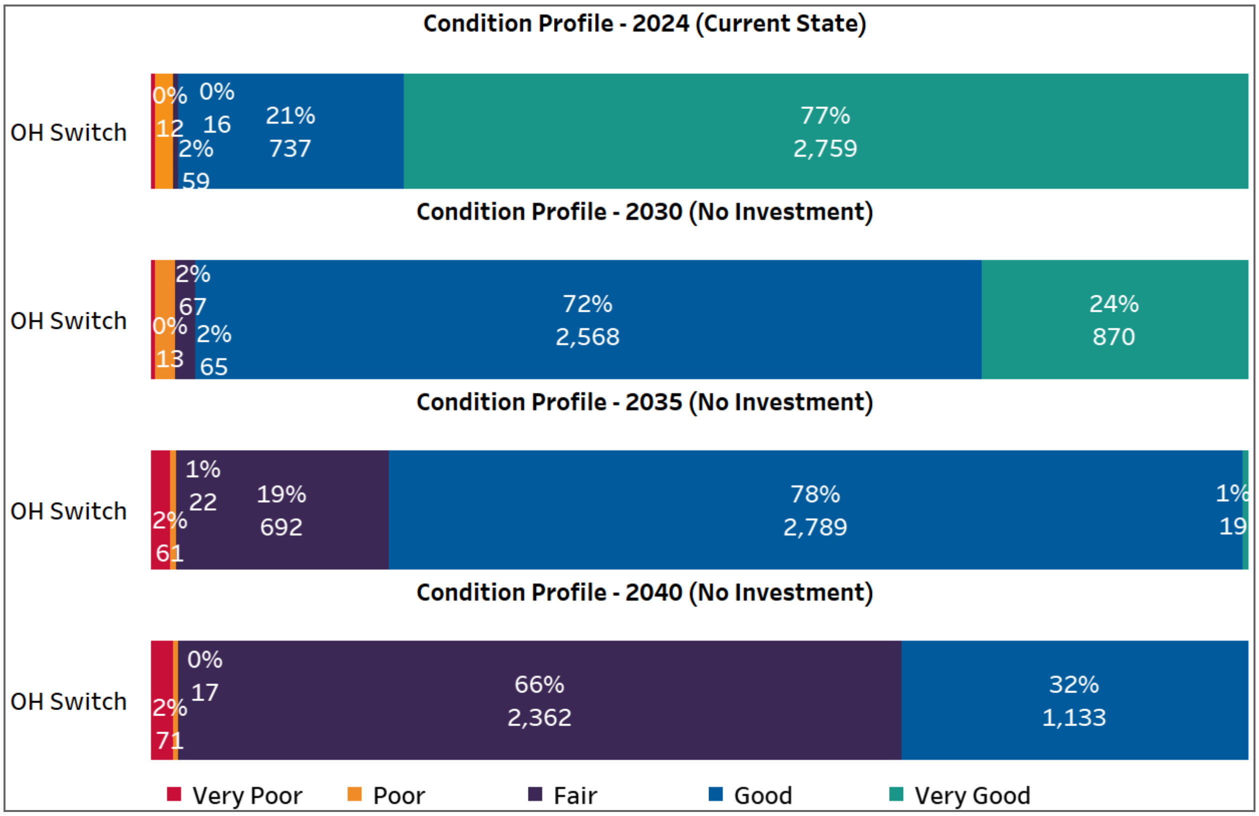
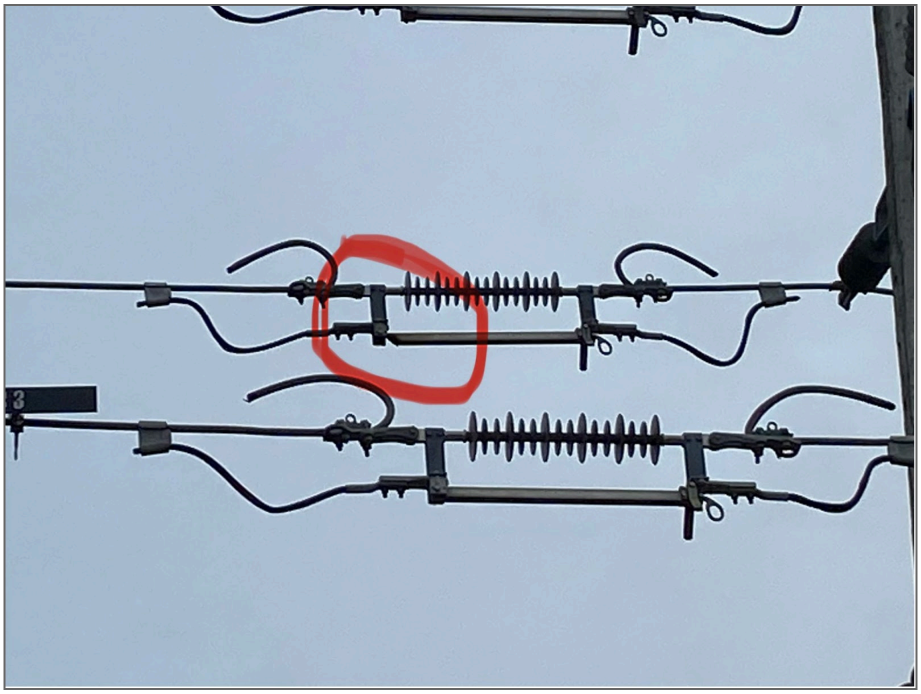


Figure 35 - Condition Profile of OH Switches



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

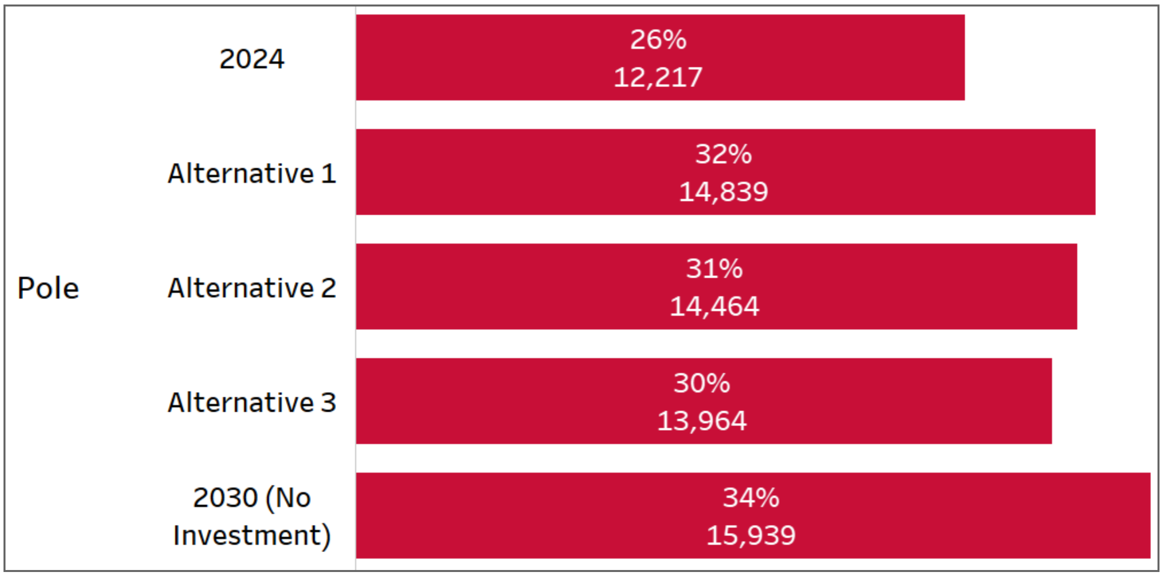


Figure 38 - Number of Poles Projected to Reach a Deteriorated Condition by 2030

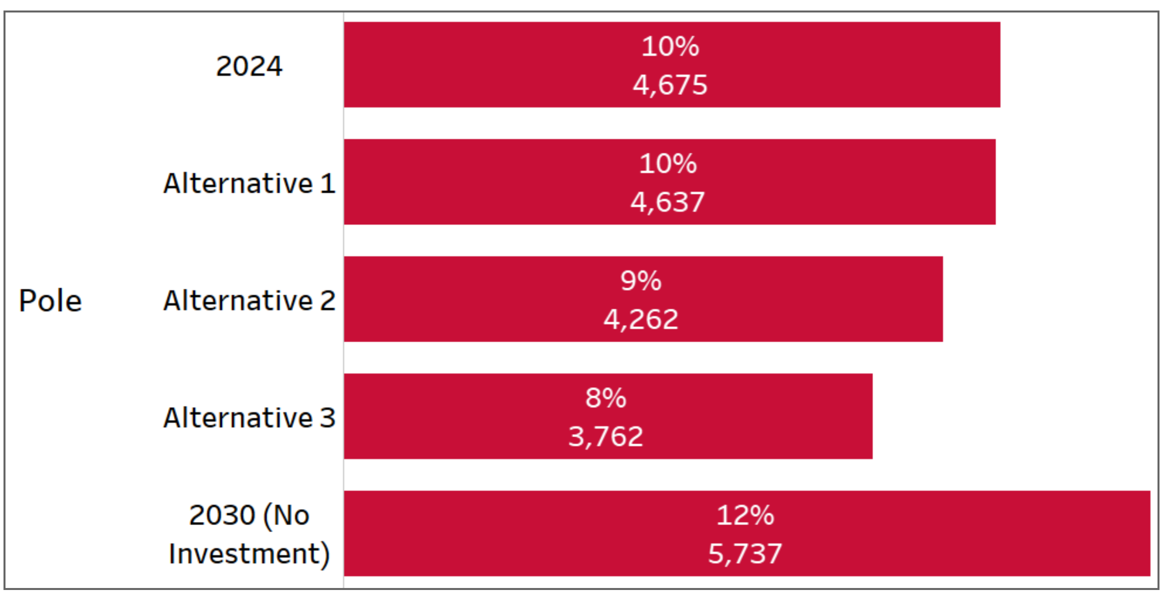


Figure 39 - Number of OH Transformers Projected to Reach Typical Useful Life by 2030

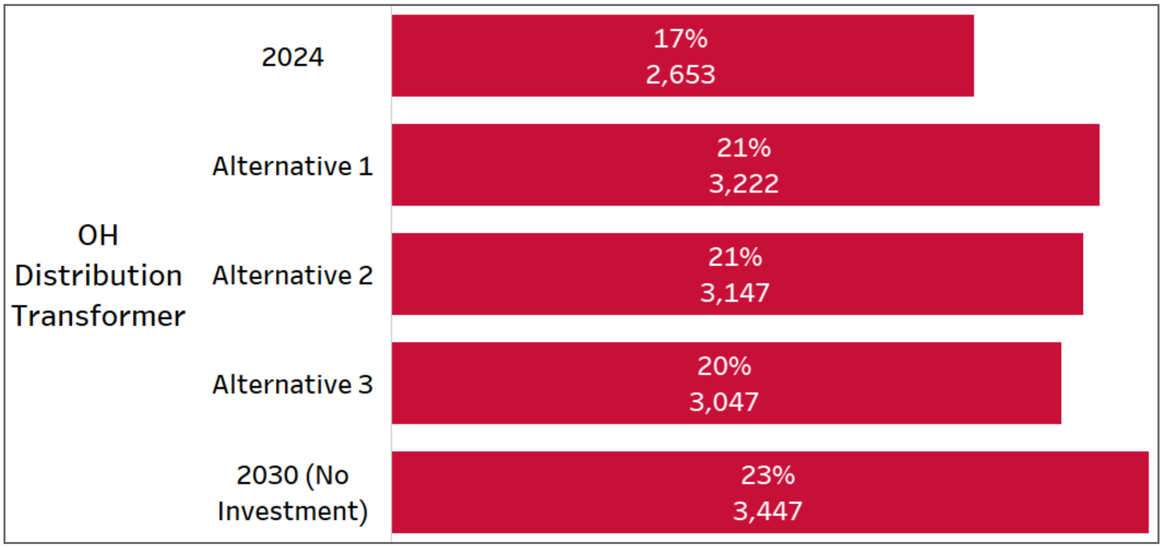


Figure 40 - Number of OH Transformers Projected to Reach a Deteriorated Condition by 2030

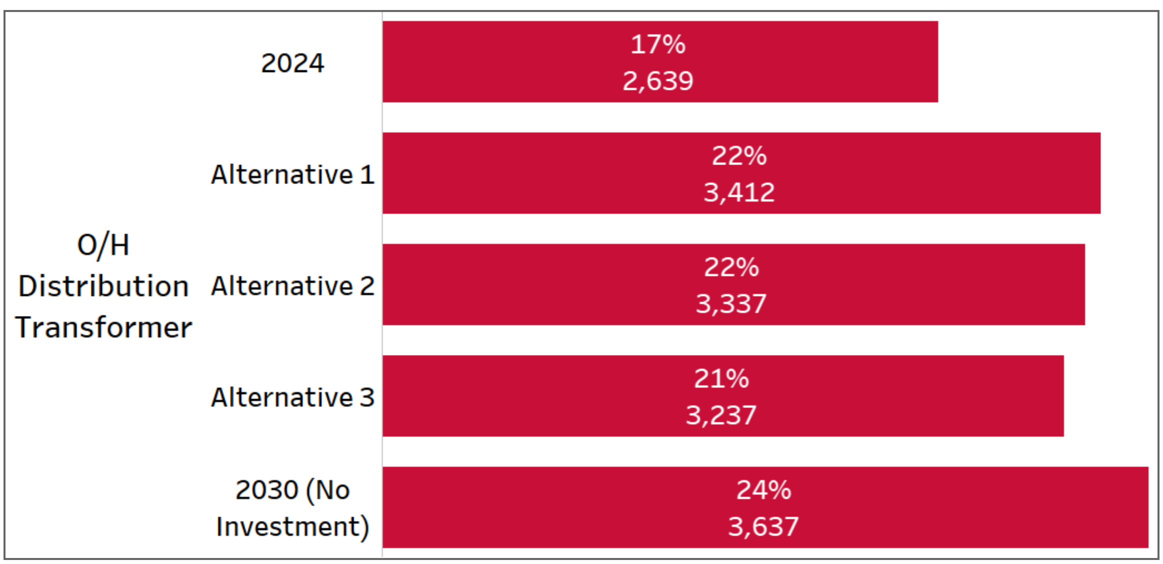


Figure 41 - Number of Overhead Switch/Recloser Projected to Reach Typical Useful Life by 2030

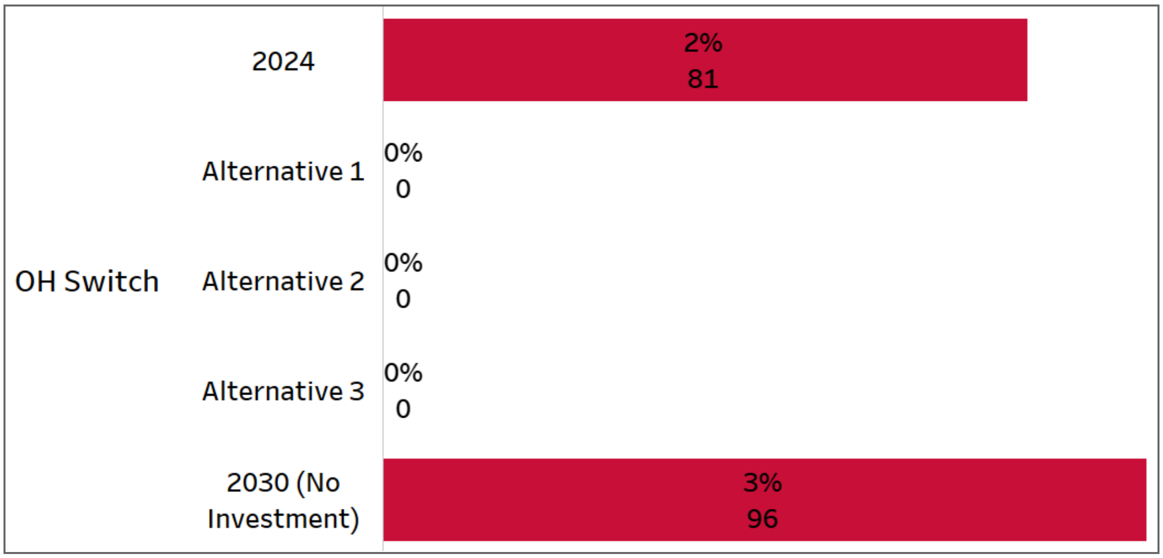
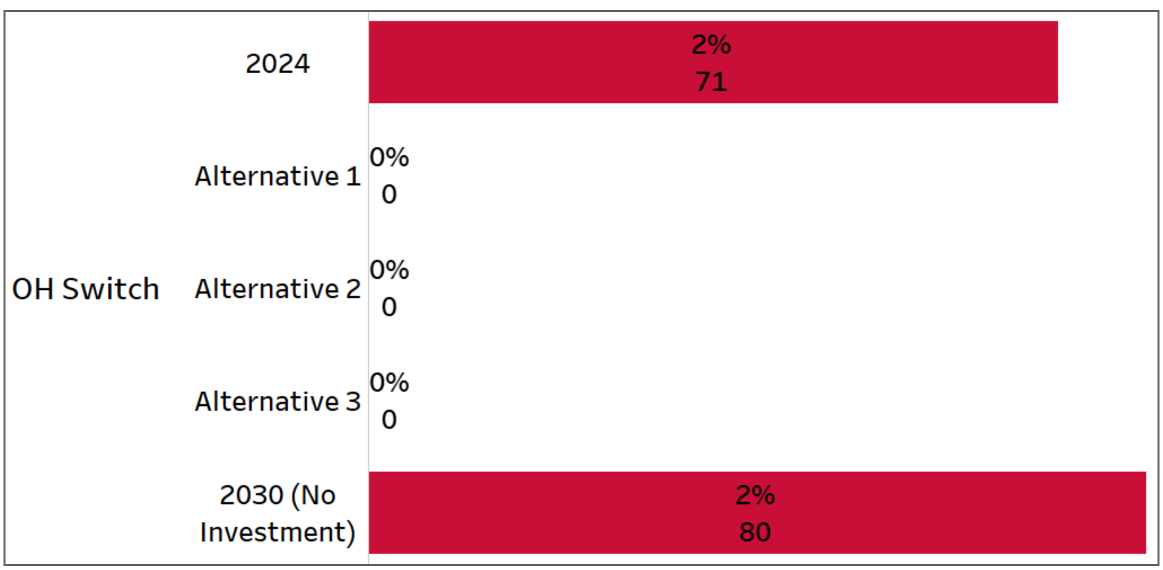


Figure 42 - Number of OH Switches Projected to Reach a Deteriorated Condition by 2030



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.

1

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

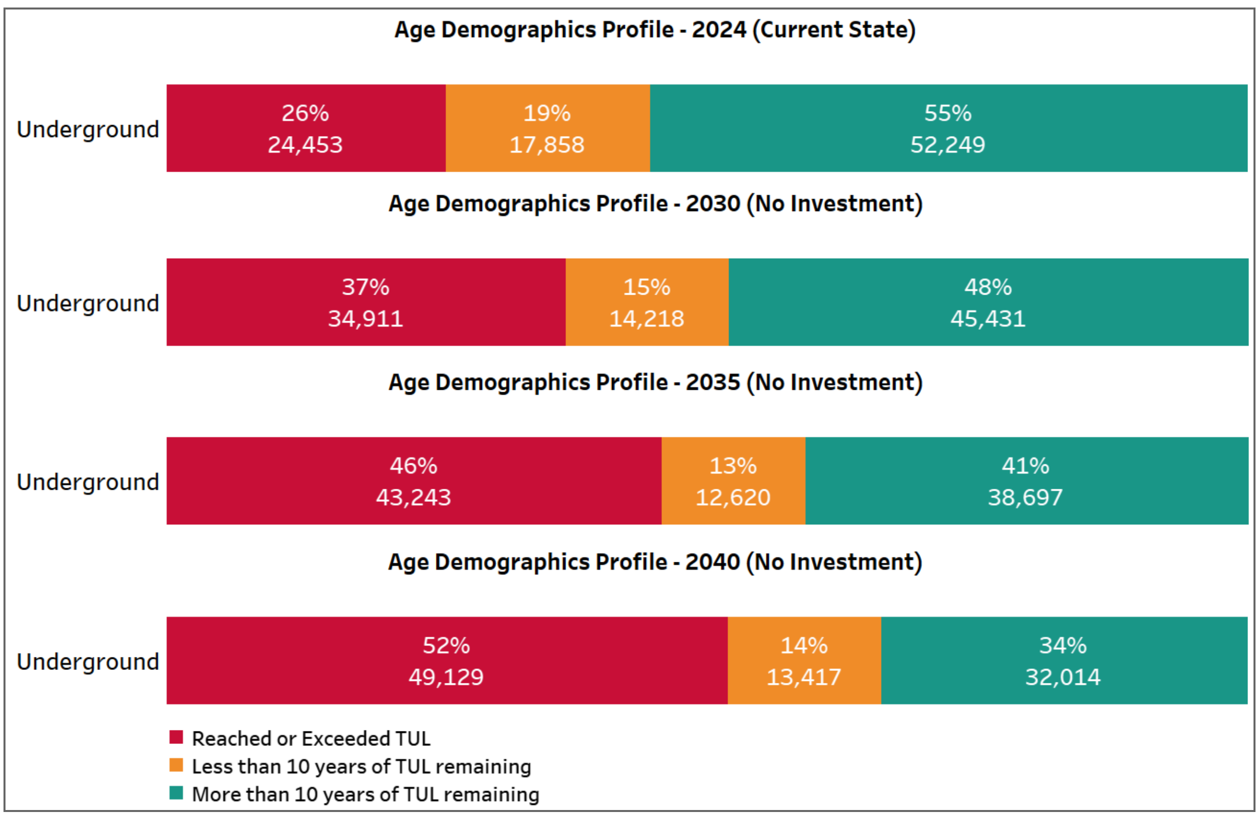
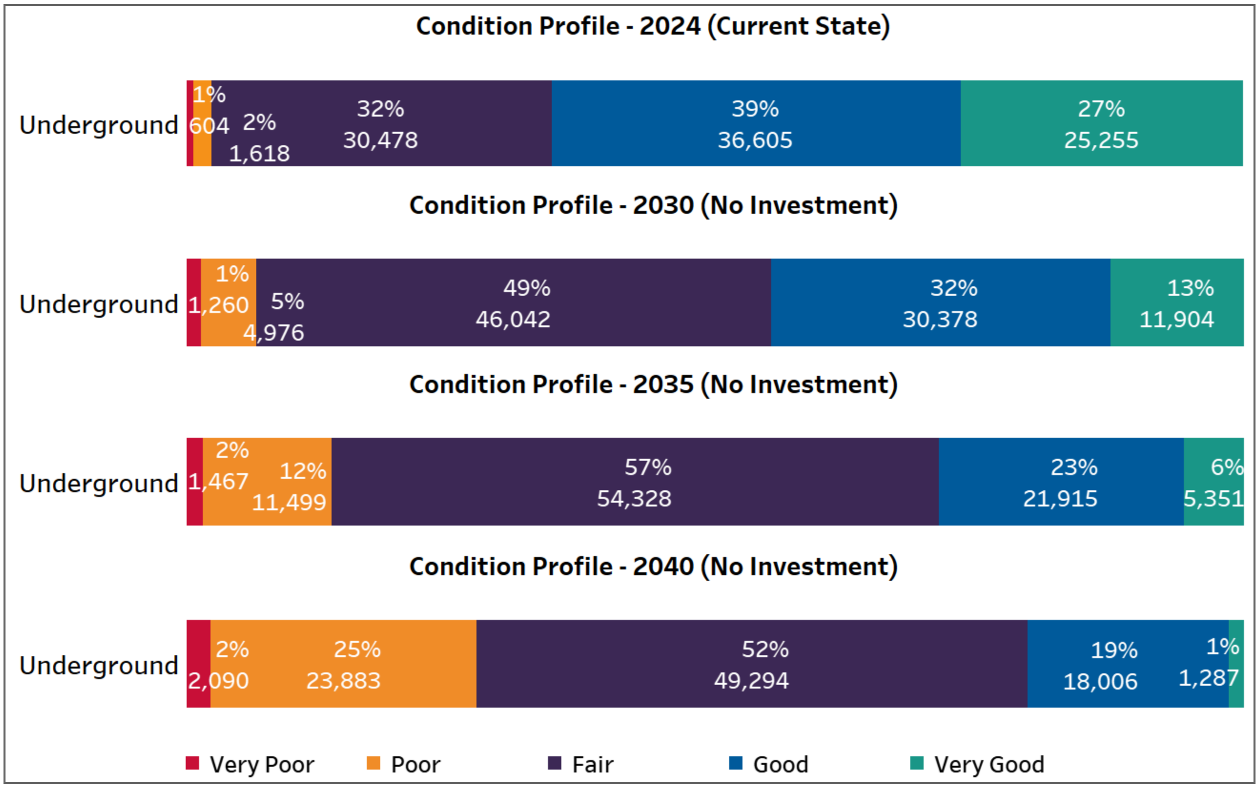


Figure 44 - Overall Condition Profile of UG Distribution Assets



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.

1 **Figure 45 - Age Demographics Profile of UG Switchgear**

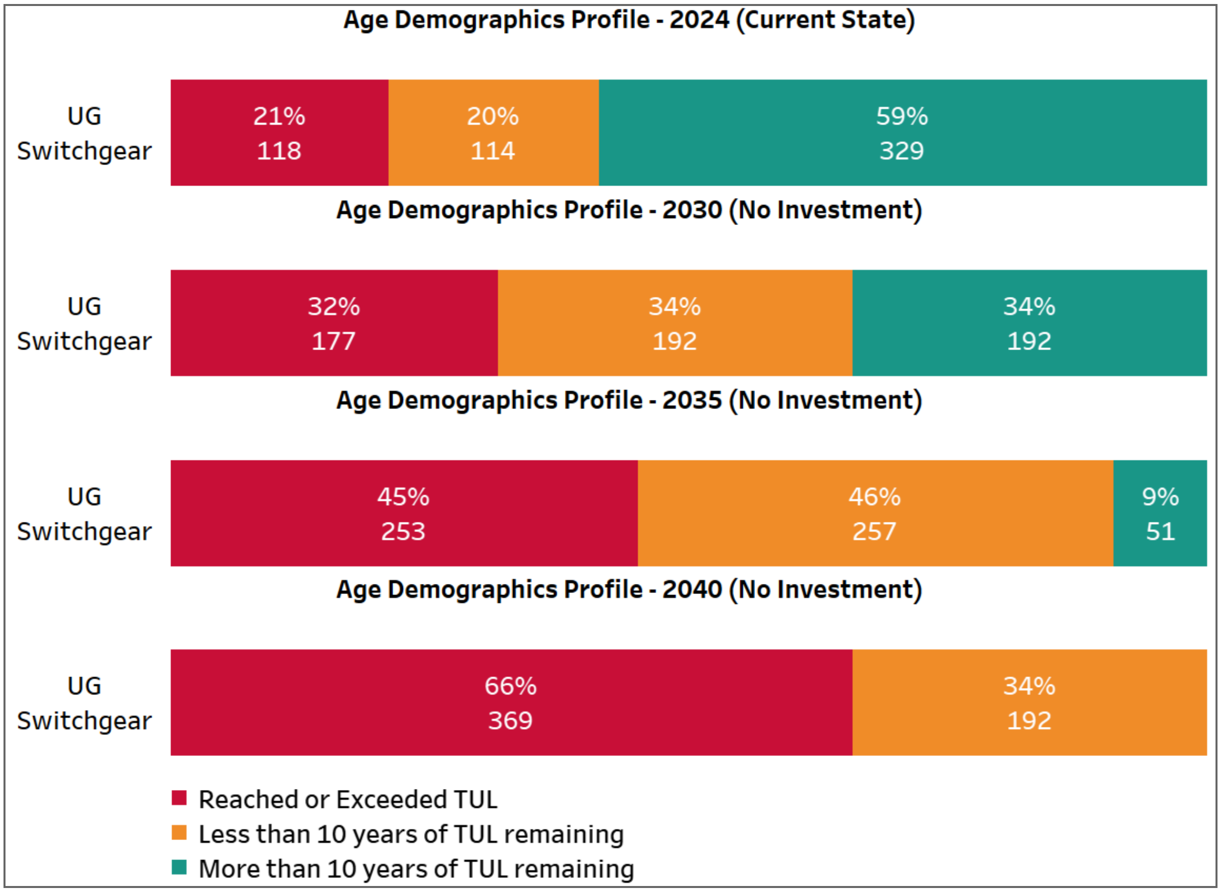


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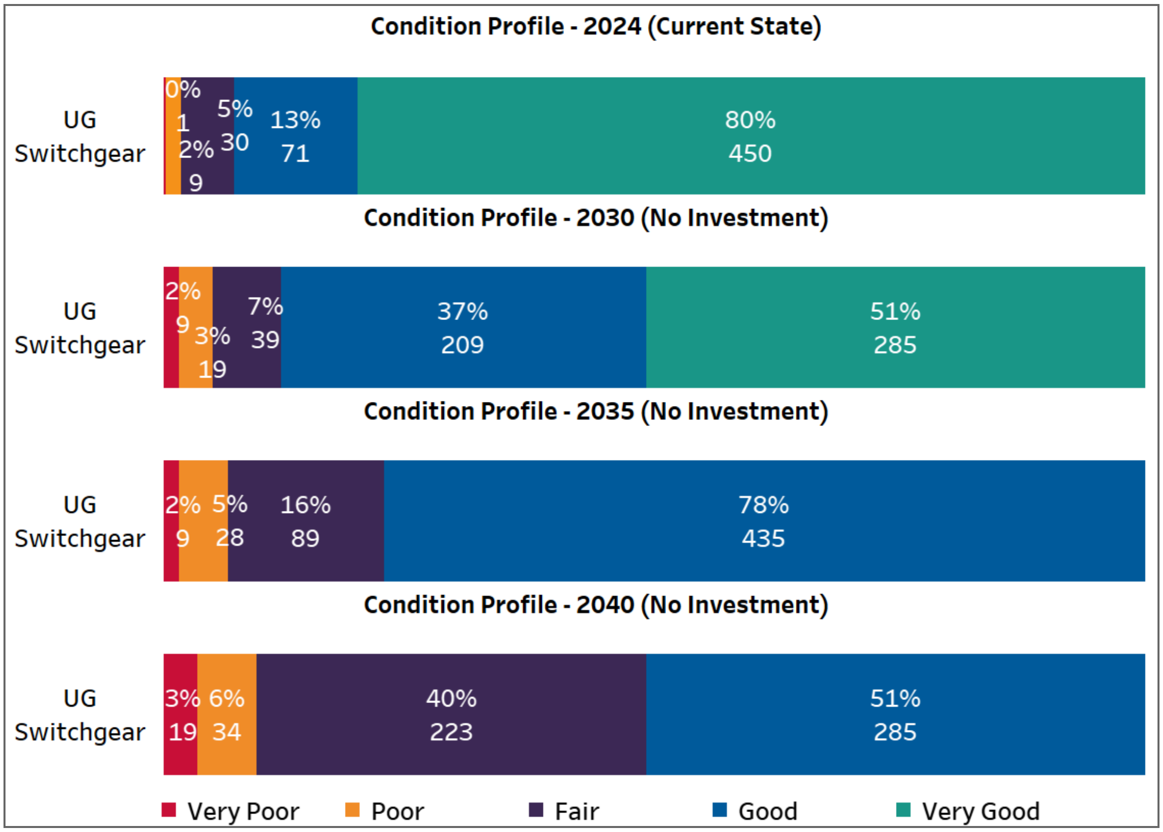
Figure 46 - Condition Profile of UG Switchgear



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.

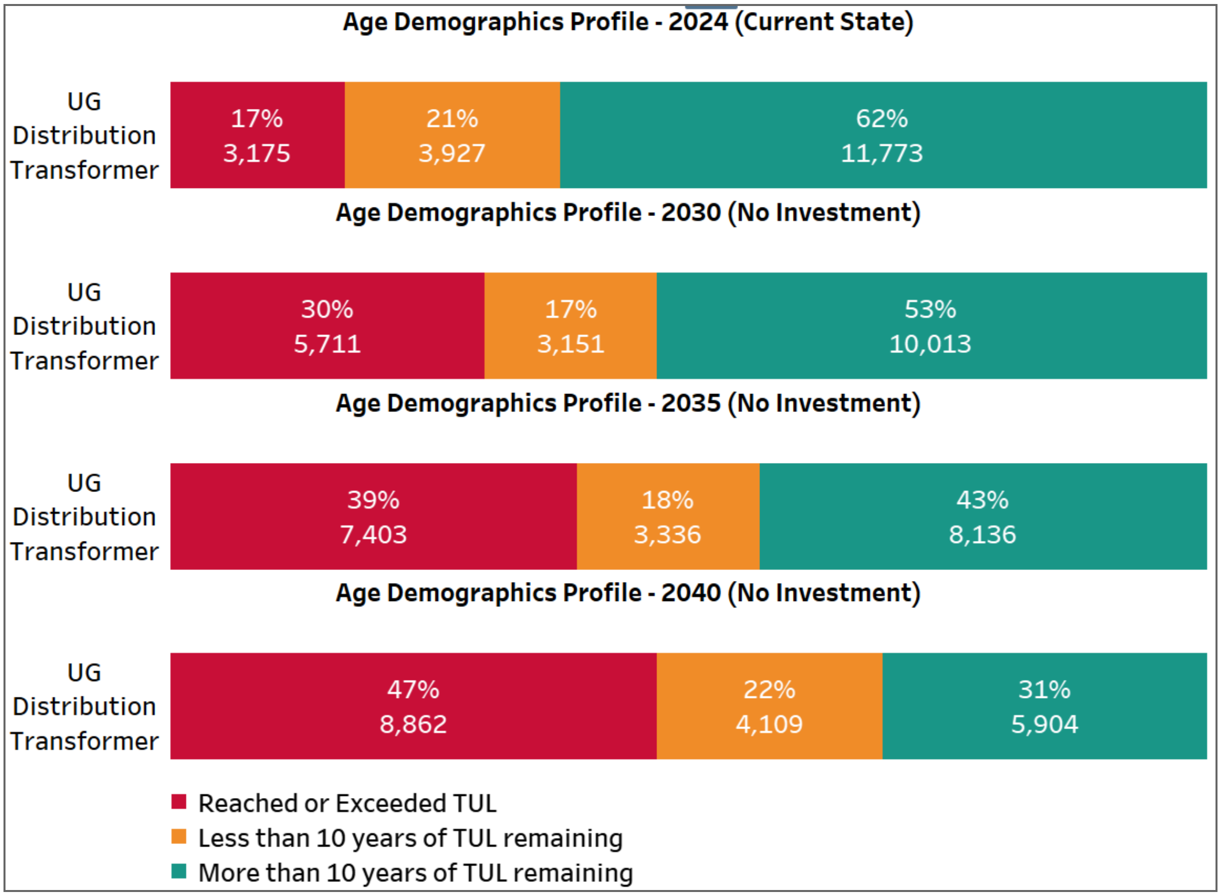
There have also been some premature SF_6 leaks with the UG gas insulated switchgear fleet, tied to a specific manufacturer, thereby increasing the environmental impact due to SF_6 gas emissions. These switchgear failures had to be tackled under the Emergency Renewal budget program, as outlined in Section 6 - Corrective Renewal.

Figure 47 - UG Air Type Switchgear Failure

4.3.4. UG Transformers and Cables

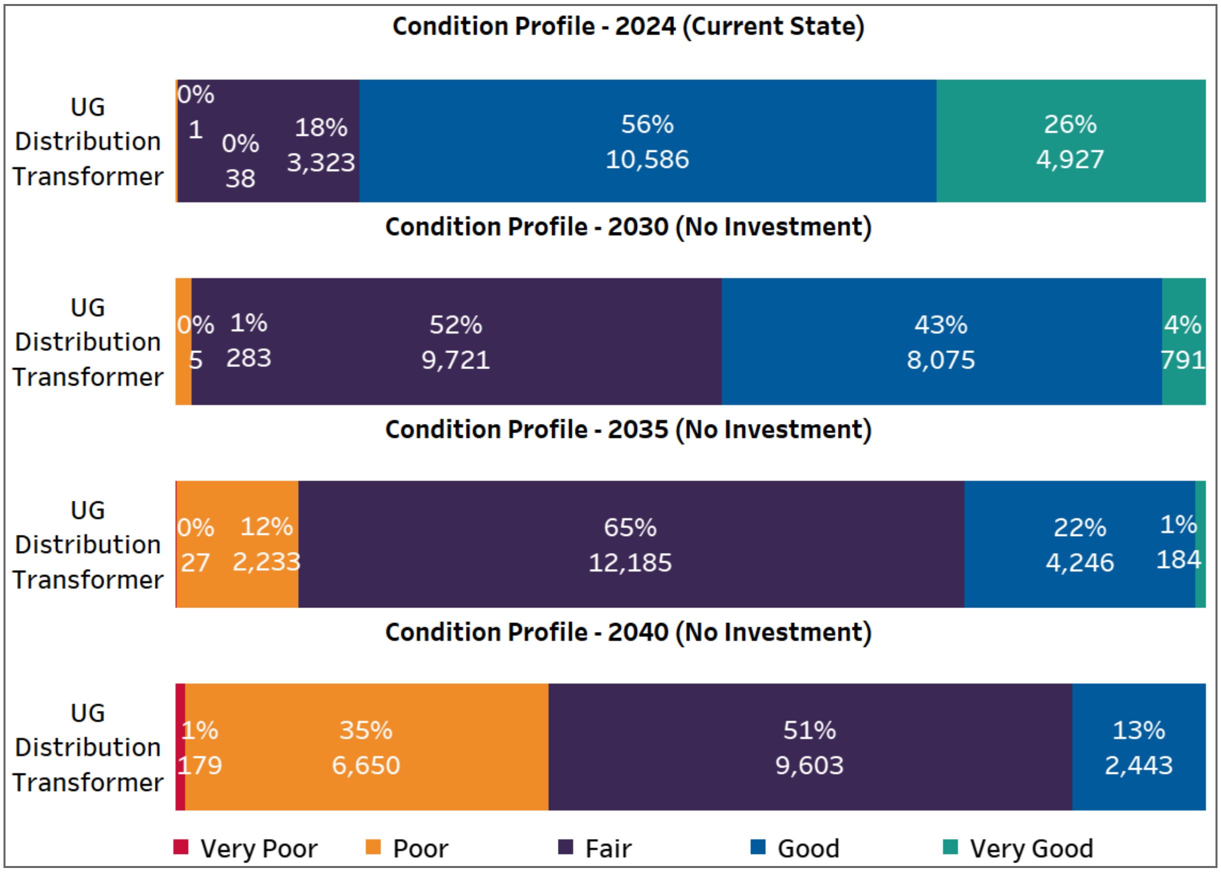
Figures 48 and 49 demonstrate that Hydro Ottawa's UG transformers are reaching end of life and projecting to degrade at a high rate. Specifically, Copperleaf PA forecasts that without intervention the percentage of UG transformers that have reached their end of life will continue to grow at a rate of 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)**

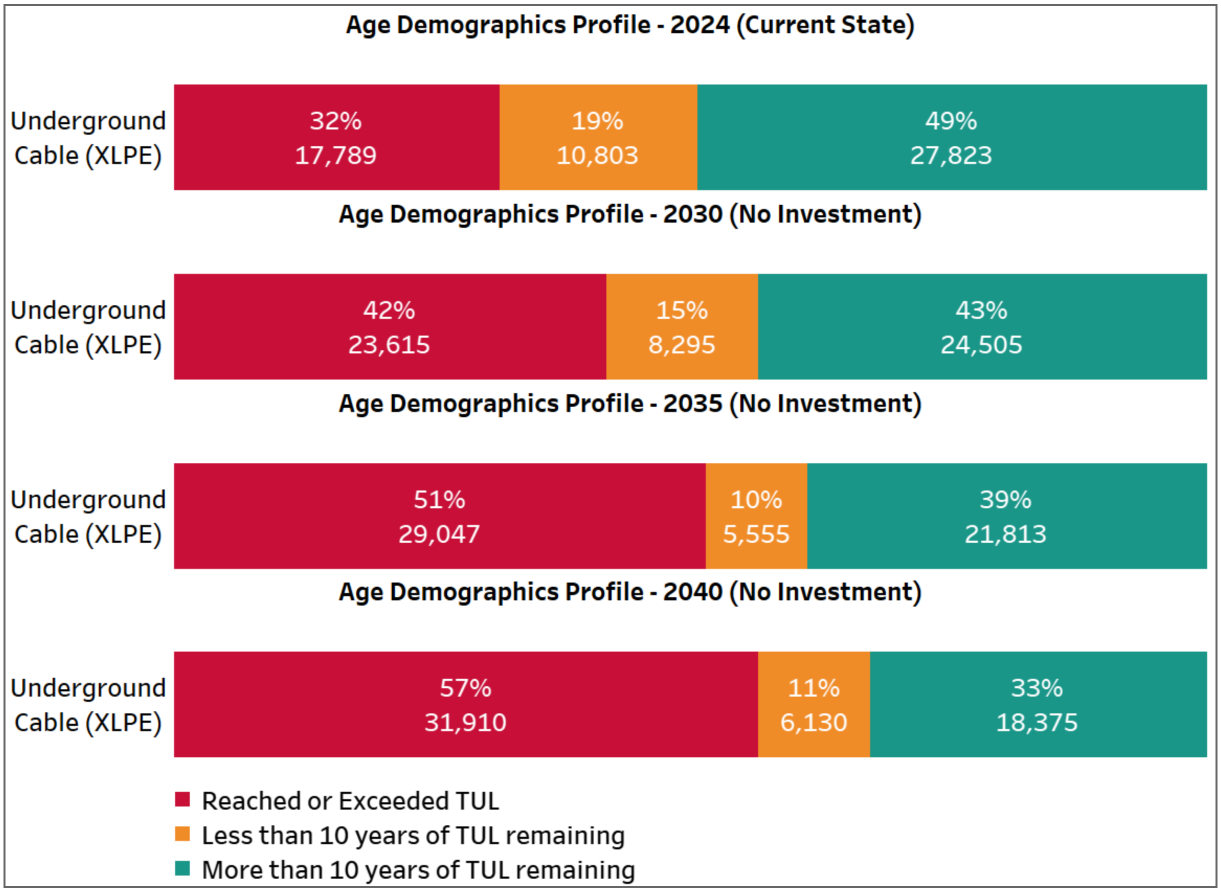


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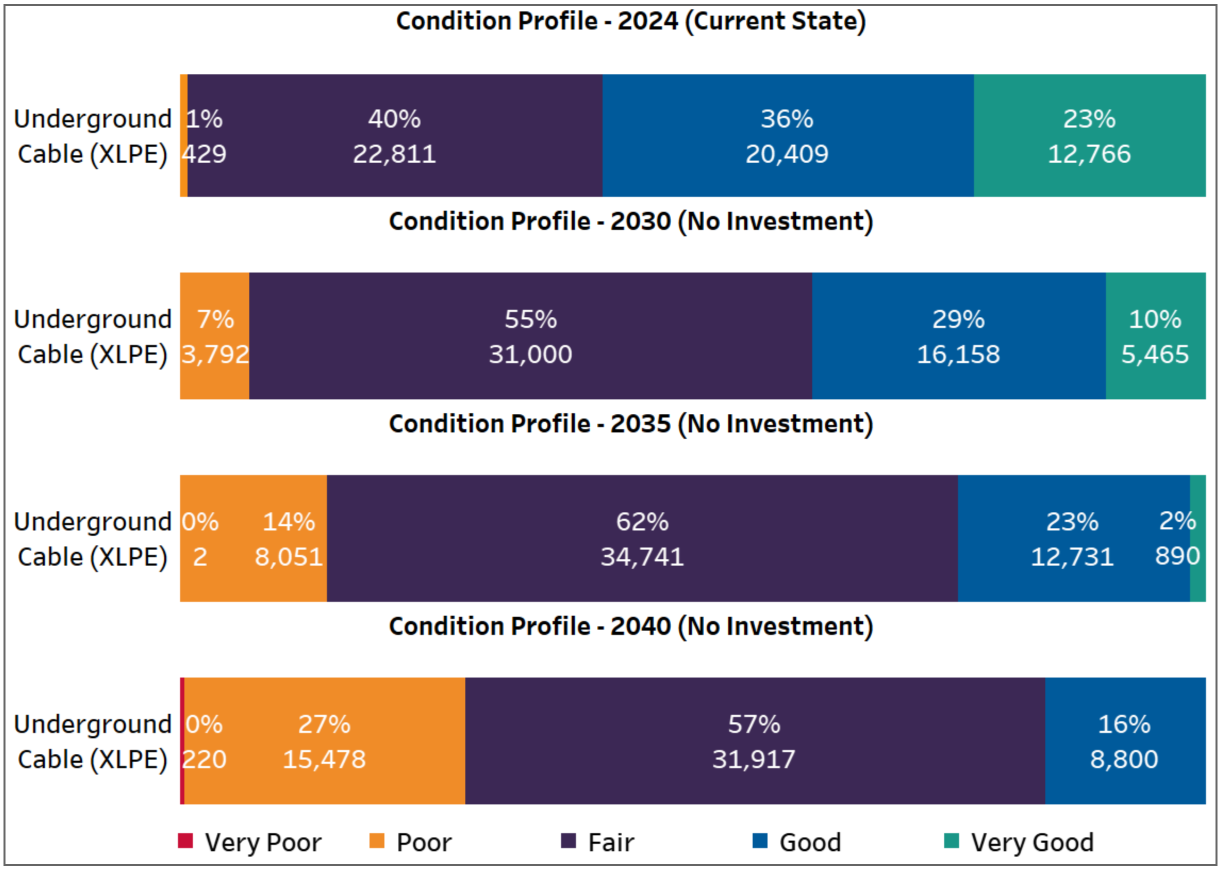
Figure 51 - Condition Profile of UG Cables (XLPE)



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

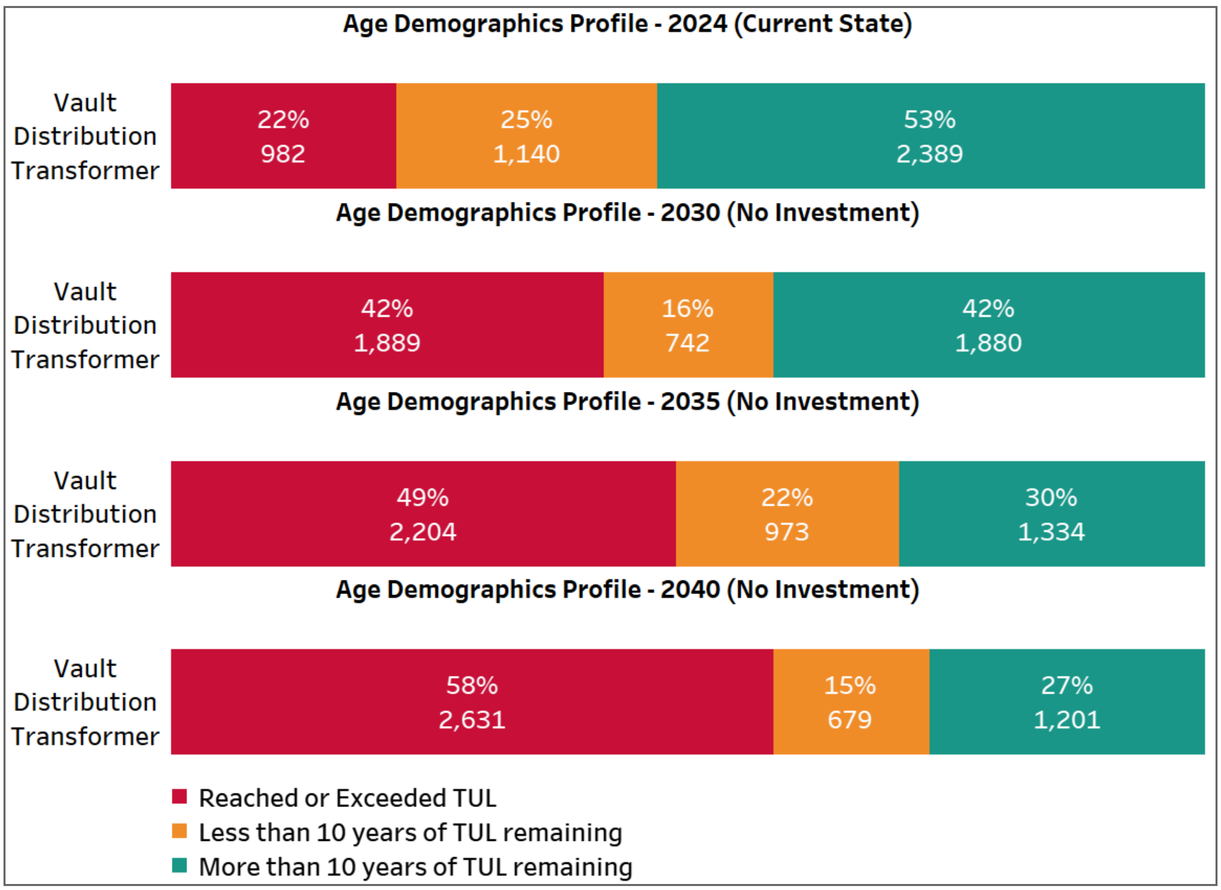


Figure 54 - Condition Profile of Vault Transformers

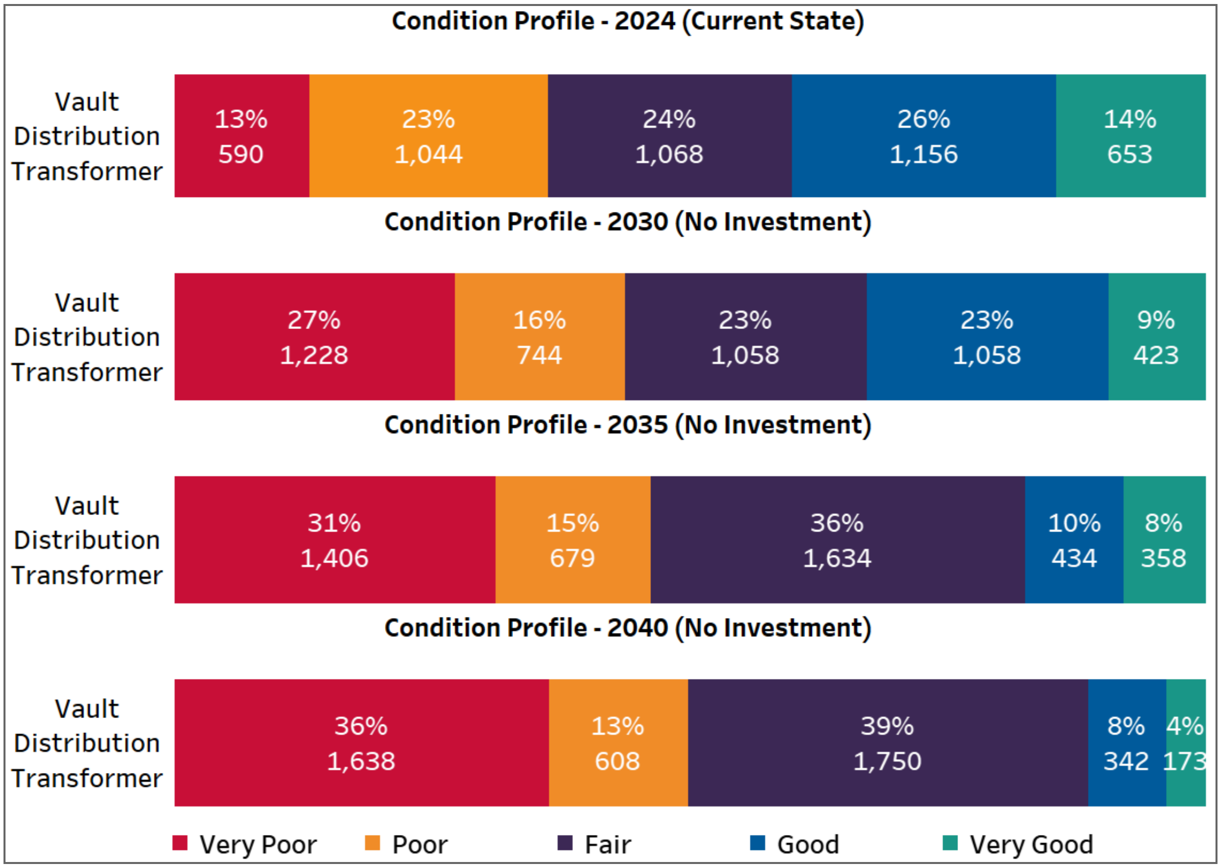


Figure 55 - Age Demographics Profile of Vault Switchgear (excl. customer-owned)

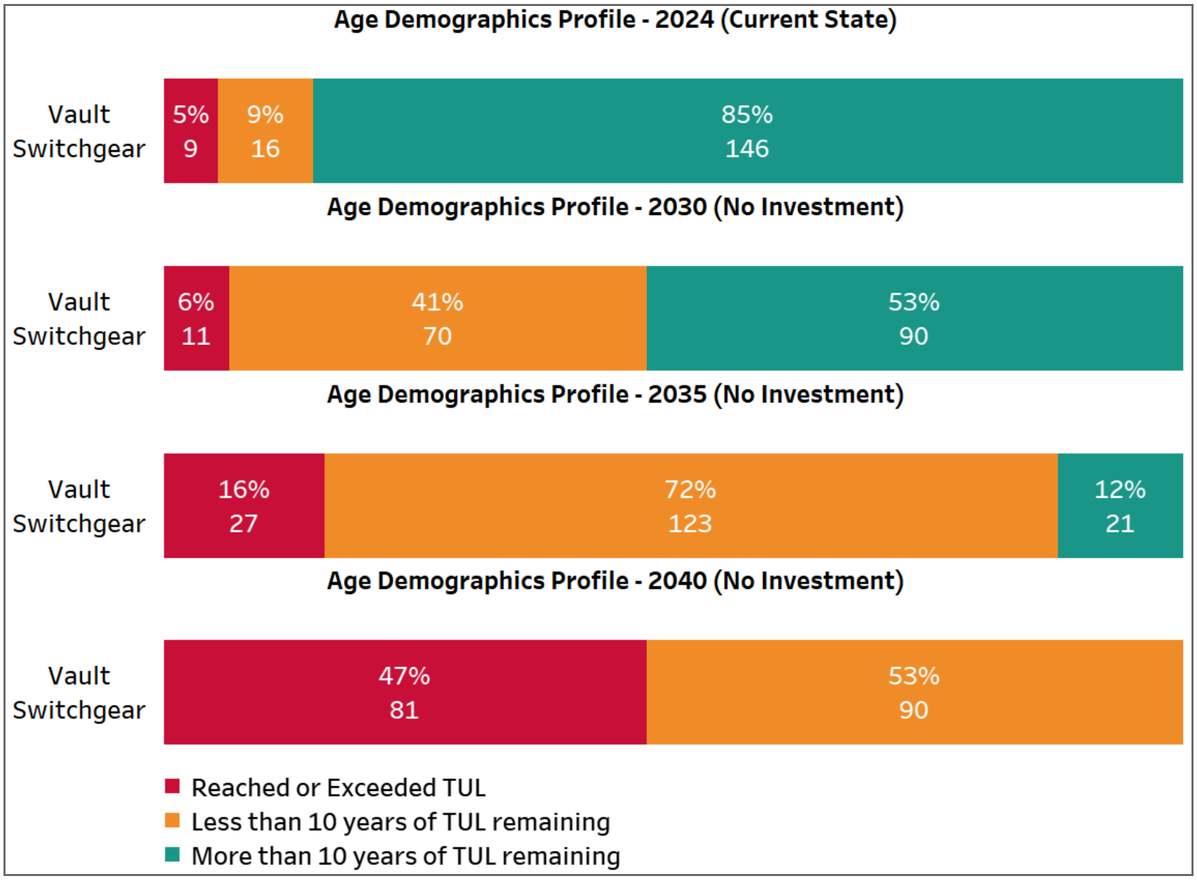


Figure 56 - Condition Profile of Vault Switchgear (excl. customer-owned)

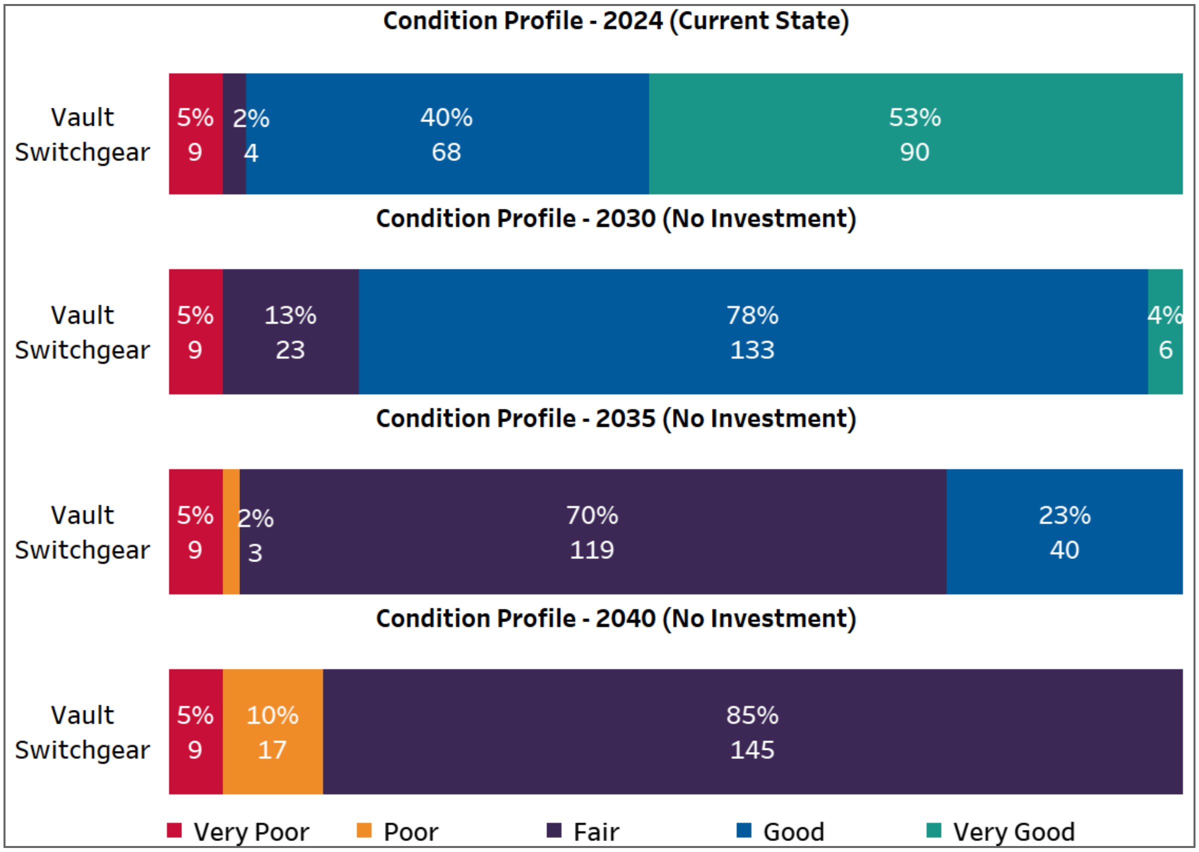


Table 14 displays age demographic projections for customer owned vault switchgear, current state and in 2030 (without investments). Currently, 3% of the vault switchgear units have reached or exceeded their TUL and 8% have less than 10 years of TUL remaining. By 2030, if no investment is made, 5% of 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.

Figure 58 - Age Demographics Profile of Cable Chambers

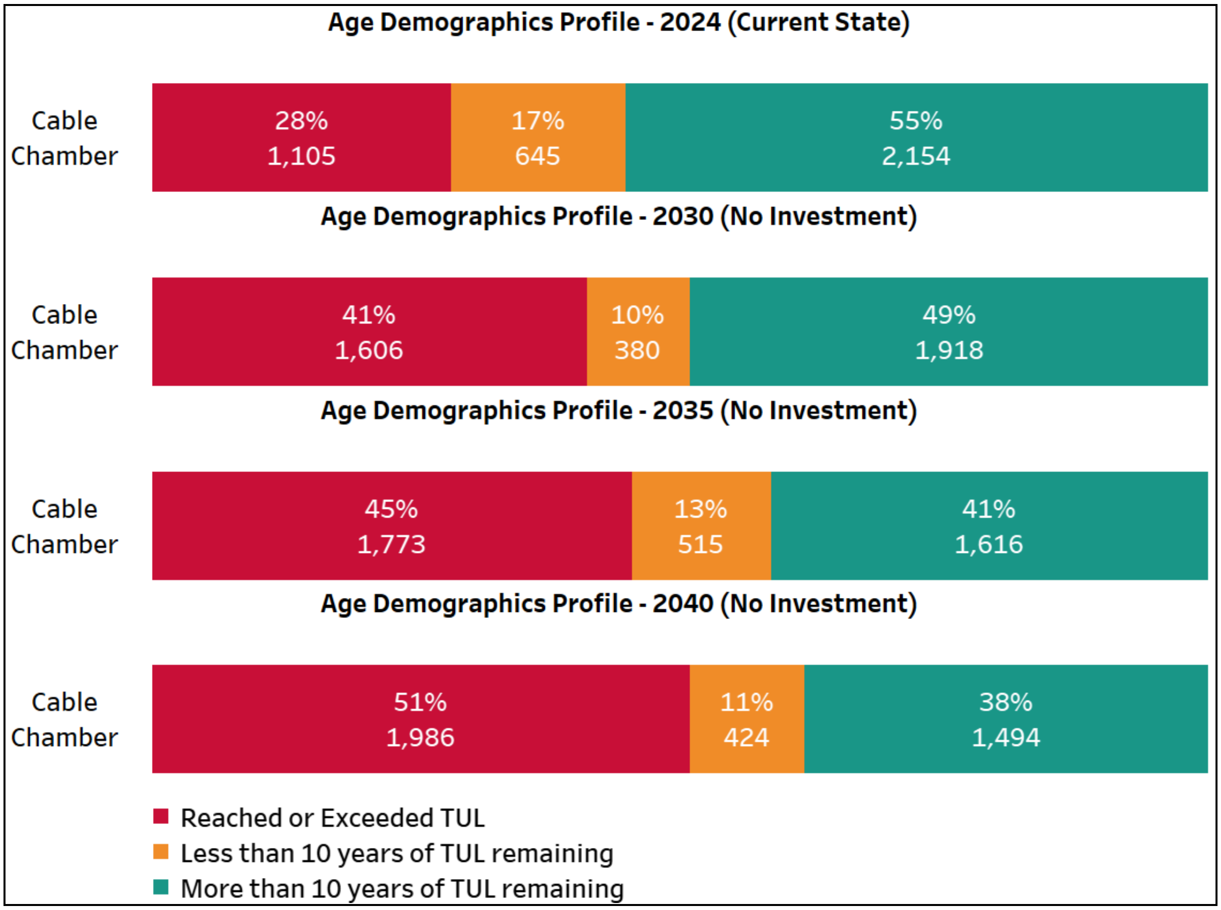
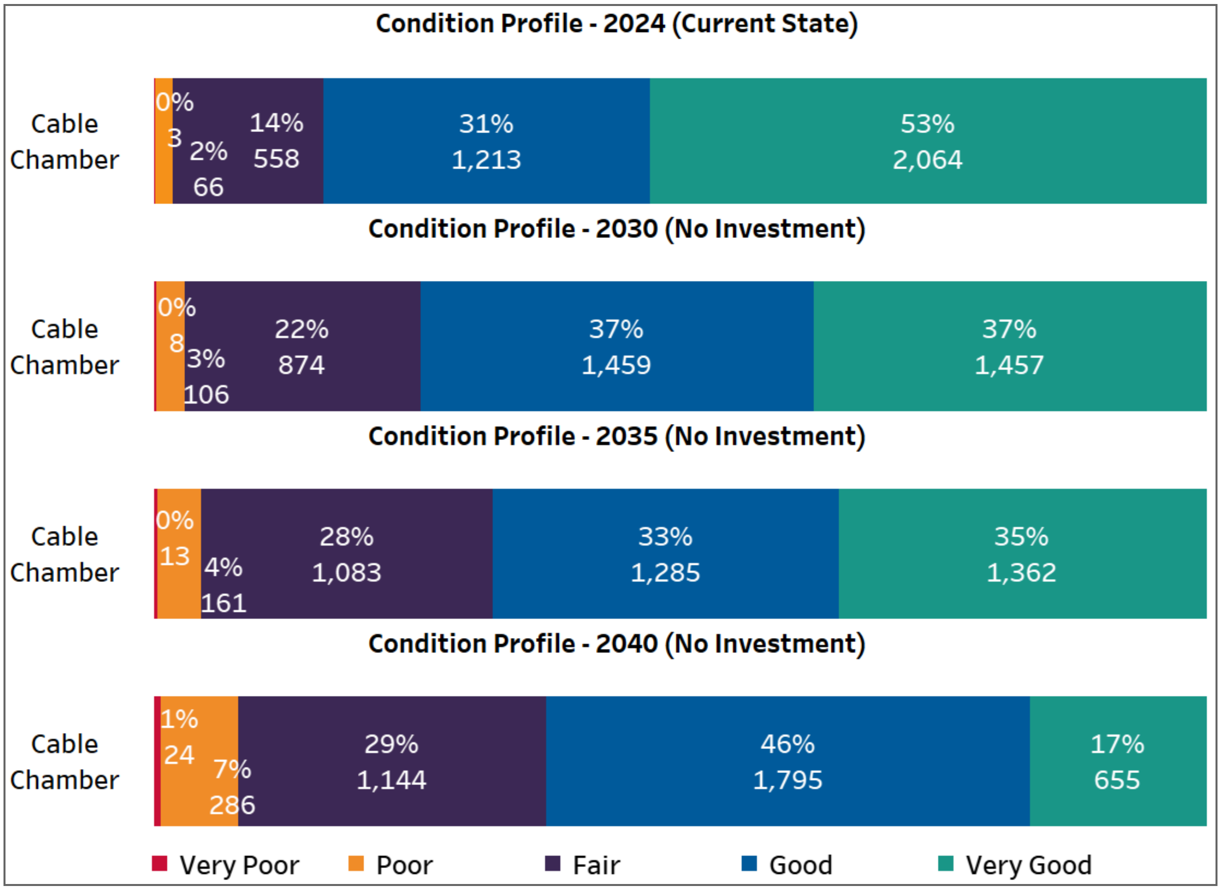


Figure 59 - Condition Profile of Cable Chambers



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

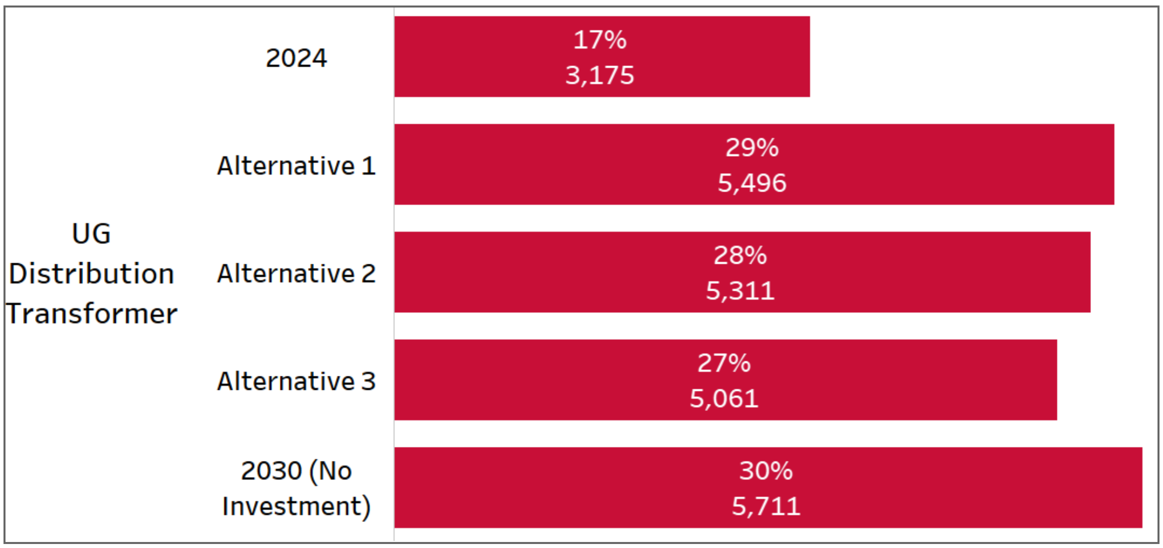


Figure 61 - Number of UG Distribution Transformers Projected to Reach a Deteriorated Condition by 2030

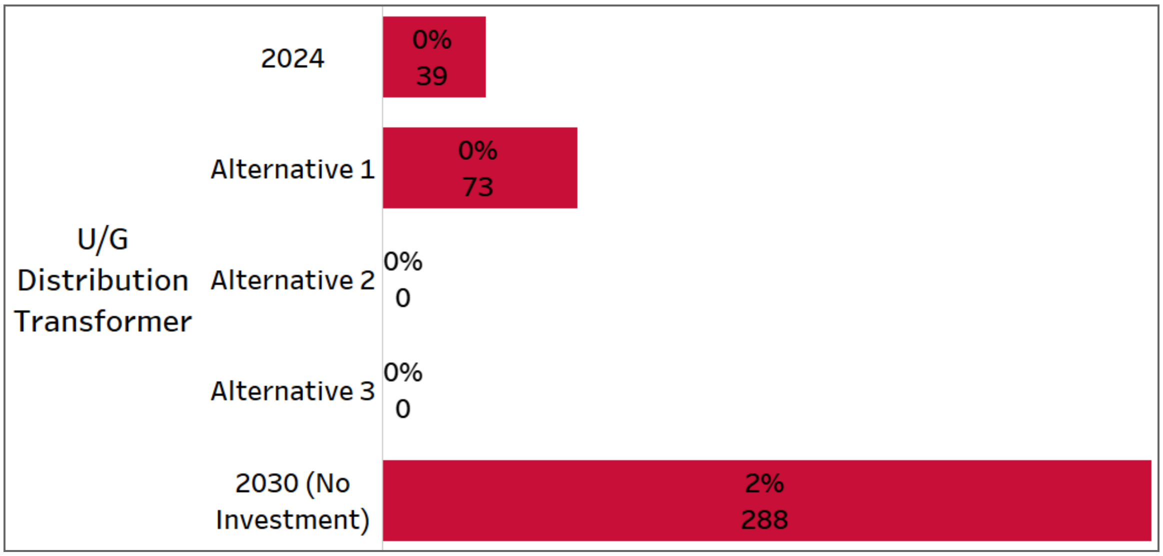


Figure 62 - Number of UG Switchgear Projected to Reach Typical Useful Life by 2030

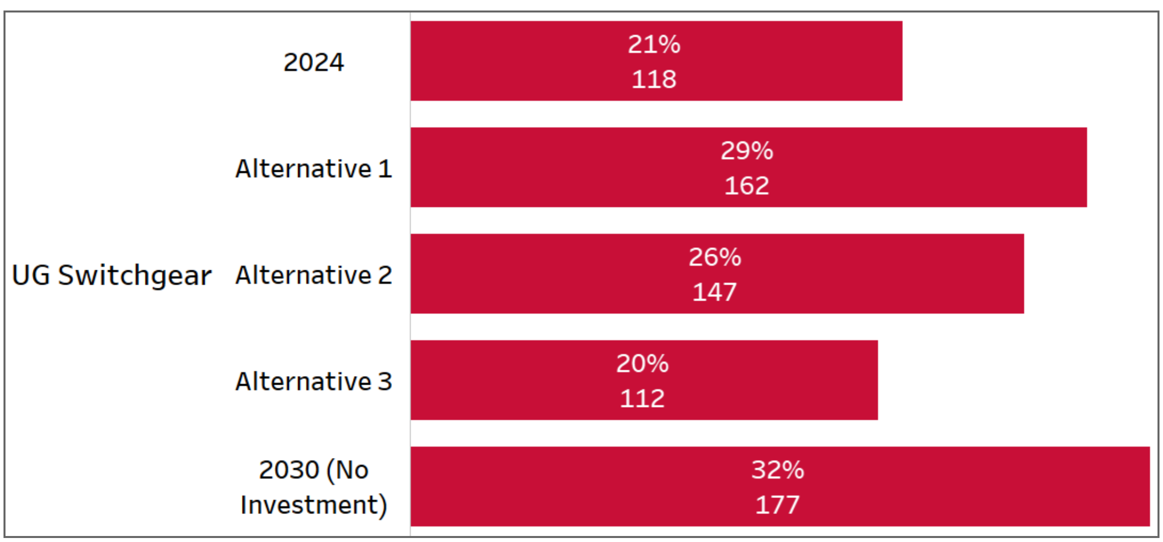


Figure 63 - Number of UG Switchgear Projected to Reach a Deteriorated Condition by 2030

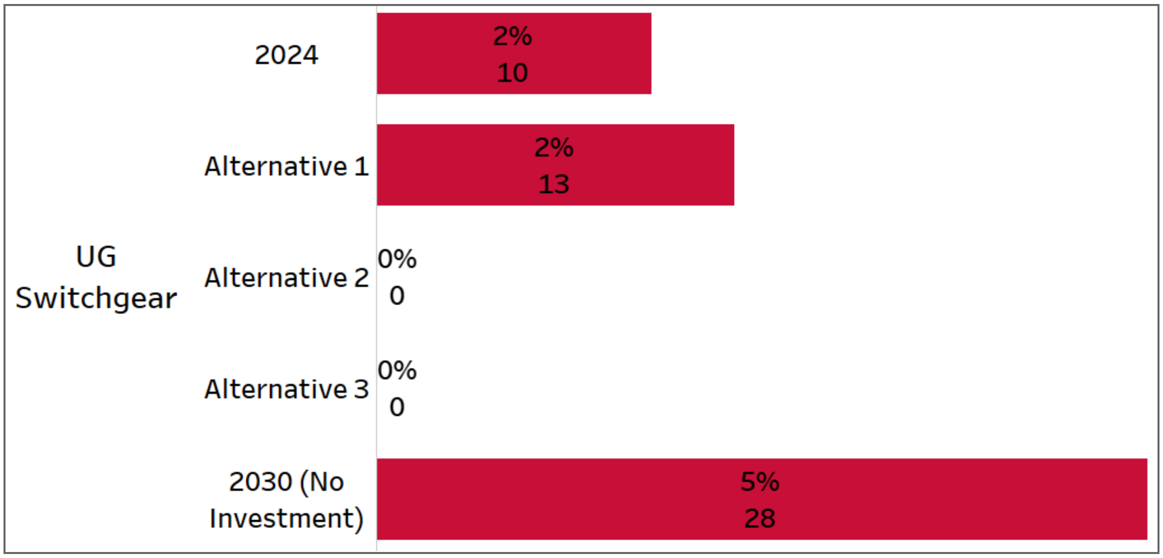


Figure 64 - Length (in km) of UG XLPE Cables Projected to Reach Typical Useful Life by 2030

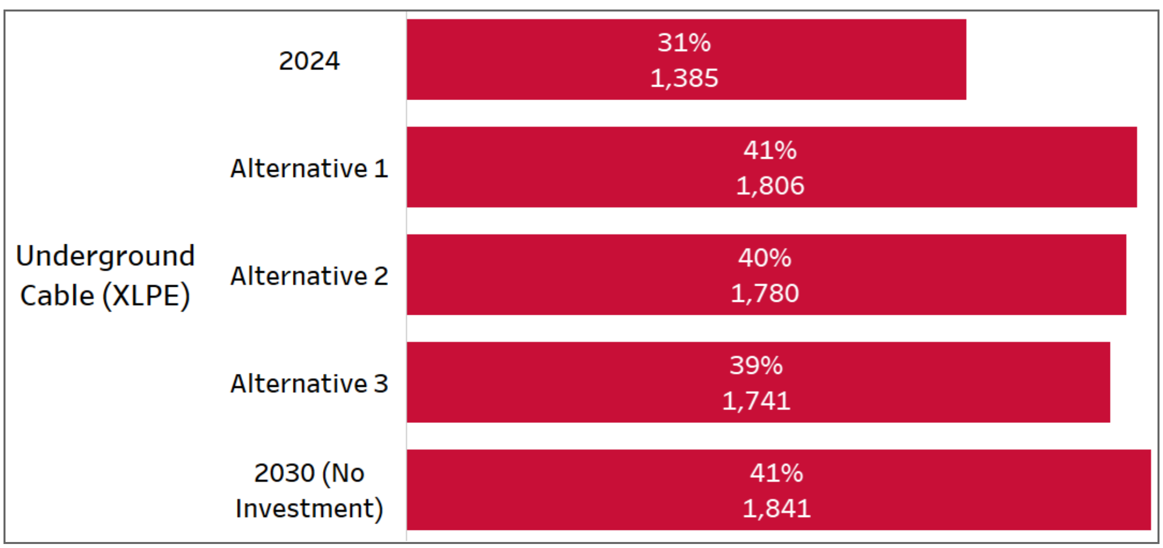


Figure 65 - Length (in km) of UG XLPE Cables Projected to Reach a Deteriorated Condition by 2030

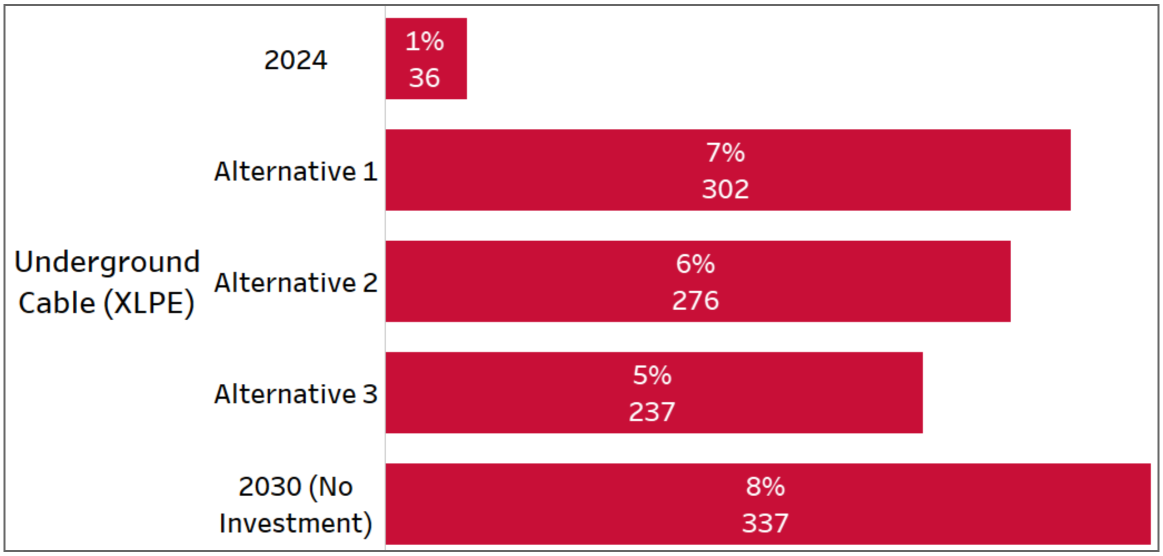


Figure 66 - Number of Vault Distribution Transformers Projected to Reach Typical Useful Life by 2030

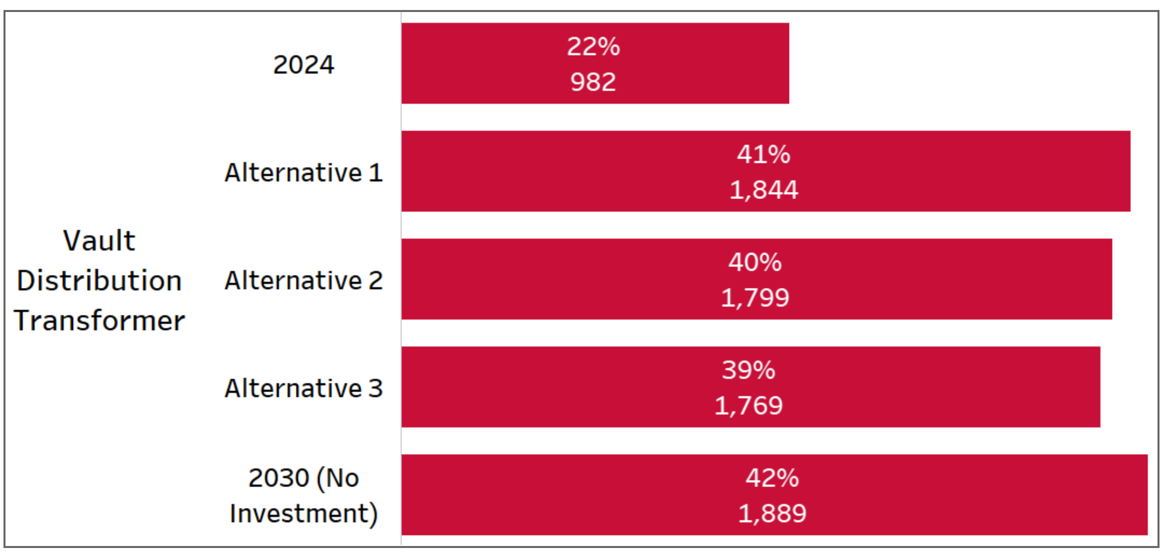


Figure 67 - Number of Vault Distribution Transformers Projected to Reach a Deteriorated Condition by 2030

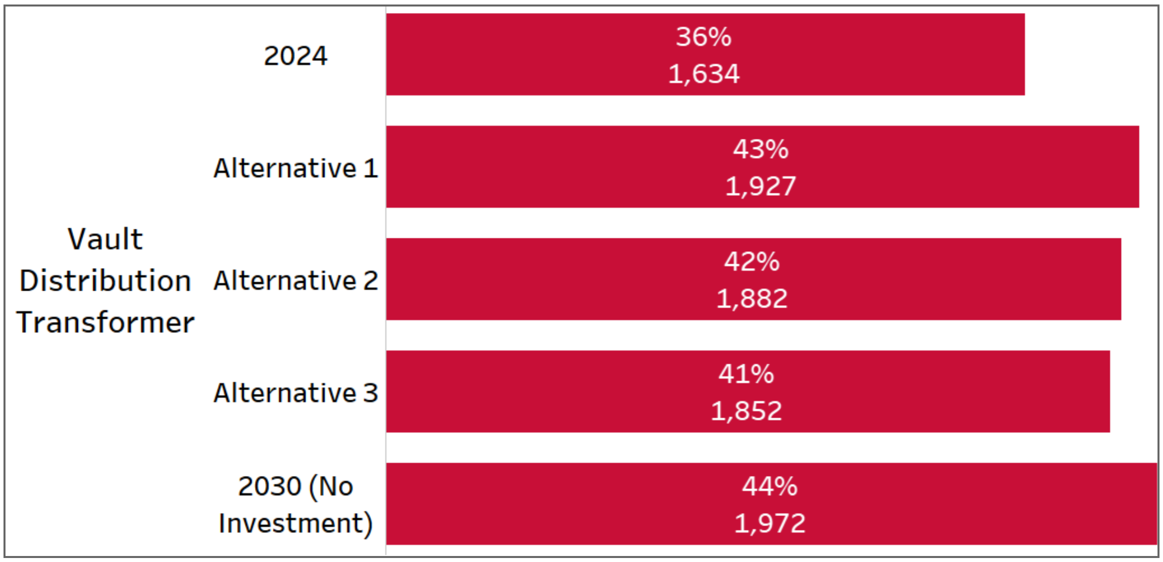


Figure 68 - Number of Vault Switchgear (excl. Customer-Owned) Projected to Reach Typical Useful Life by 2030

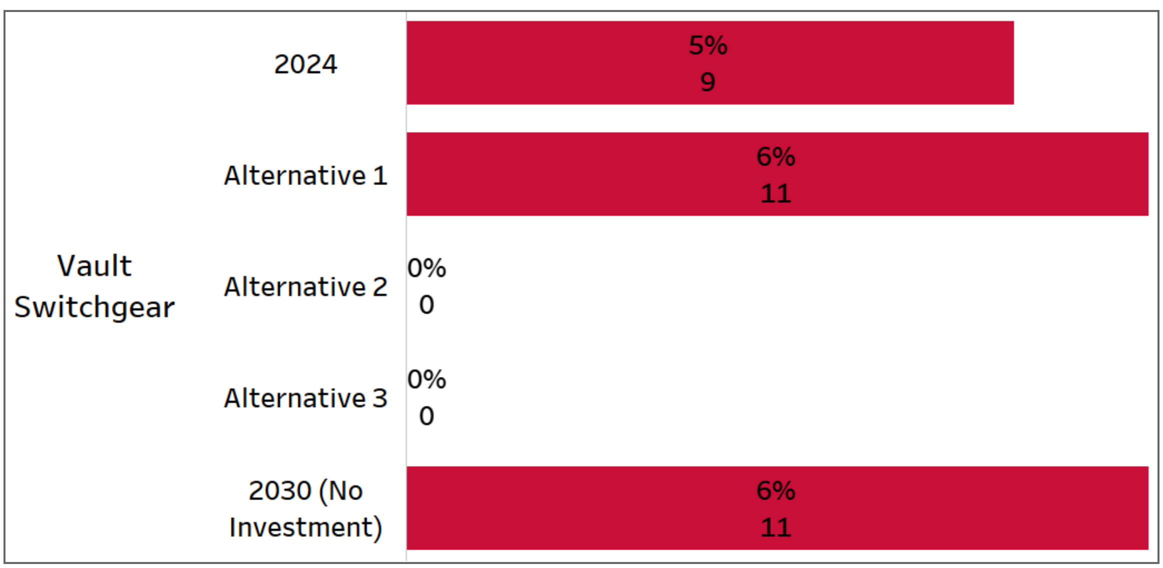


Figure 69 - Number of Vault Switchgear (excl. Customer-Owned) Projected to Reach a Deteriorated Condition by 2030

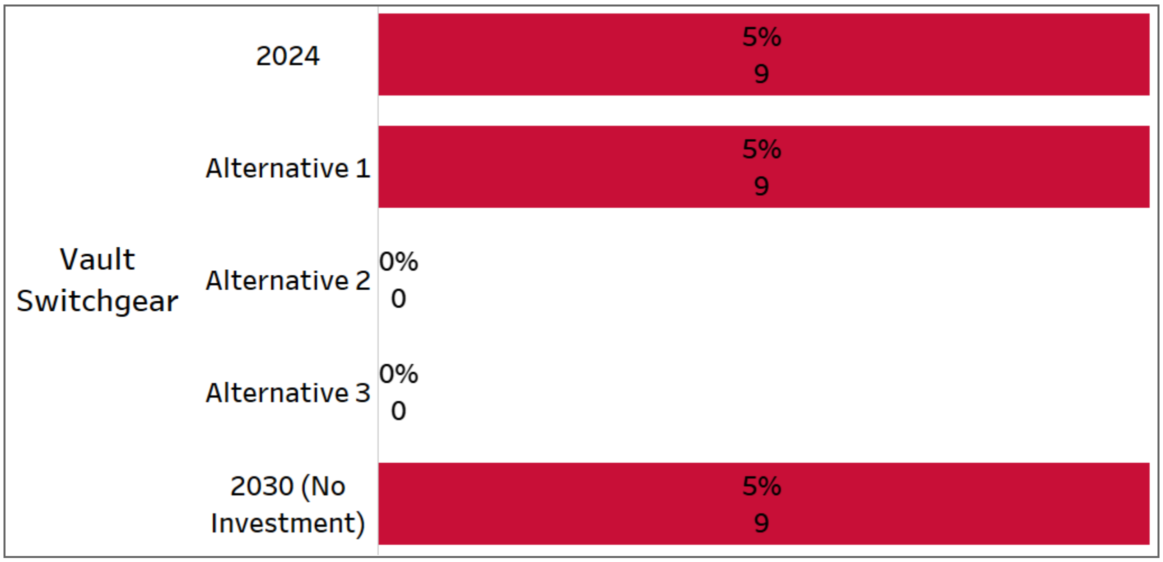


Figure 70 - Number of Cable Chambers Projected to Reach Typical Useful Life by 2030

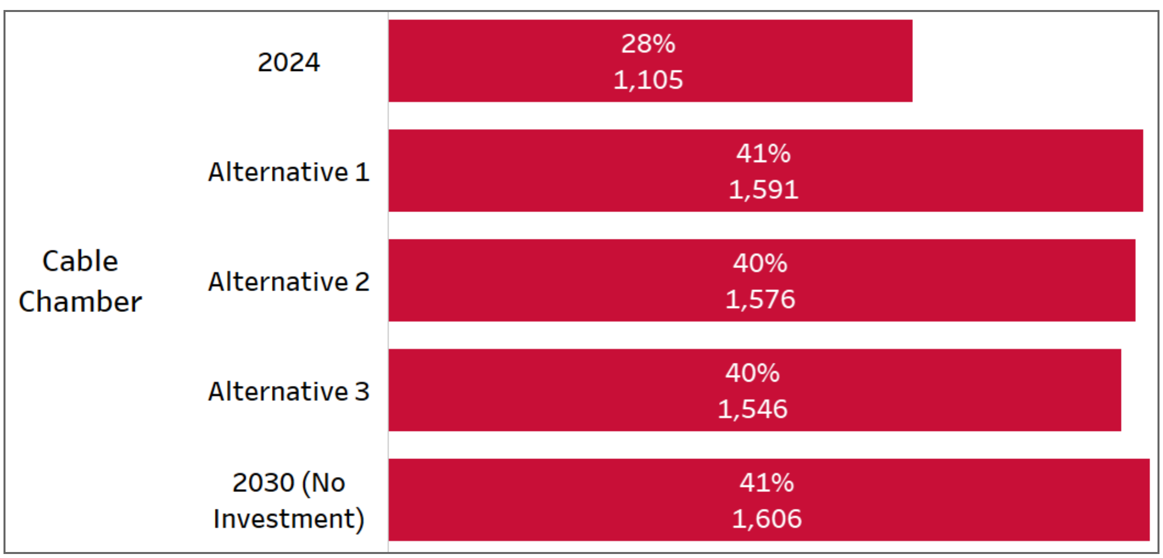
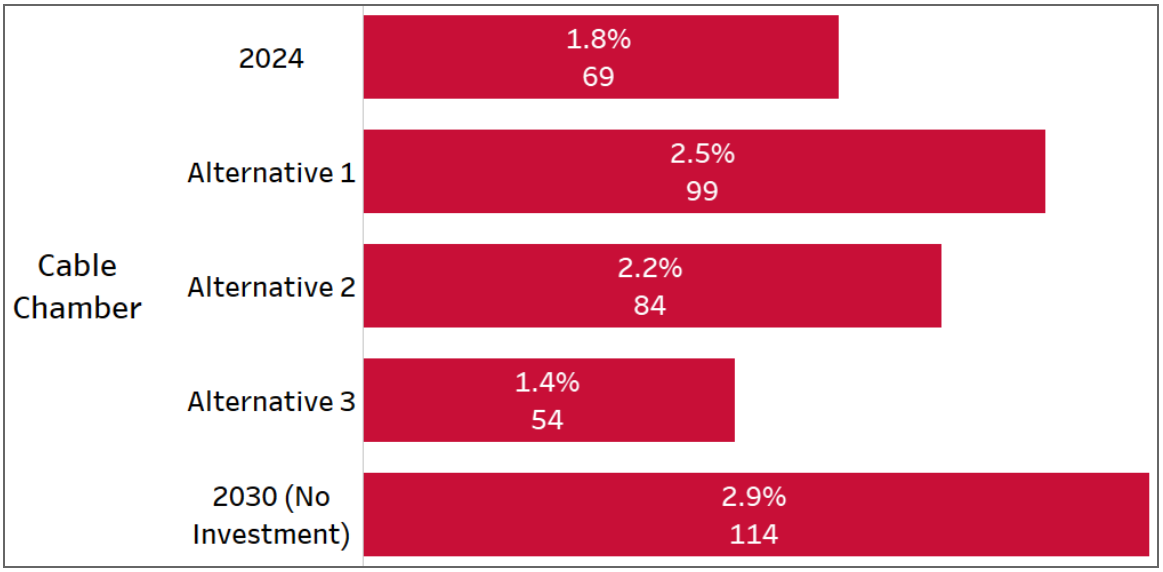


Figure 71 - Number of Cable Chambers Projected to Reach a Deteriorated Condition by 2030



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.

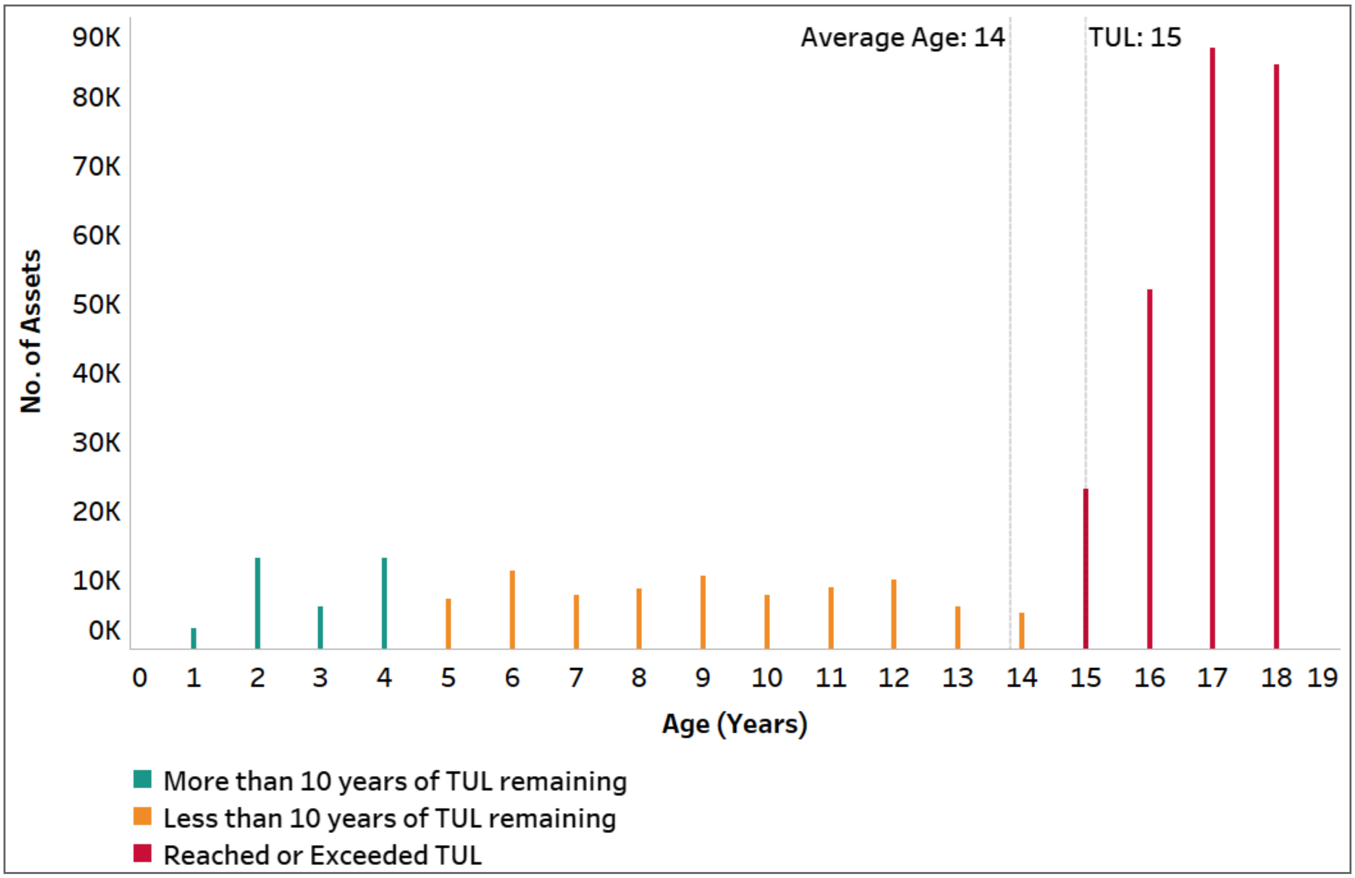
5.3.2. Current Issues

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)**

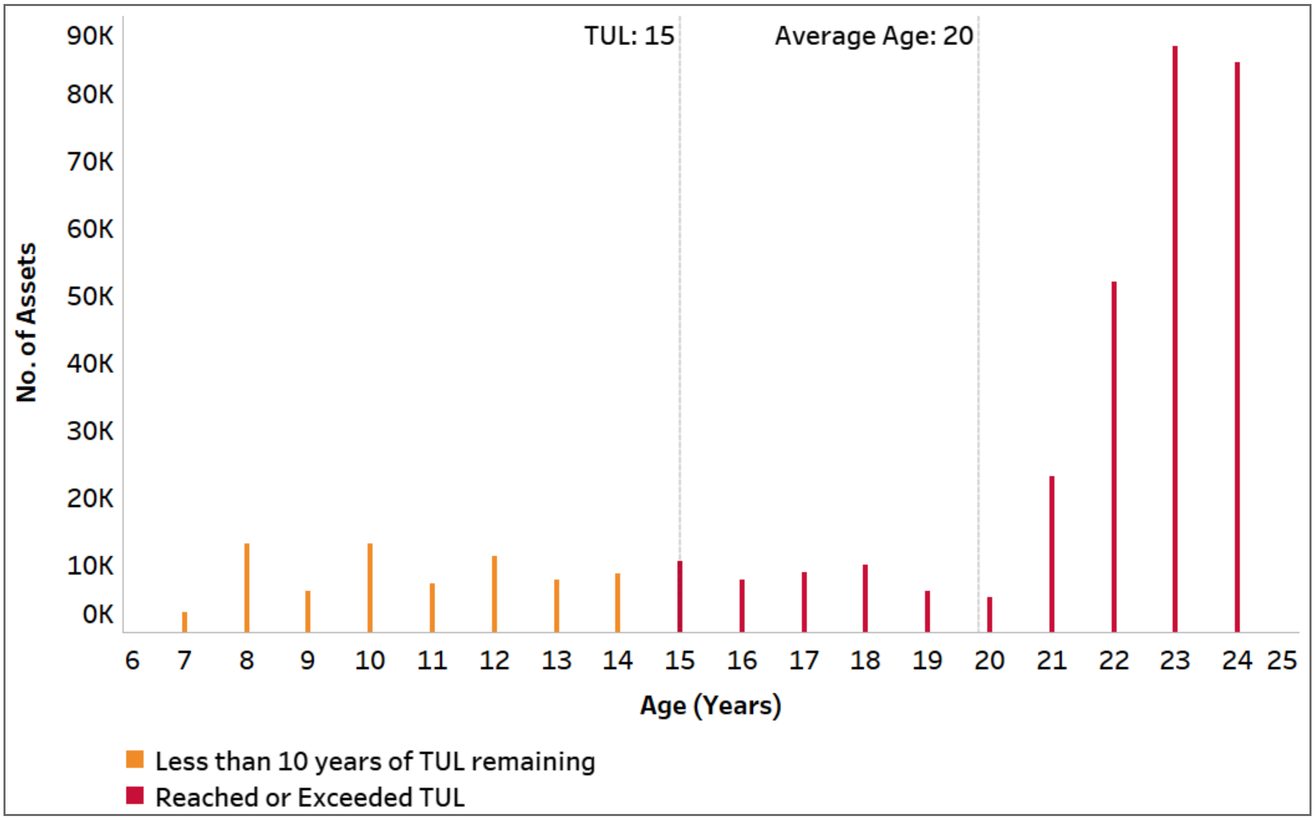
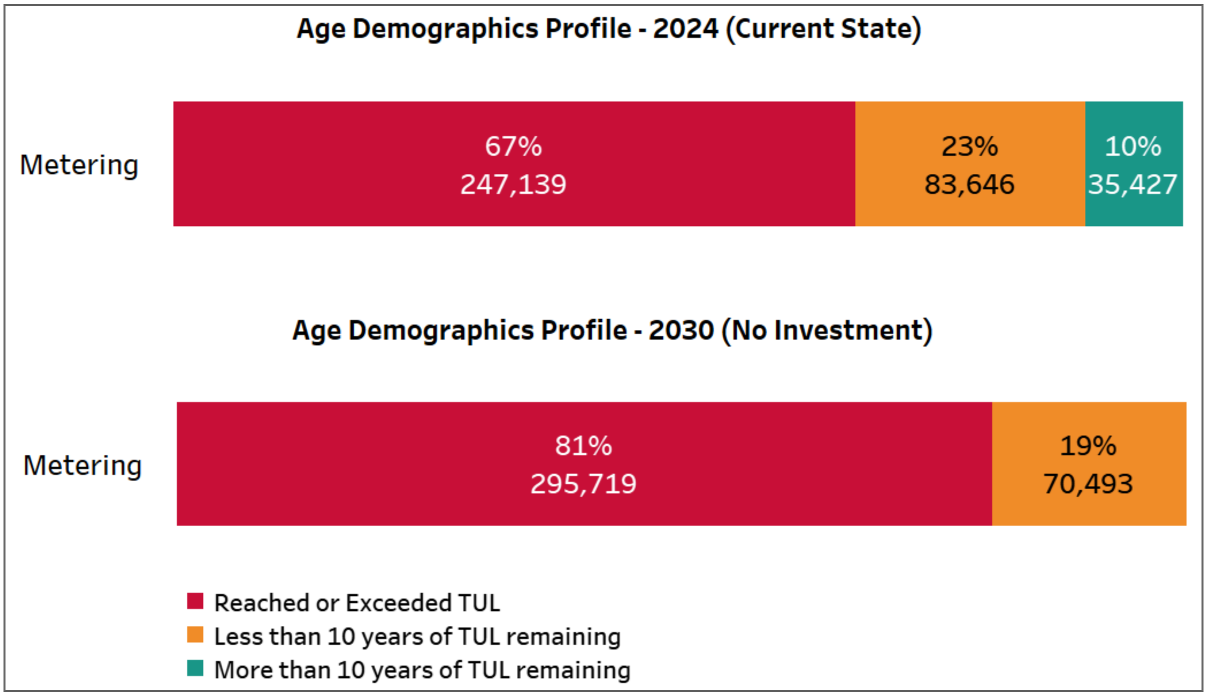
3 

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.

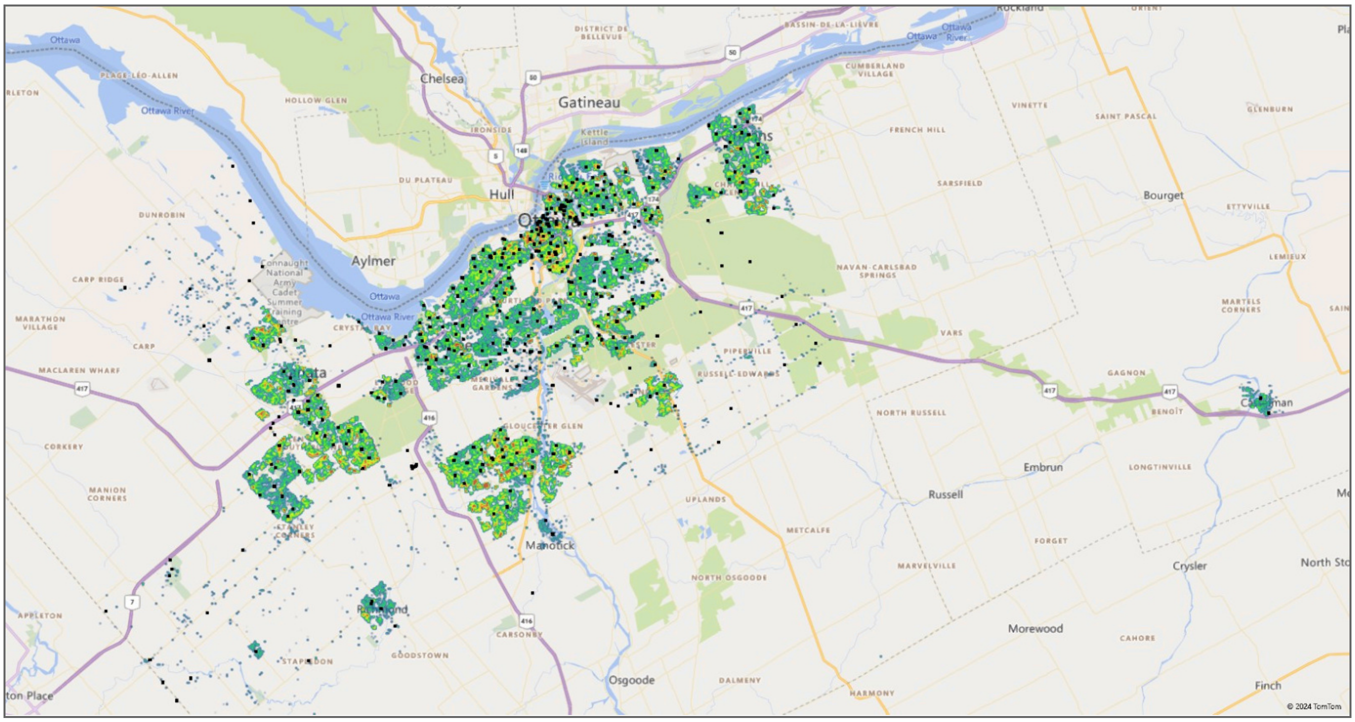
The recommended approach, Alternative 2, addresses Hydro Ottawa's aging metering fleet through a phased renewal of metering infrastructure, balancing the need for replacement with customer affordability and preventing future cyclical investment patterns. This approach creates a pathway for the progressive 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.

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.

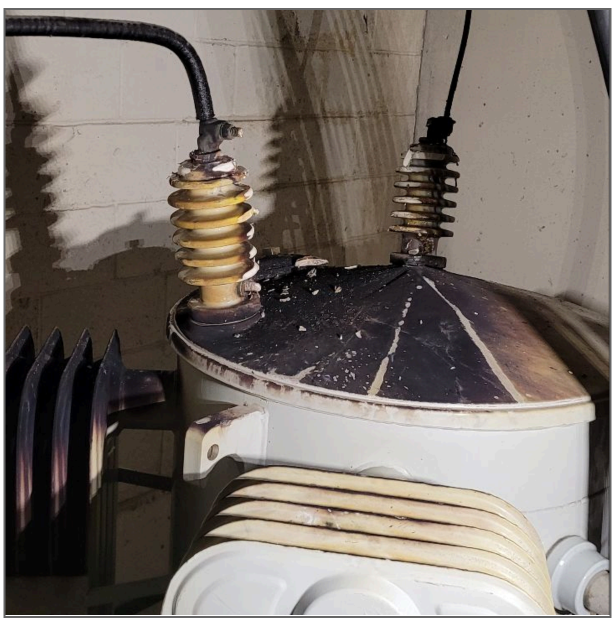
Table 28 shows the existing proportion of distribution assets in a deteriorated condition, requiring some form of intervention in the short term. In line with the proportion of assets in a bad condition, Hydro Ottawa has faced issues with metalclad station switchgear (air and SF_6), OH distribution apparatus (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

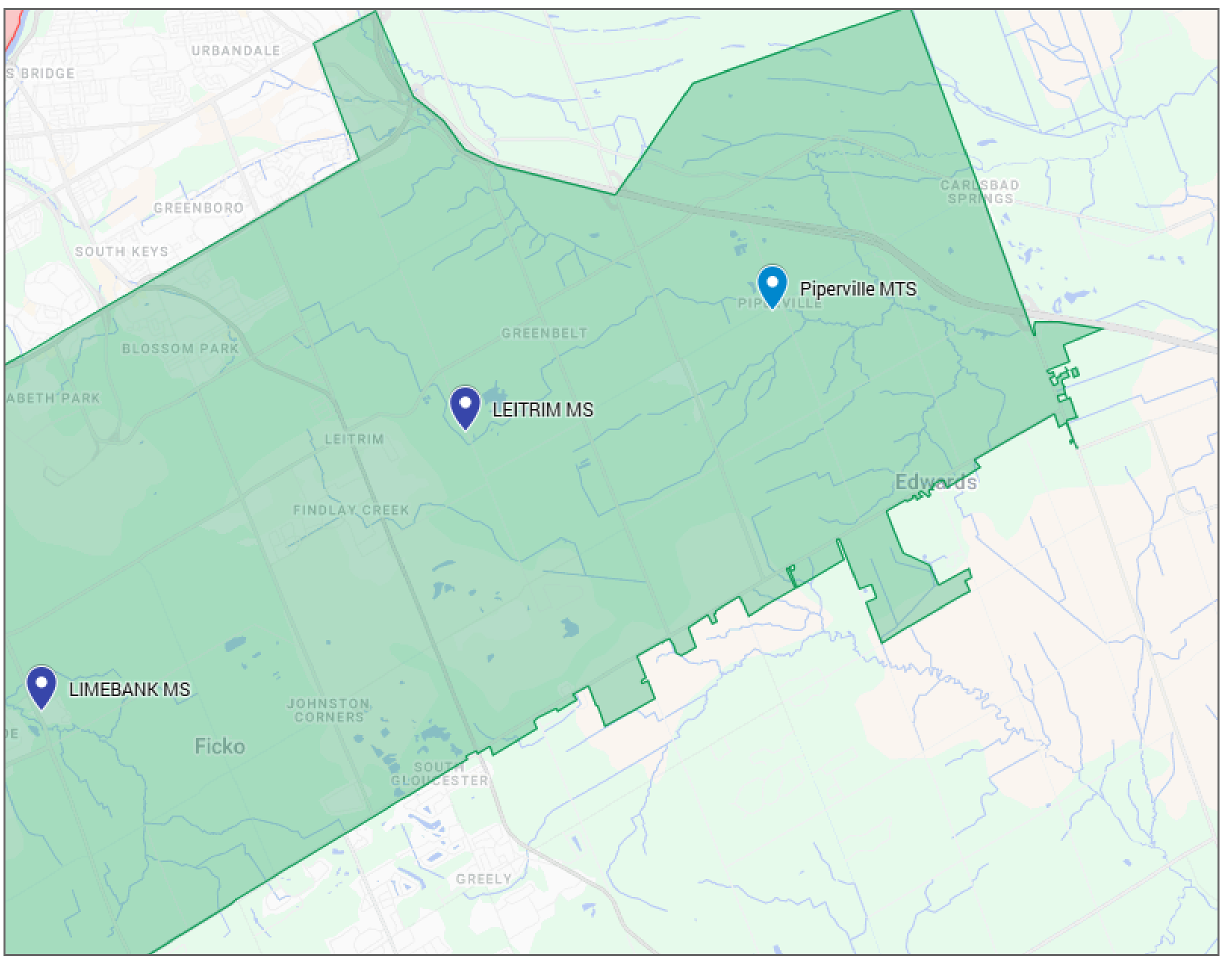
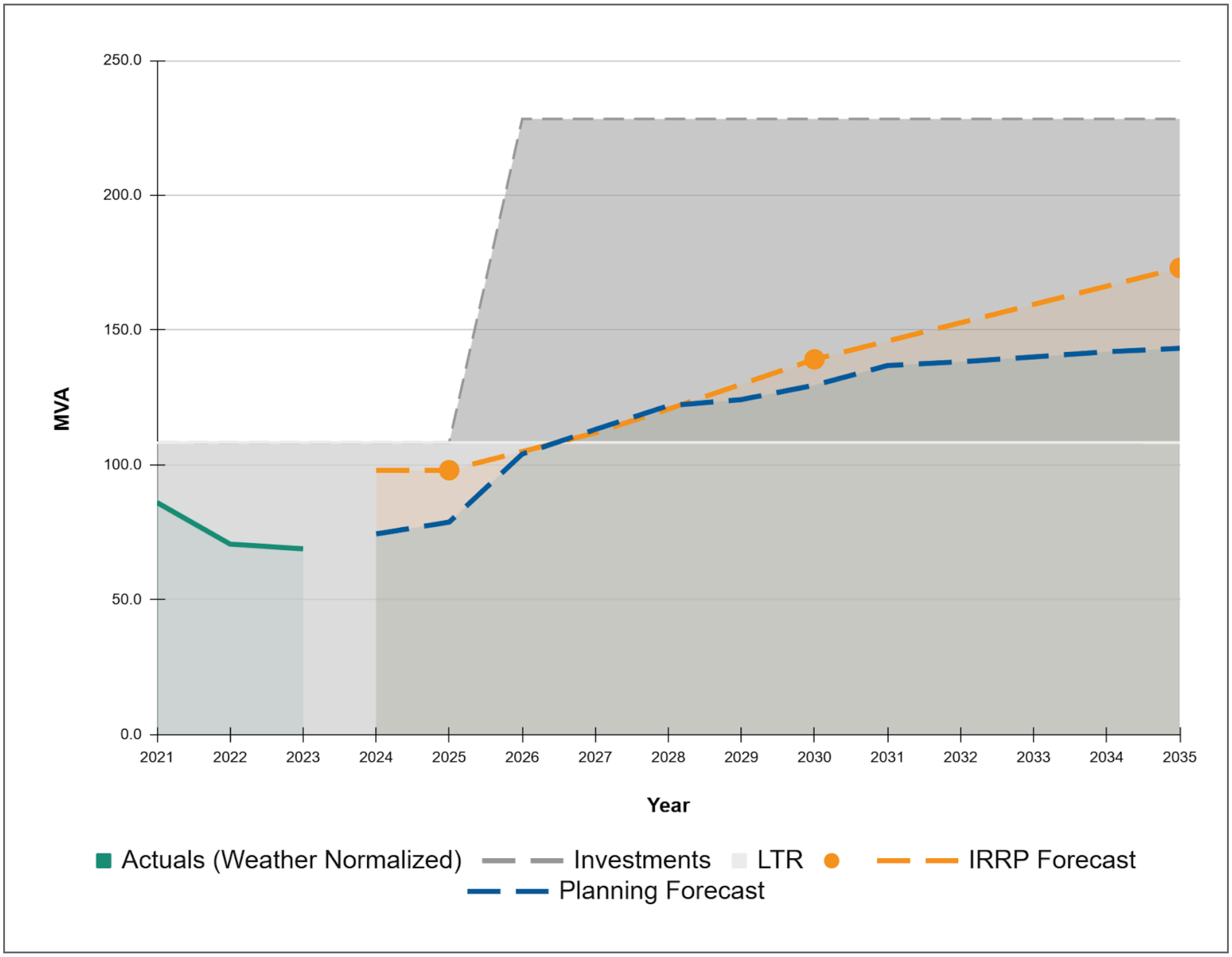


Figure 2 presents the load forecast against planned capacity, factoring the energization of Piperville MTS in 2026, which will increase the region's LTR to 230 MVA. The figure compares the IRRP Forecast and Planning Forecast of the region supported by Limebank MTS, Leitrim DS and Piperville MTS.

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

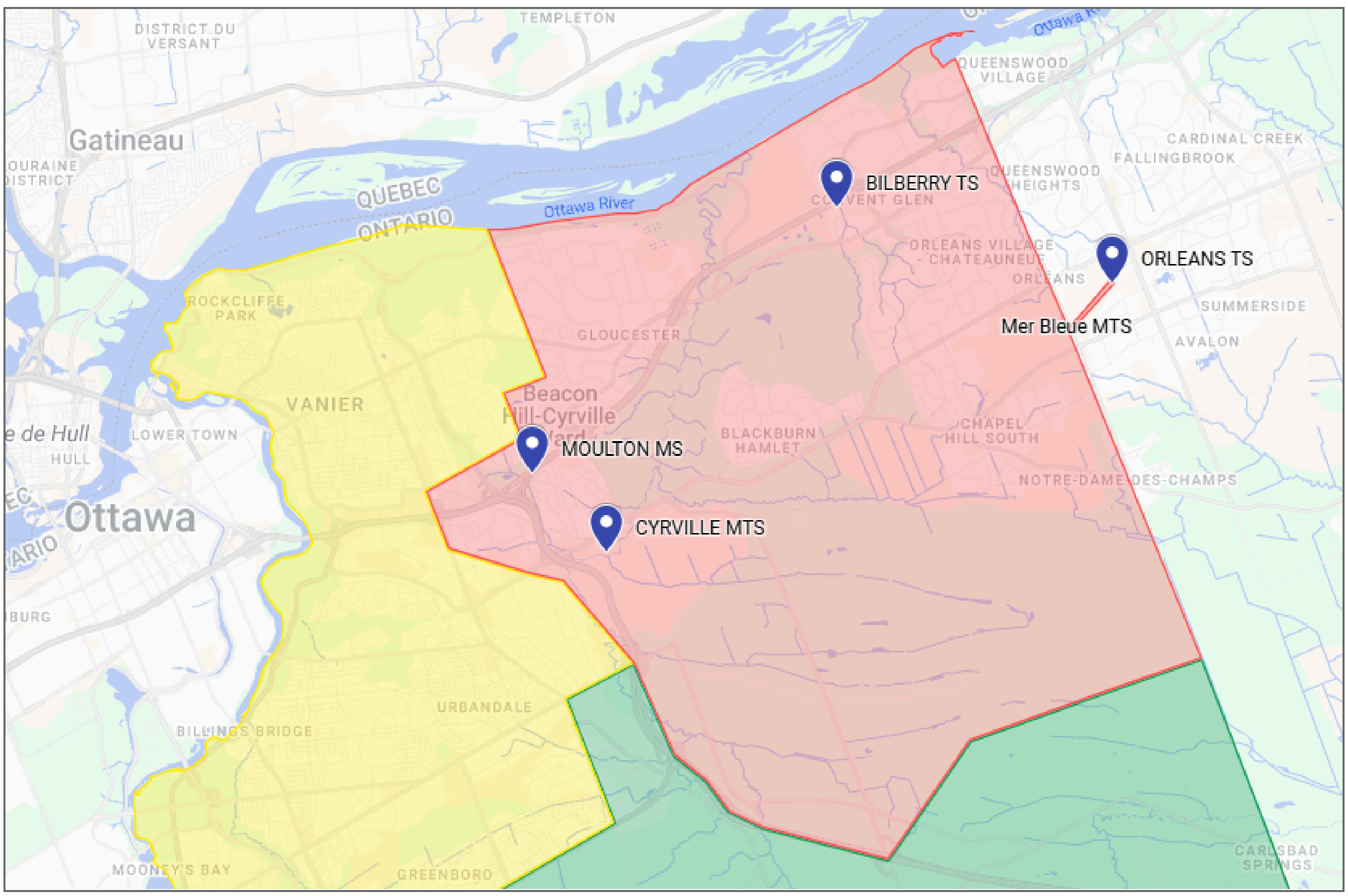


Figure 4 below presents the load forecast against planned capacity, factoring the energization of Mer Bleue MTS in 2028, which doesn't add additional capacity to the overall system (negligible addition due to Mer Bleue LTRs), due to the decommissioning of Bilberry TS, but transfers load from the constrained 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

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[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

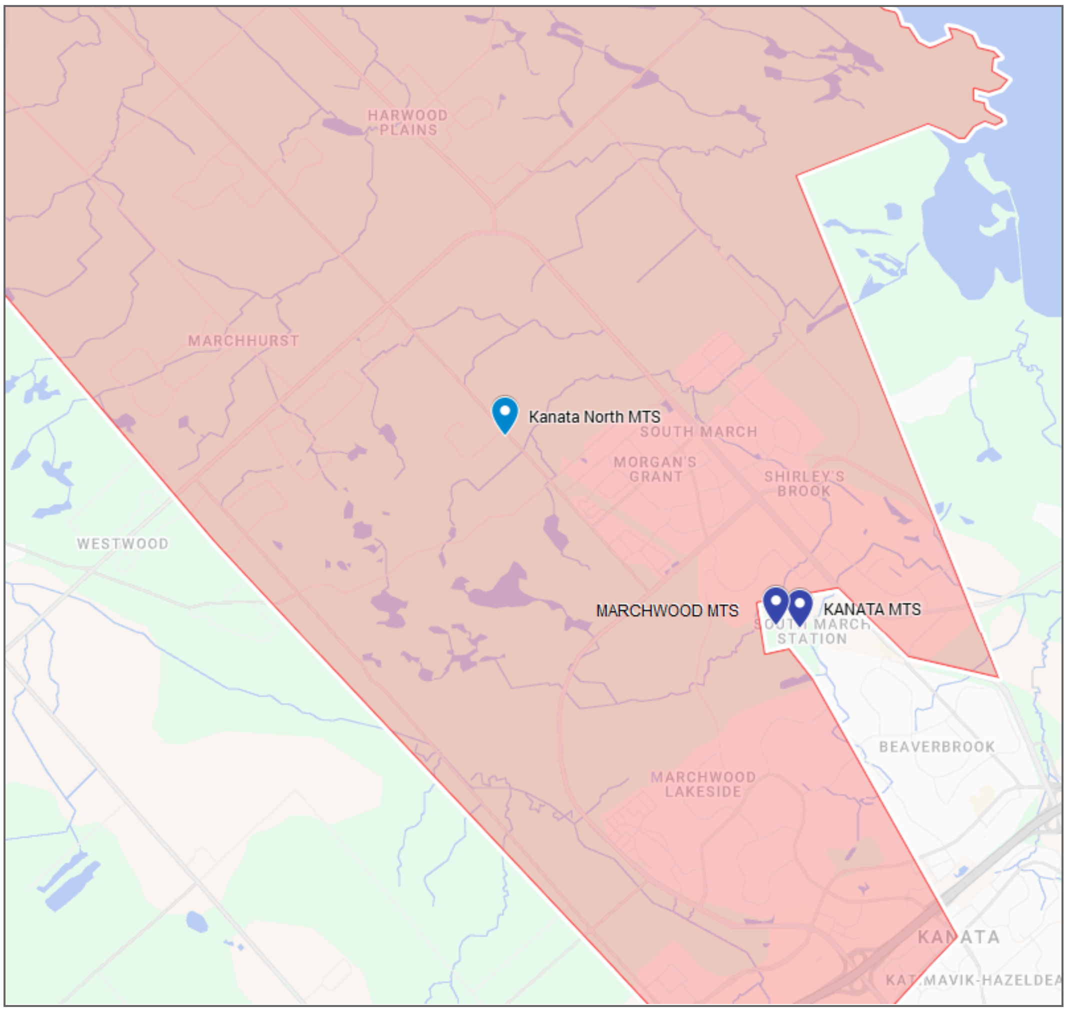
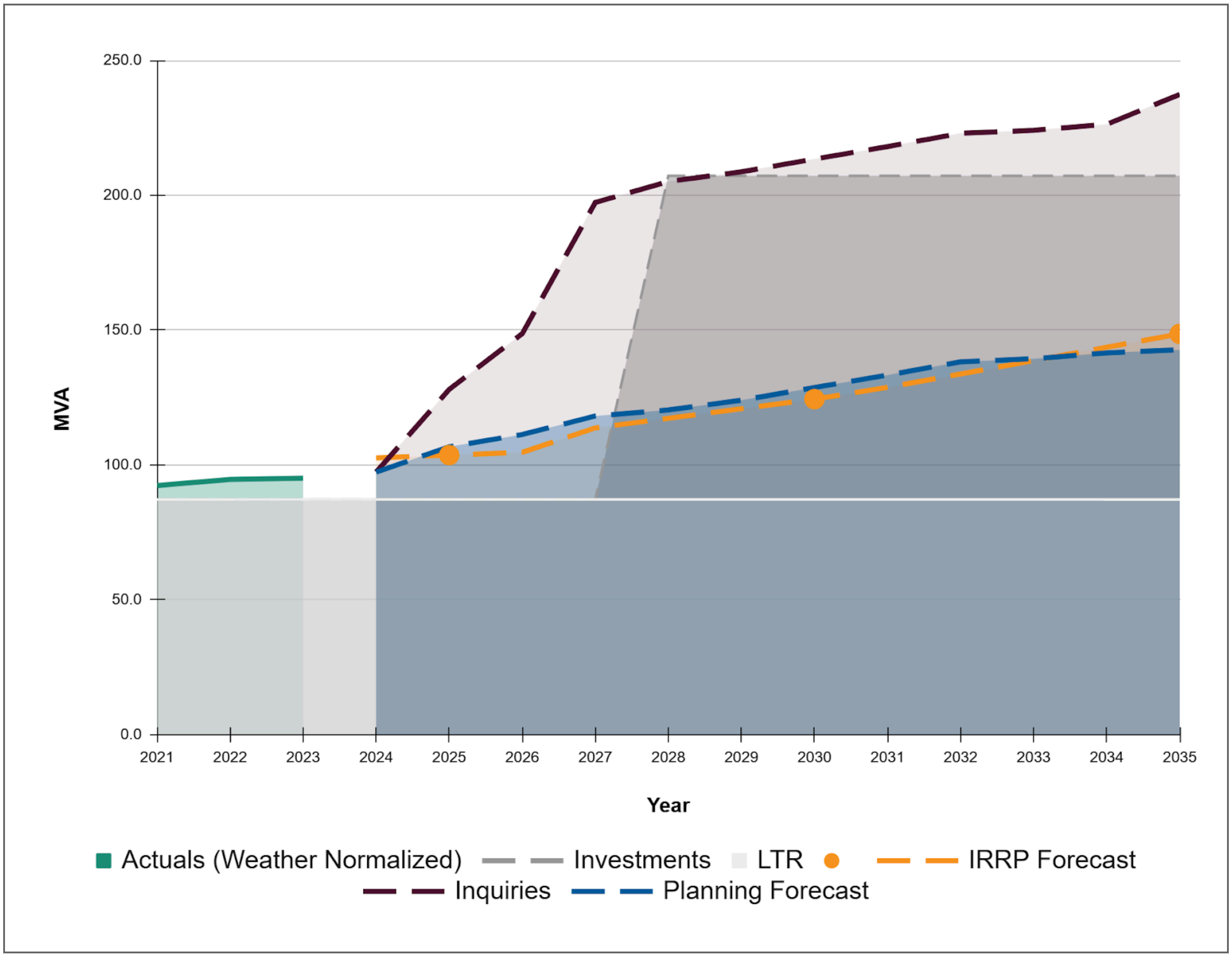


Figure 6 presents the load forecast against planned capacity (LTR), factoring the energization of Kanata North MTS in 2028, which will increase the region's capacity to 207 MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages 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

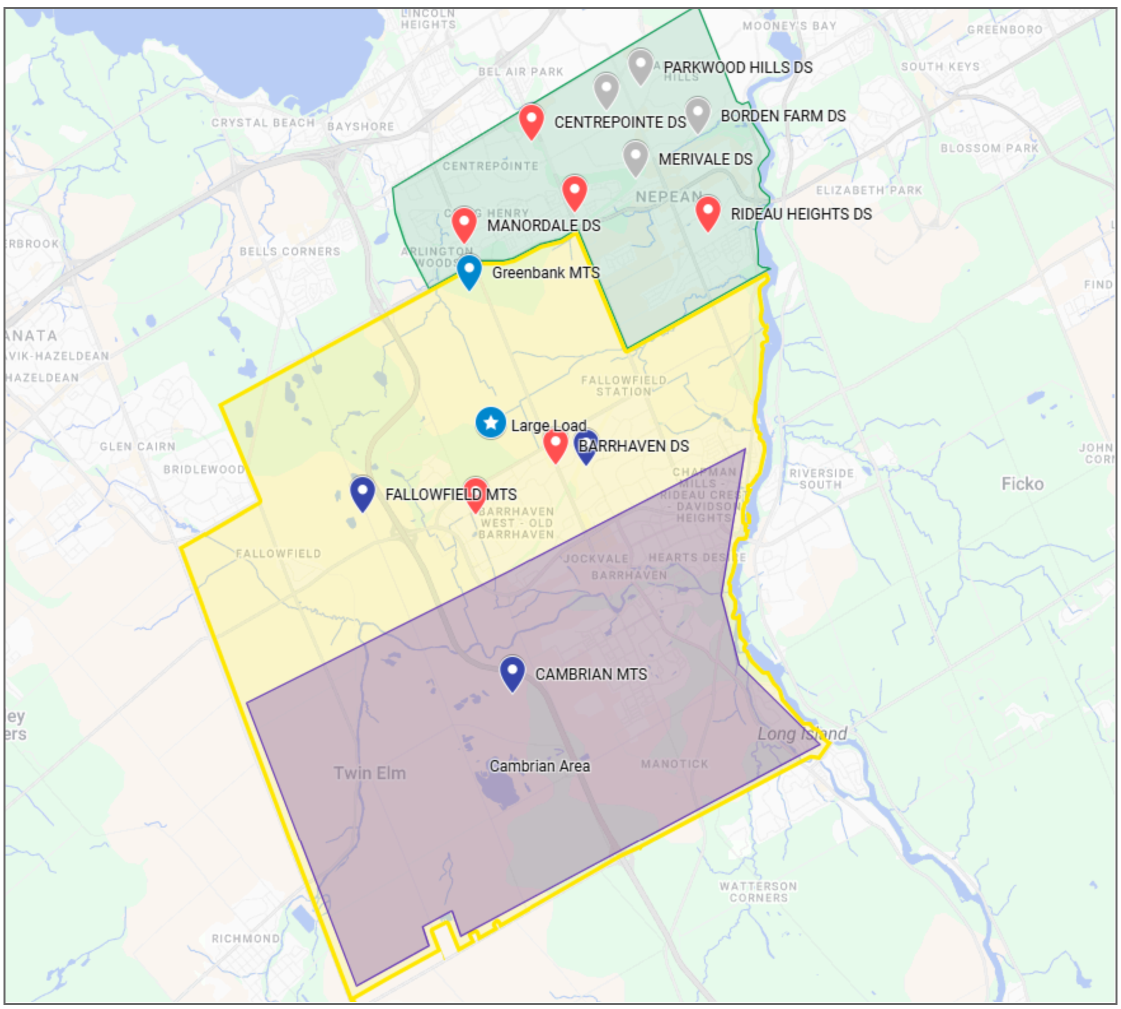
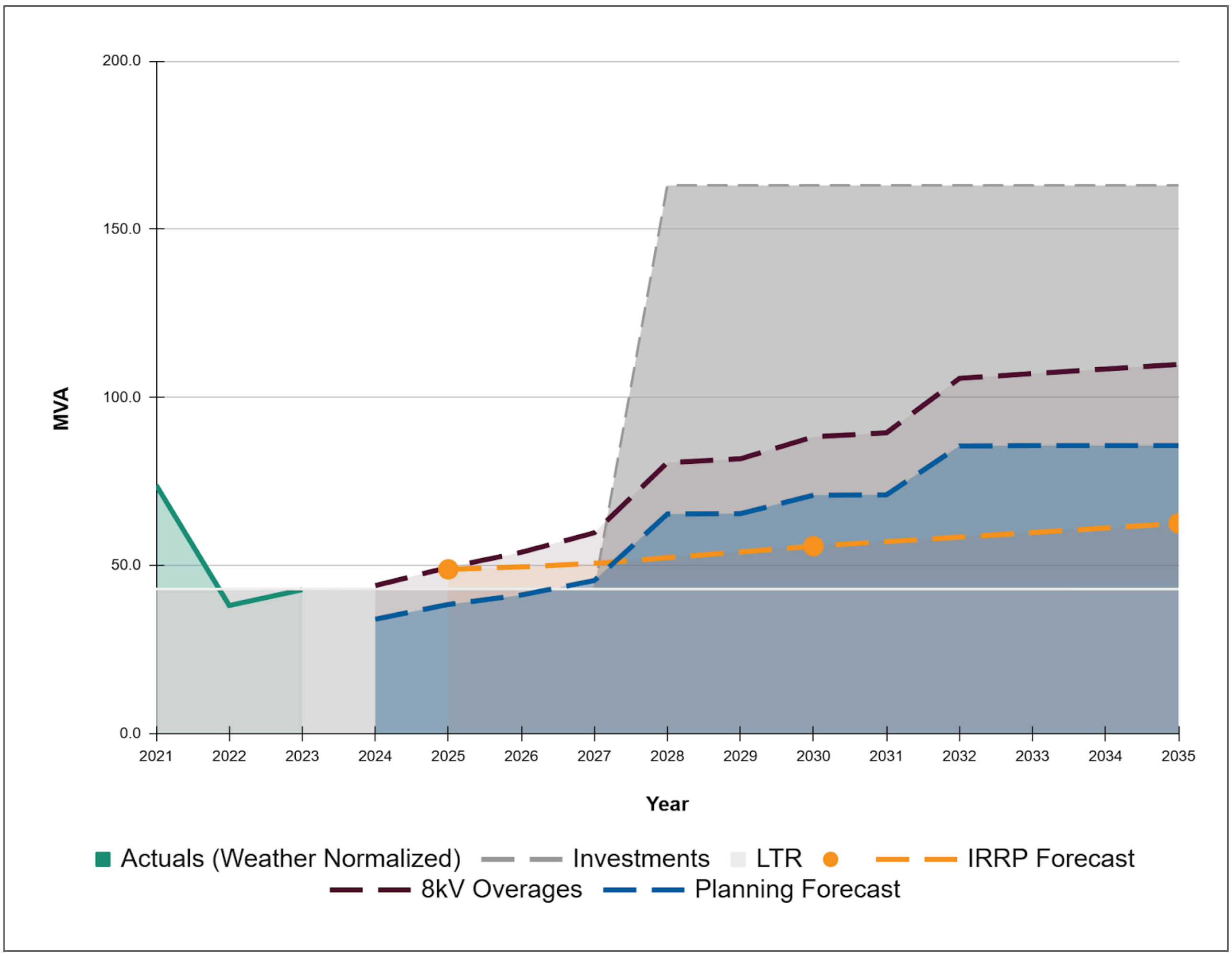


Figure 8 presents the load forecast against planned capacity, factoring the energization of Greenbank MTS in 2028, which will increase the region's LTR to 160MVA. The figure compares the IRRP Forecast, the 28 kV region Planning Forecast, and the new loads to be transferred from 8 kV overloaded stations, 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

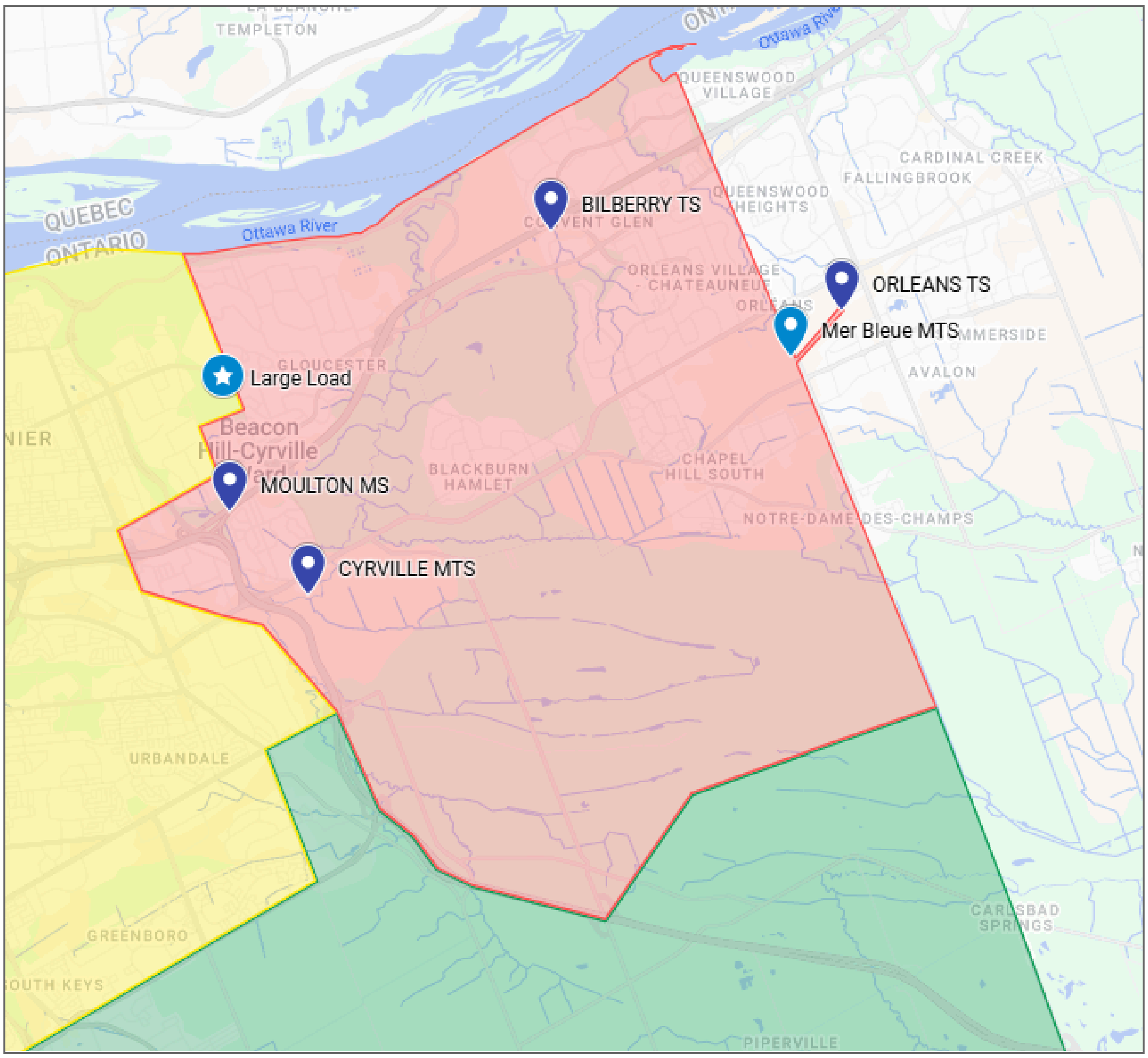
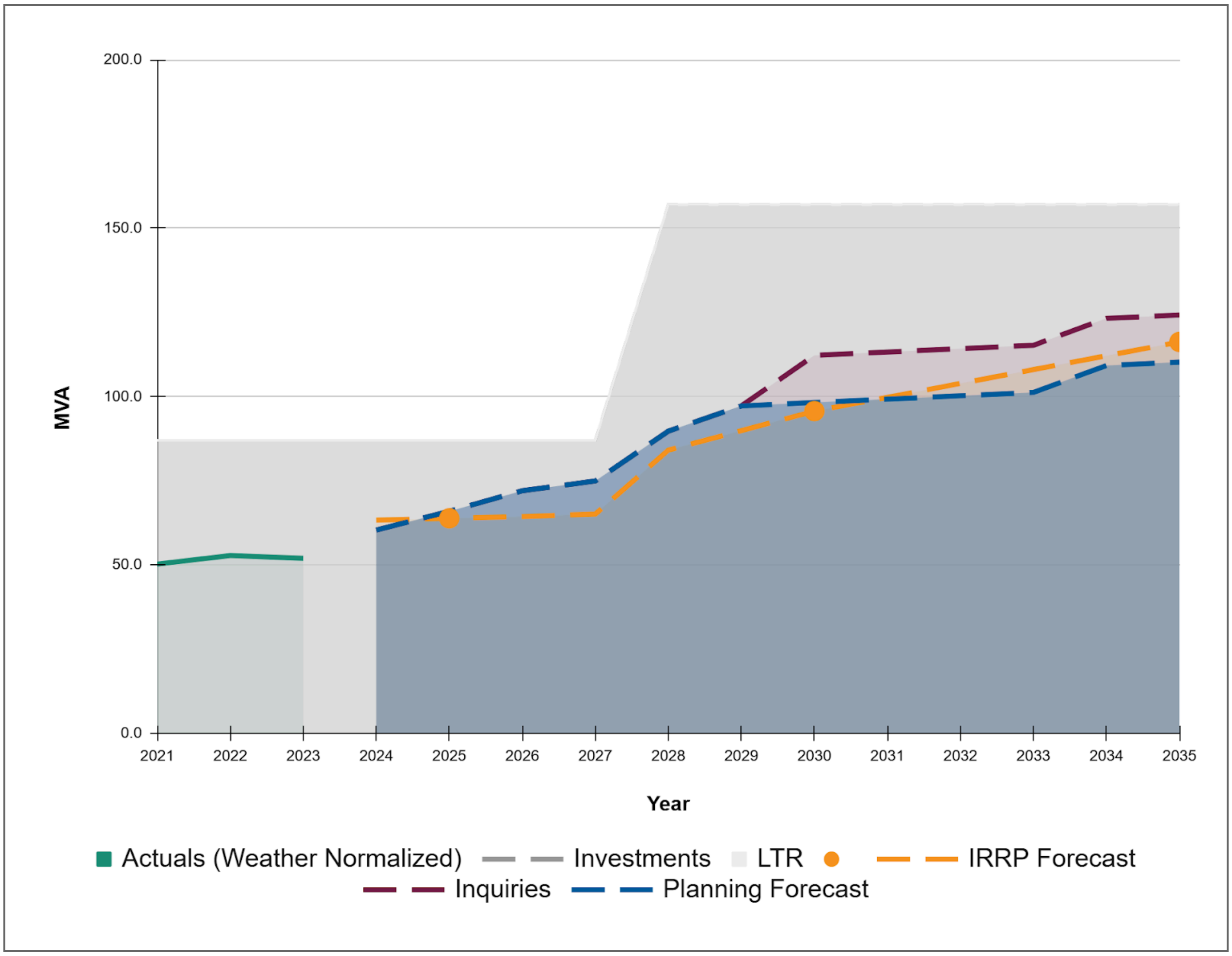


Figure 10 presents the load forecast against planned capacity, factoring the Cyrville MTS upgrade in 2028, which will increase the LTR in the region to 150 MVA. The figure compares the IRRP Forecast, Planning Forecast, and the customer load inquiries which are in the planning stages for Cyrville MTS 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

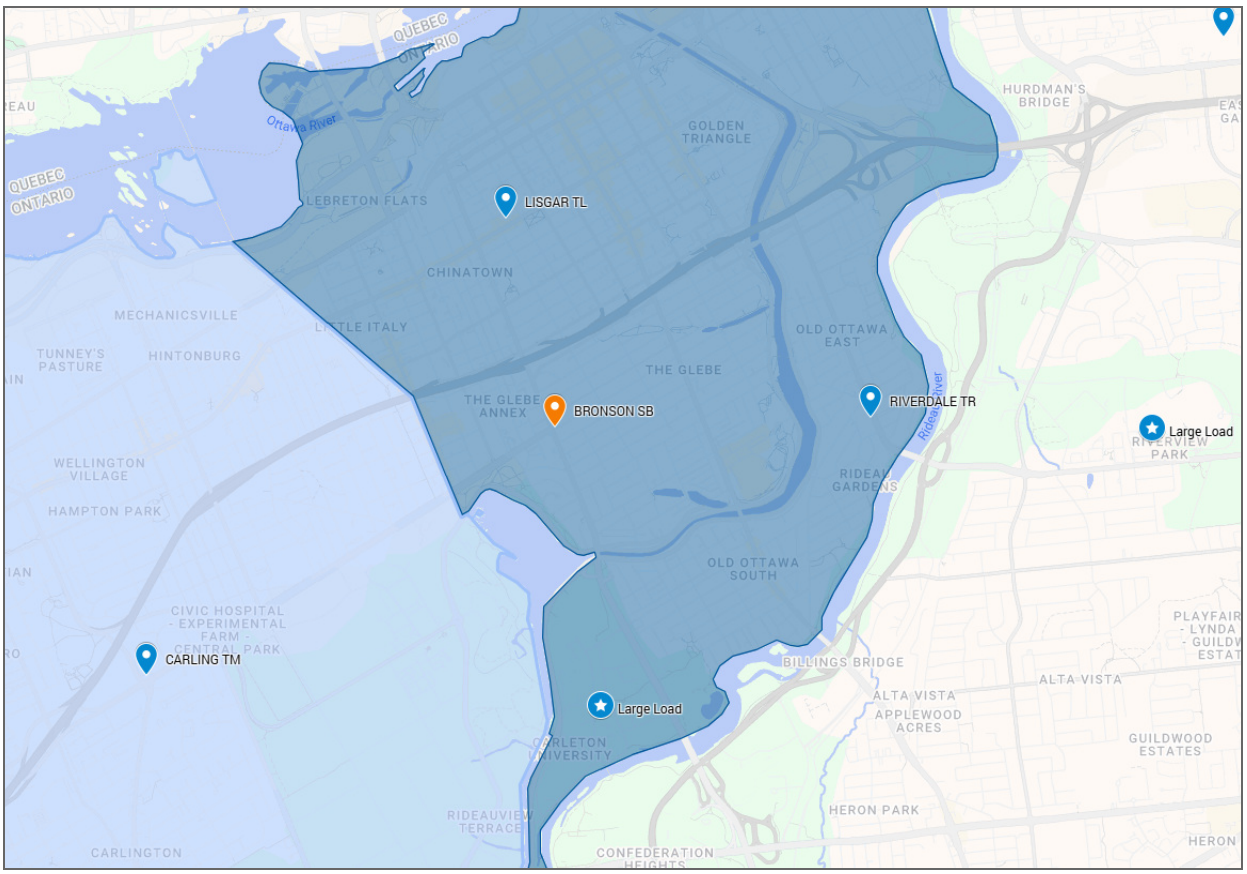
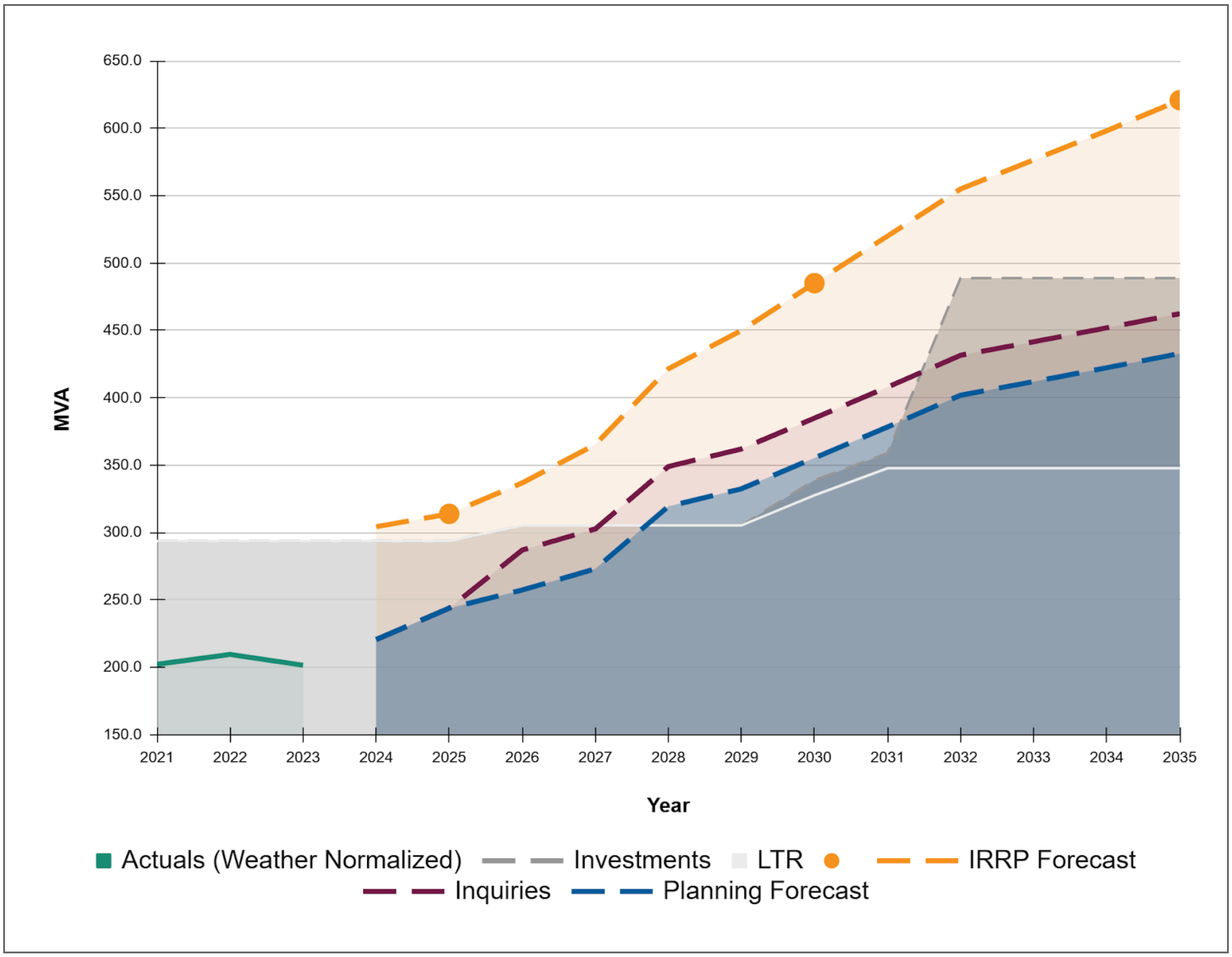


Figure 12, presents the load forecast against planned capacity (LTR), factoring two Hydro Ottawa capacity upgrade investments proposed; a NWSs (utility BESS) energizing in 2030, and the Bronson DS 13 kV upgrade, energizing in 2032 pushing the overall LTR to 500MVA. The figure compares the IRRP Forecast, 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)

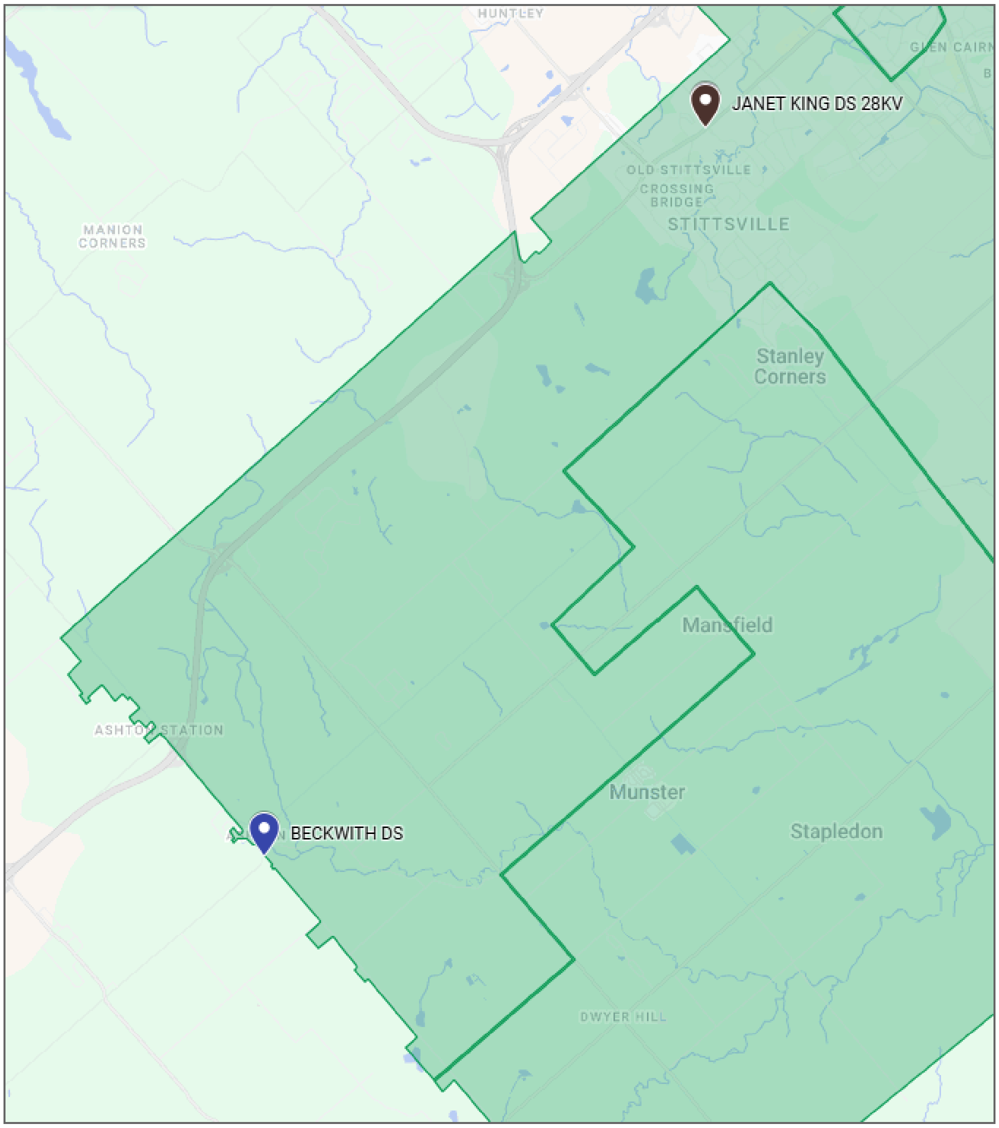
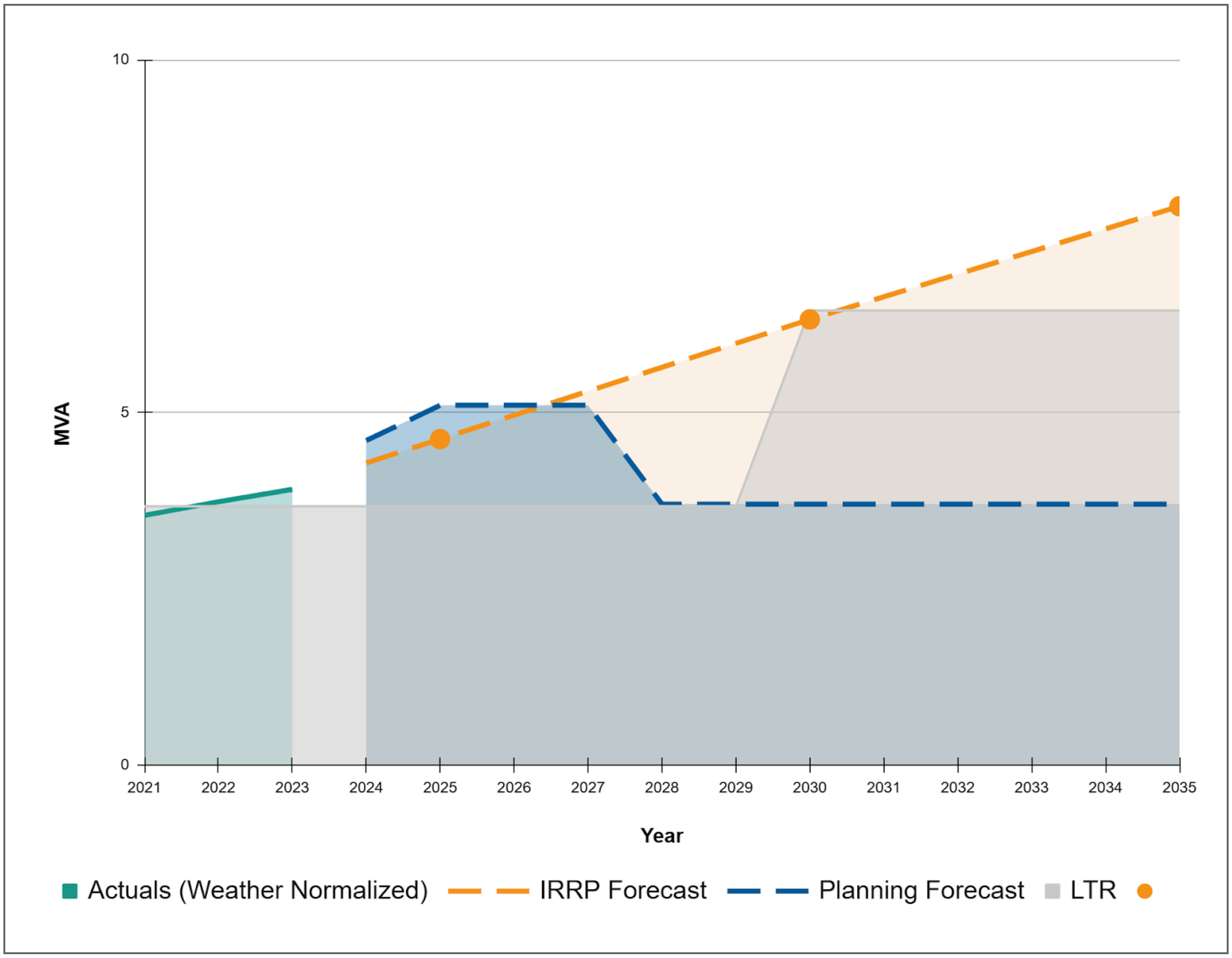


Figure 14, presents the load forecast against planned capacity (LTR) of the BECK-F2 feeder, factoring a 2.5 MW NWSs (utility BESS) energizing in 2030, pushing the overall LTR of the Beckwith region to 6.4MVA. The figure compares the IRRP Forecast and the Planning Forecast of Beckwith DS.

1 **Figure 14 - Beckwith Forecast**



2

3

4 The proposed NWSs in this region is to install a 2.5MW utility owned BESS. The issues that this
5 solution addresses are elaborated below:

6

7 - **Capacity Constraints:**The BECK-F2 feeder is currently running above its planning capacity.
8 The only ties available to the BECK-F2 feeder is from Janet King F4 feeder which is also heavily
9 loaded (95% of planning capacity). Some load from Beckwith is planned to be moved to

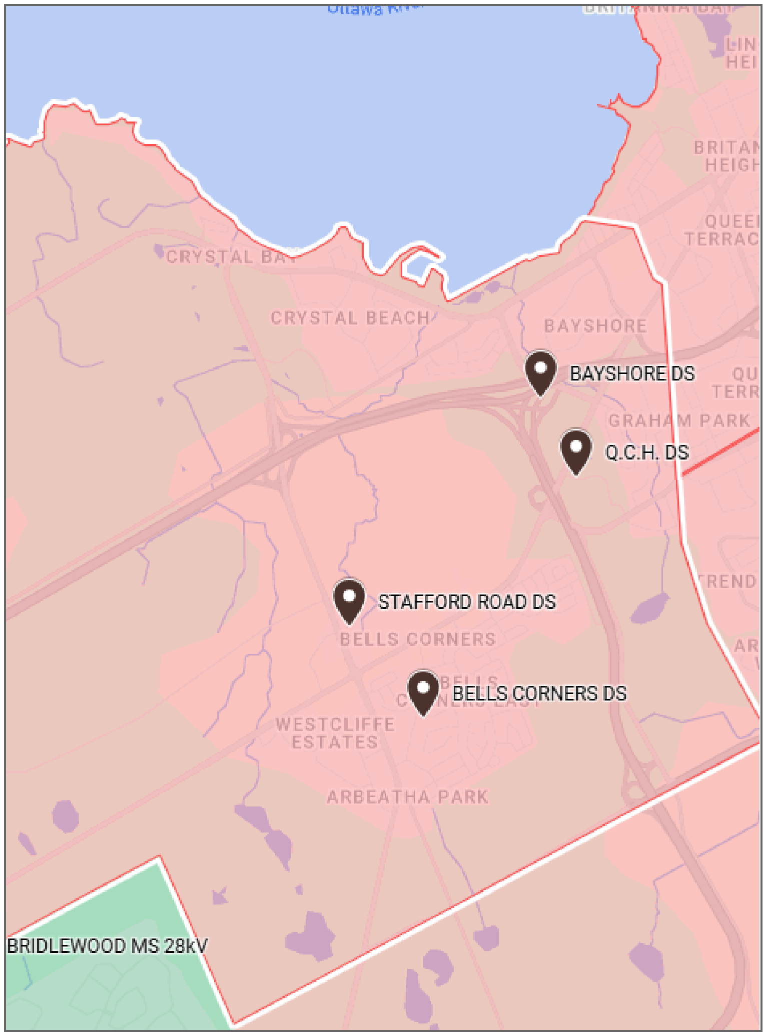
Richmond South MTS in 2028 to reduce loading to its planning capacity but that will not be enough to manage load growth considering the long term outlook (IRRP Forecast).

- **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

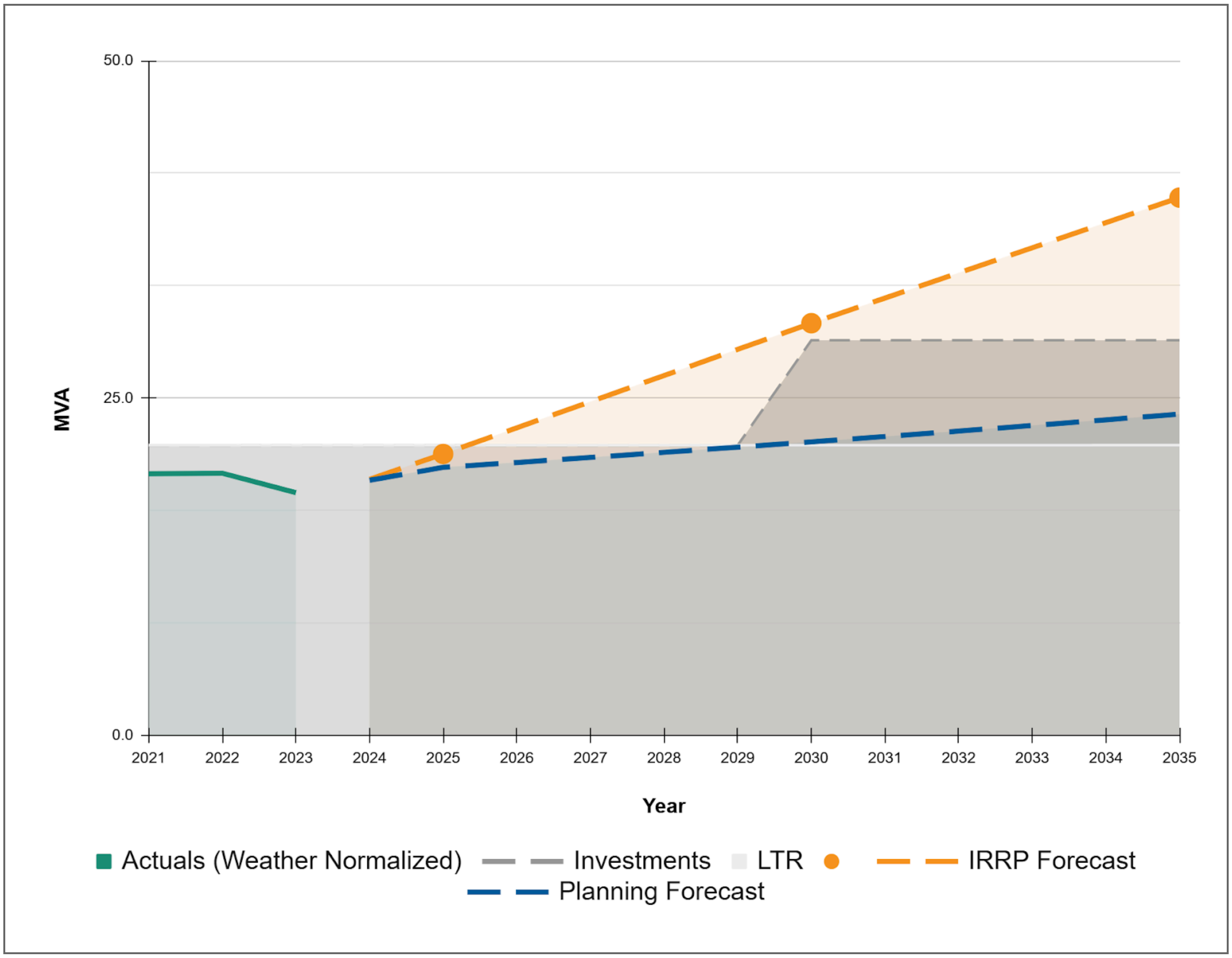
The Bells Corners/Bayshore 8kV supply region covers the northwest portion of Nepean. This region is supplied by Bayshore DS, Queensway-Carleton Hospital (Q.C.H) DS, Stafford Road DS, and Bells Corners DS as shown in Figure 15.

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.

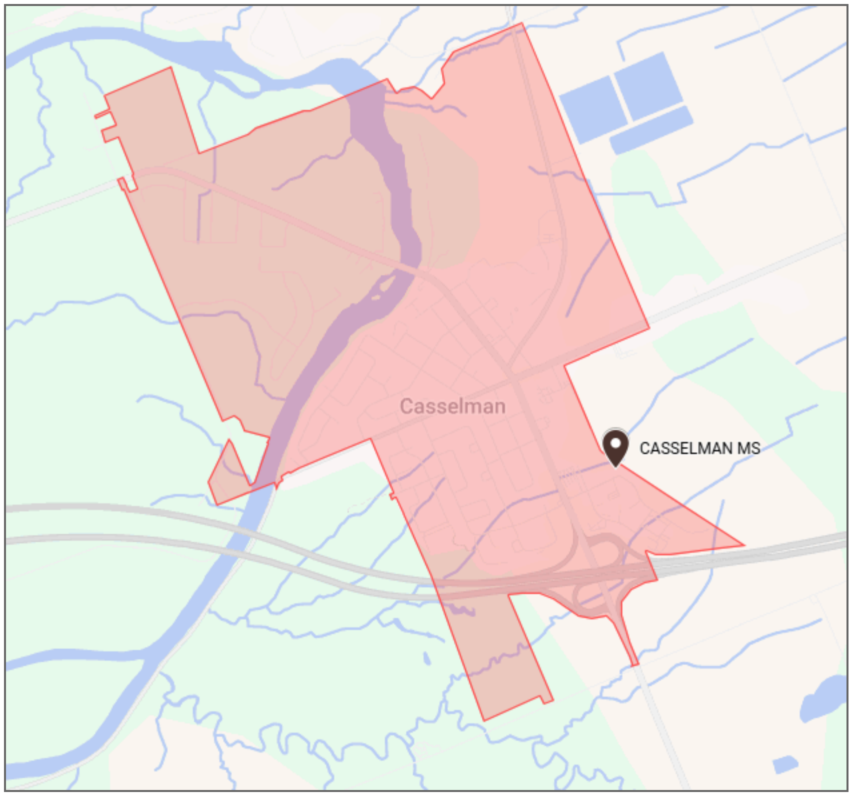
- **Capacity Constraints**: Bayshore DS is currently at 94% of planned capacity and Q.C.H DS is at 74% of planned capacity and based on the planning forecast, capacity will be exceeded by 2030. Capacity is also insufficient considering the long term outlook (IRRP forecast).

- **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.

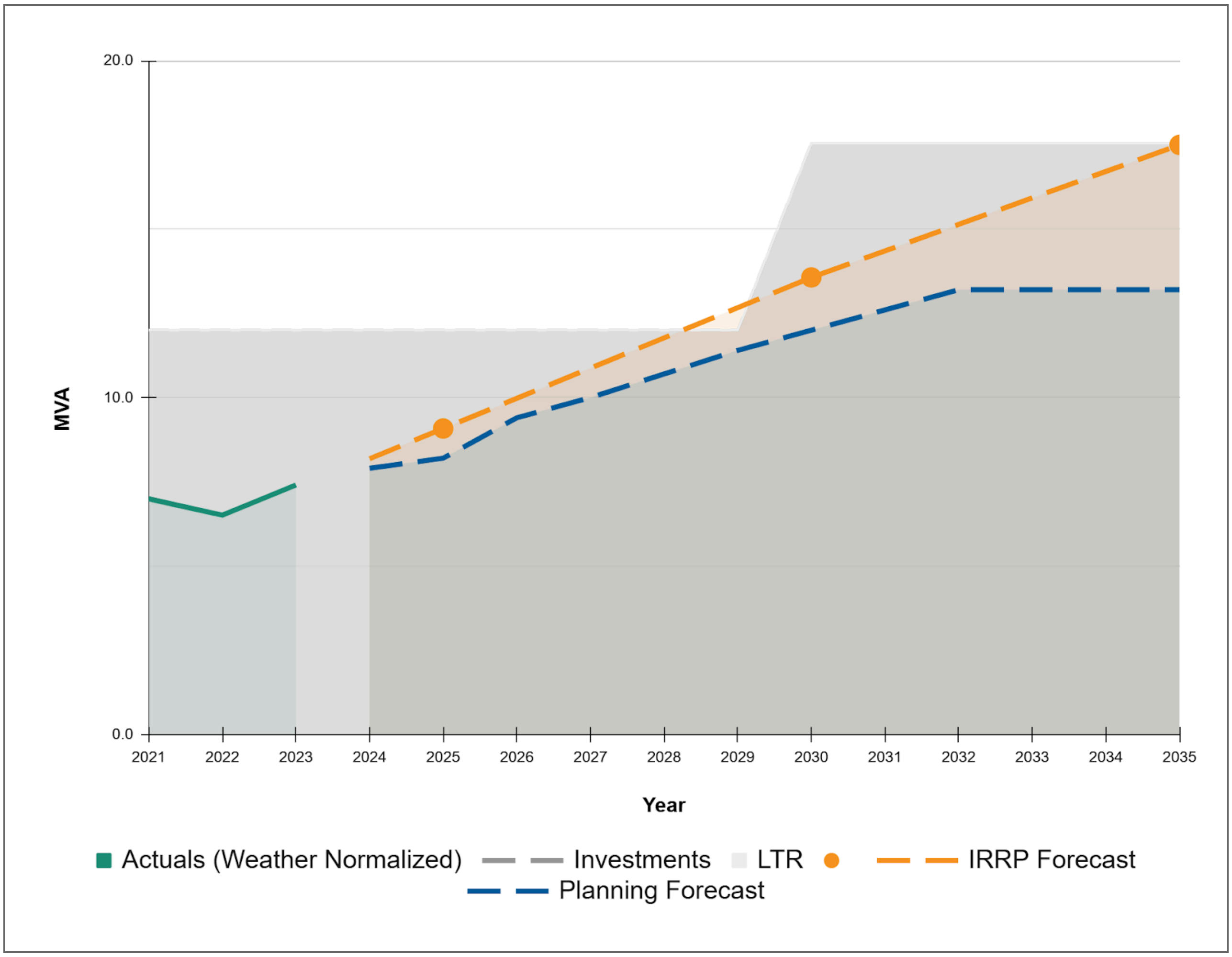
1 **Figure 17 - Casselman 8kV**



2

3 Figure 18 presents the load forecast against planned capacity (LTR) of Casselman DS factoring a 5
4 MW NWSs (utility BESS) energizing in 2030, pushing the overall LTR of the region to 17 MVA. The
5 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

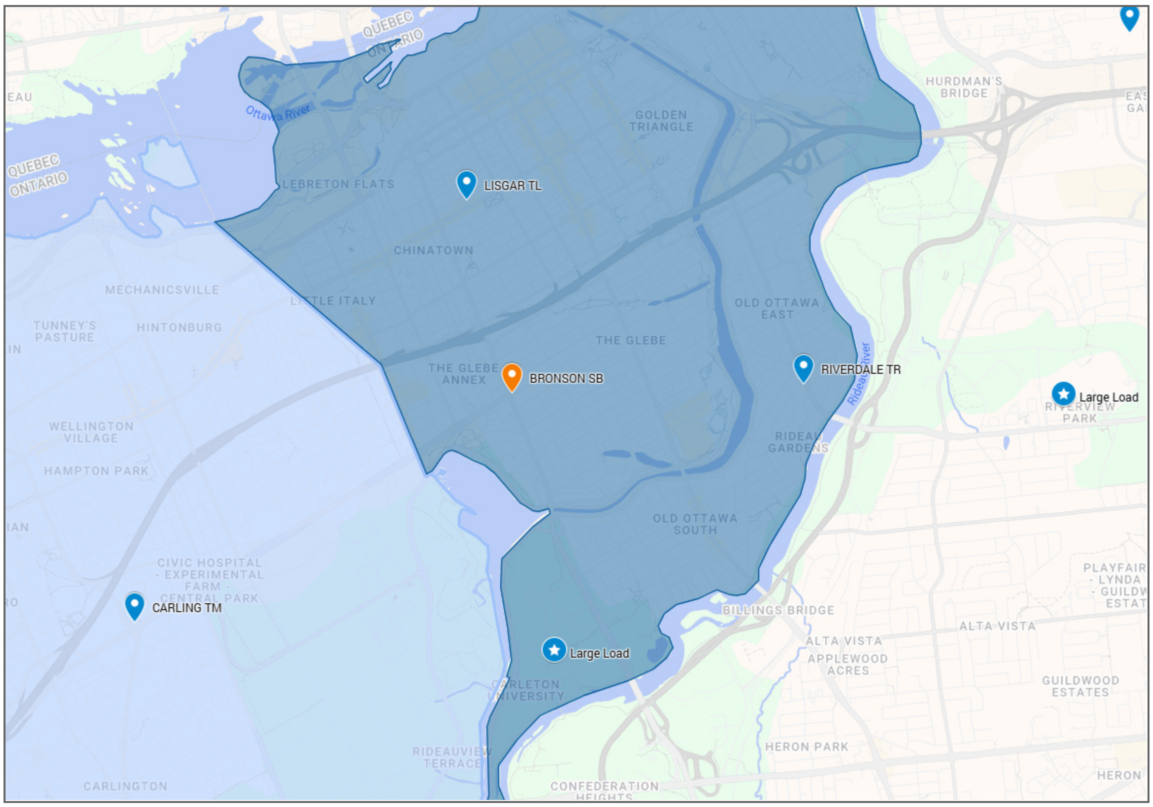
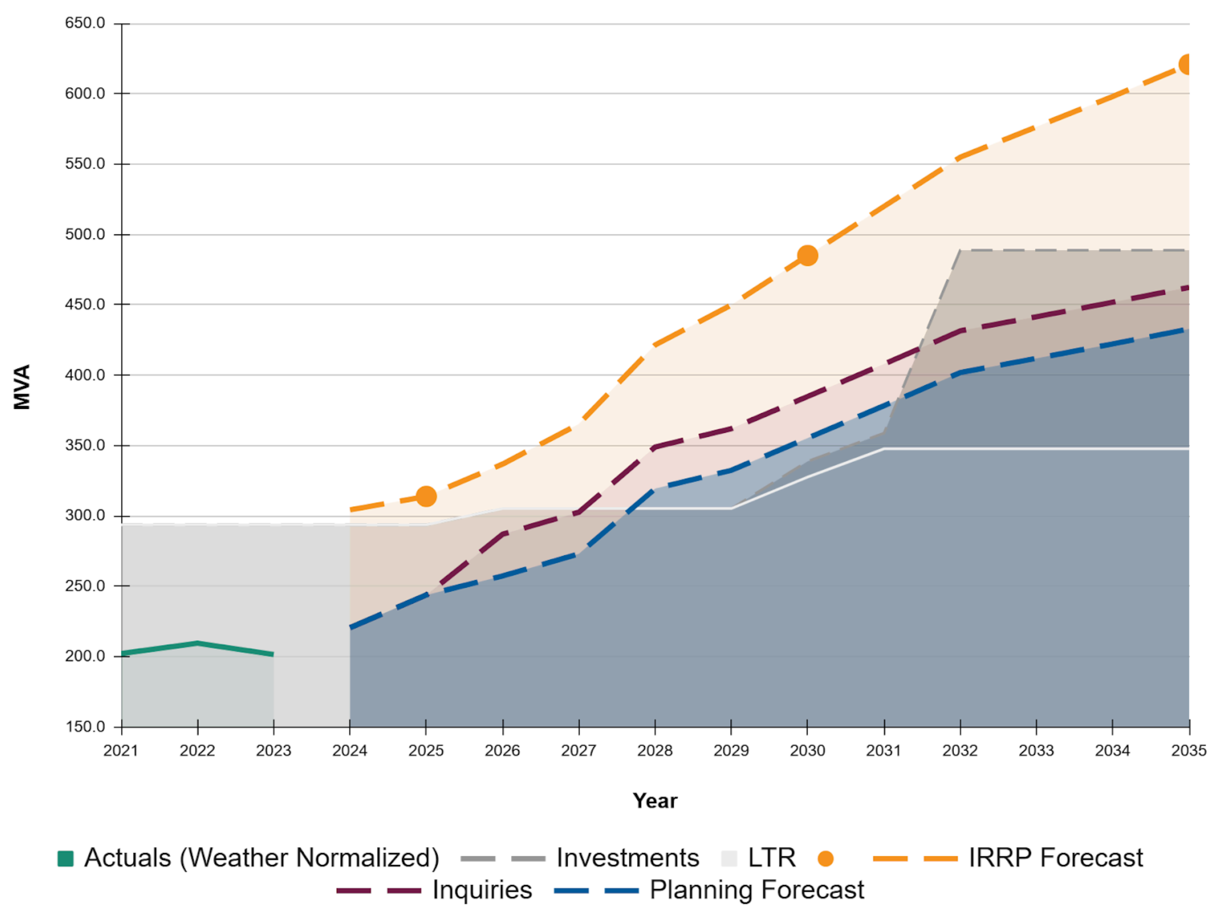


Figure 20 presents the load forecast against planned capacity (LTR), factoring two Hydro Ottawa capacity upgrade investments proposed; a 10MW NWSs (utility BESS) energizing in 2030, and the Bronson DS 13 kV upgrade, energizing in 2032 pushing the overall LTR to 500MVA. The figure compares the IRRP Forecast, 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.

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.

1 **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

2

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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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

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.

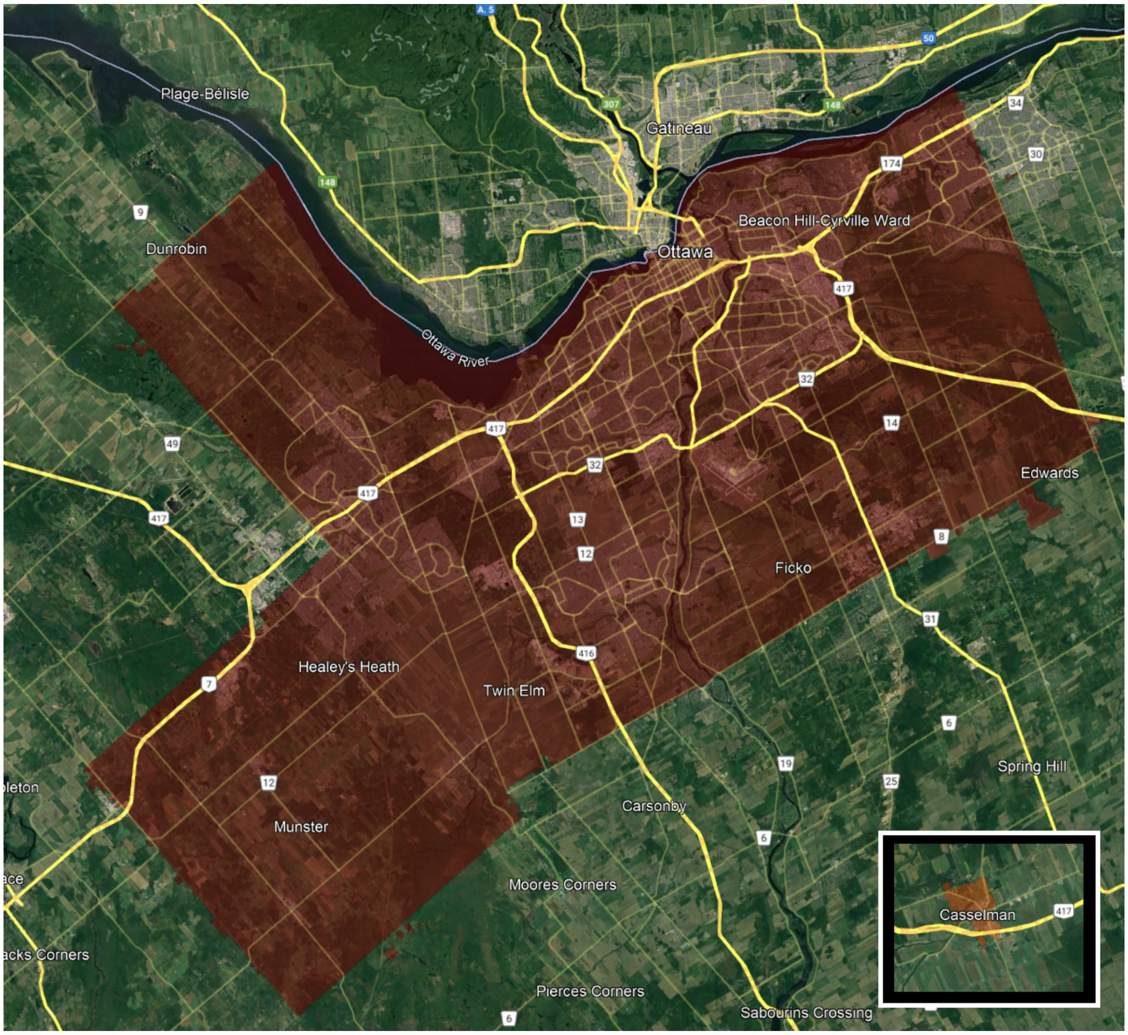


Figure 1 – Hydro Ottawa Service Territory (Casselman inset)

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.

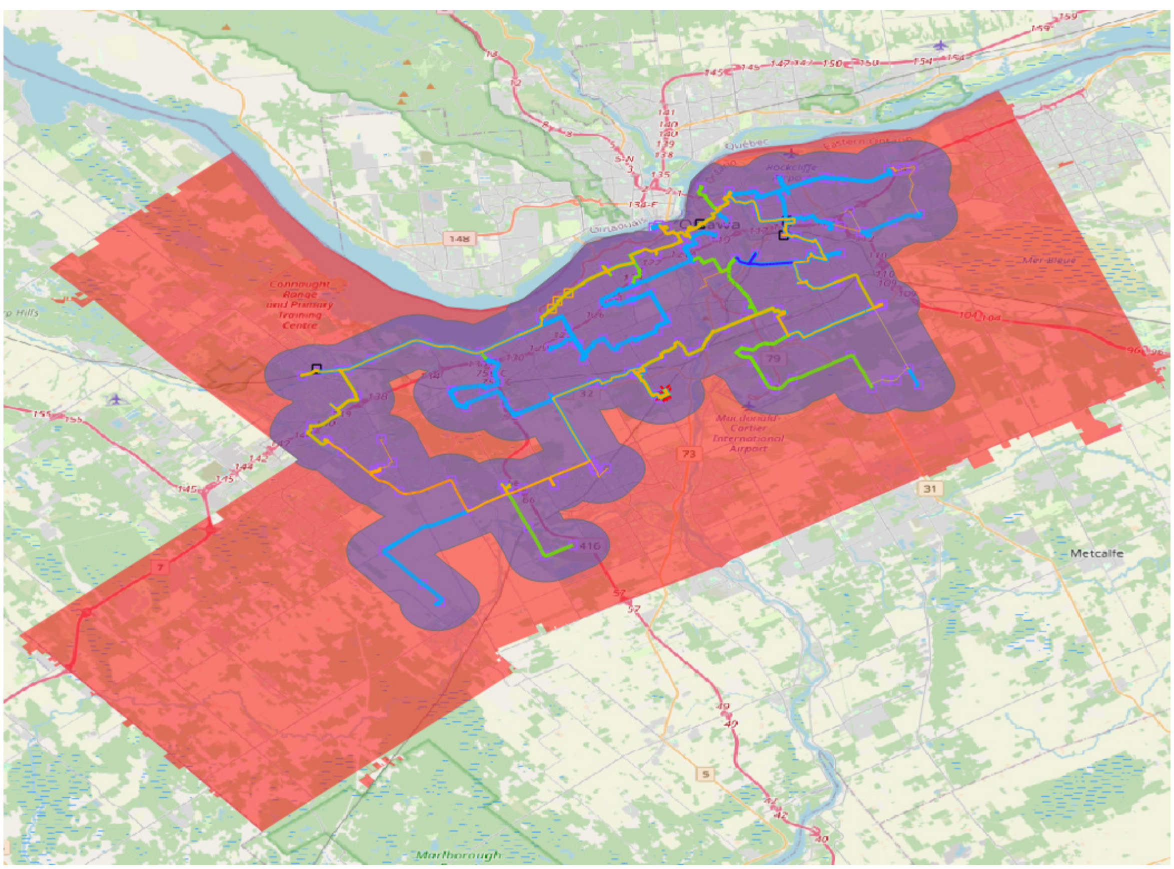


Figure 2 – HOL Fibre Extent + 1 mile buffer

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.

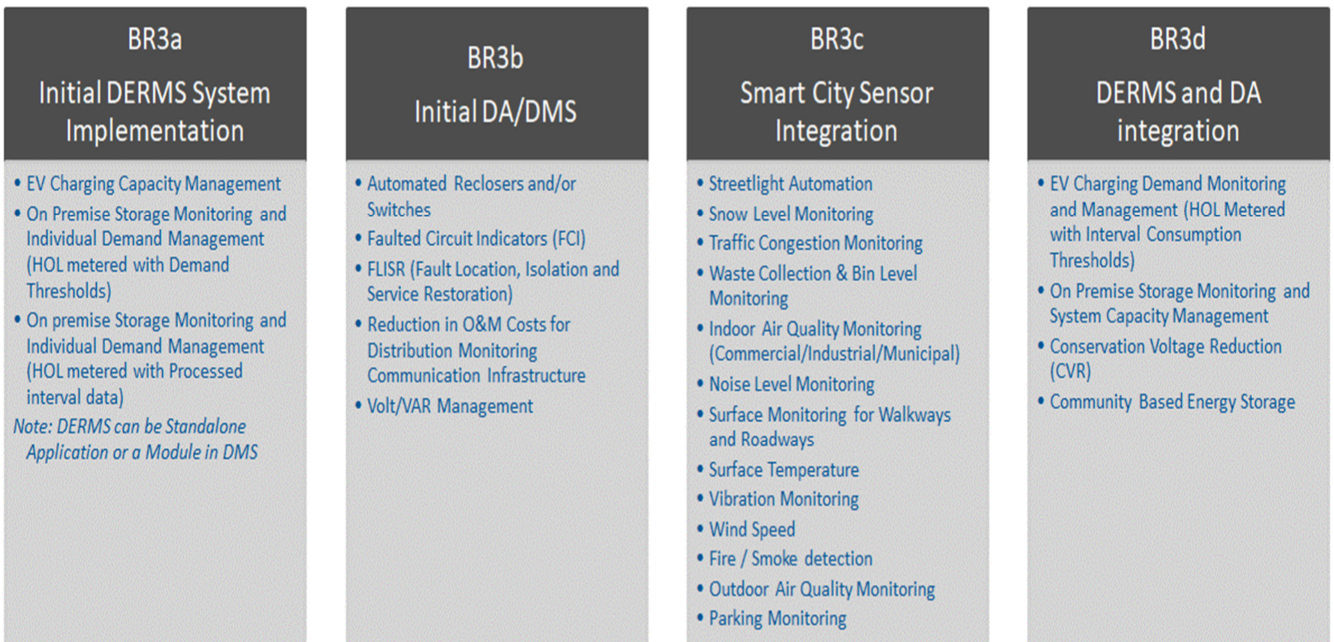


Figure 3 – Phase 3 Business Releases

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.

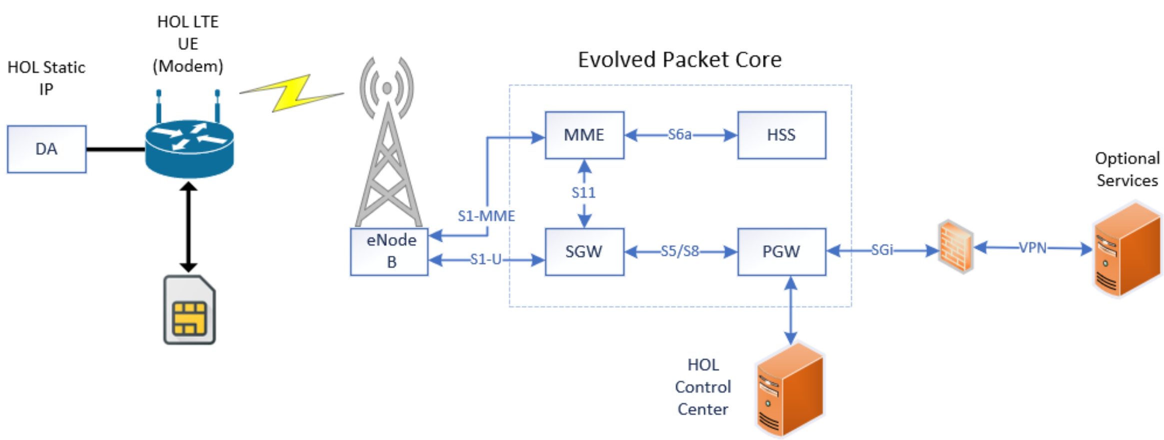


Figure 5 – LTE Detail Diagram

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.

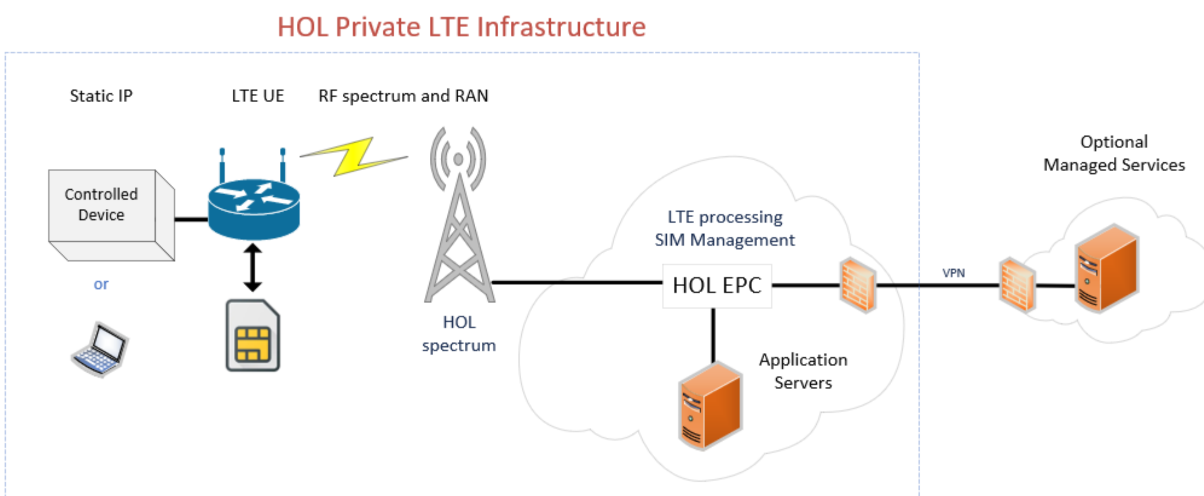


Figure 6 – Private Network Architecture

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.

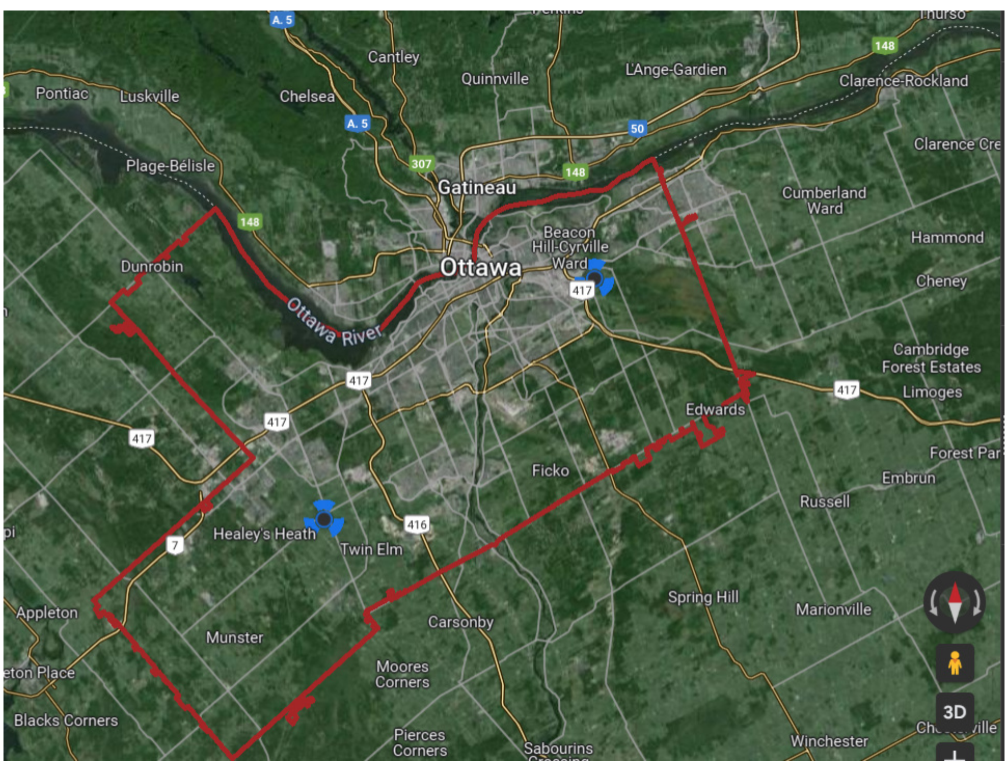


Figure 7 – Coverage Prediction locations

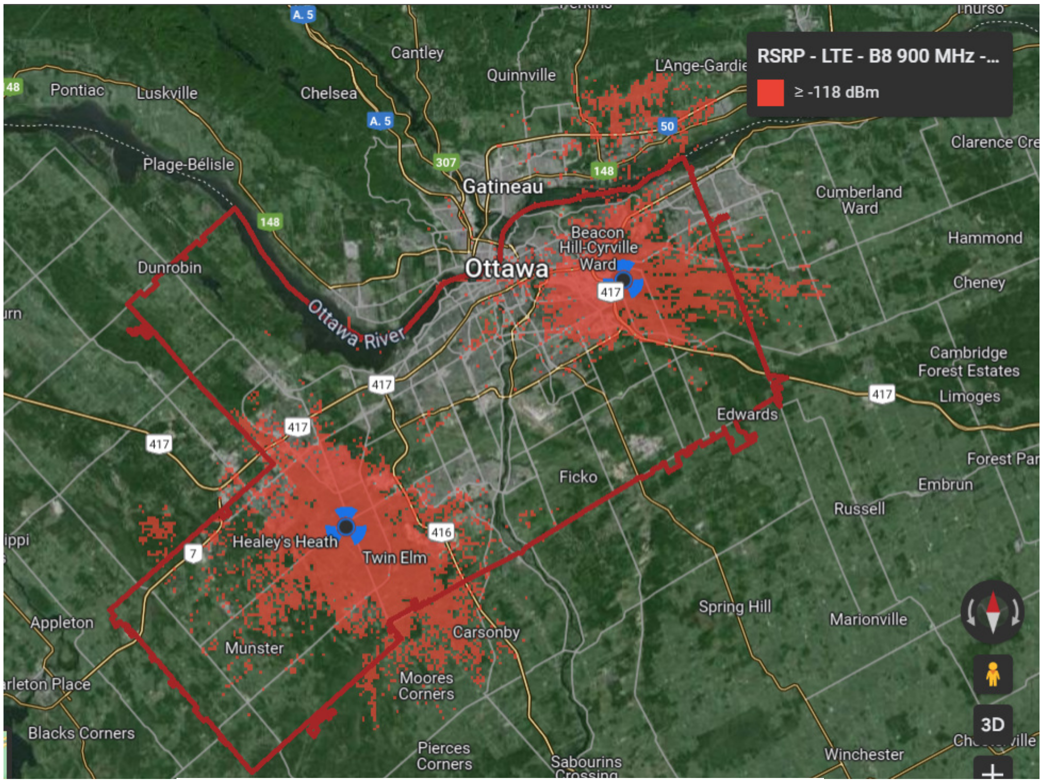


Figure 8 – Coverage Prediction at 23-metre antenna centre line

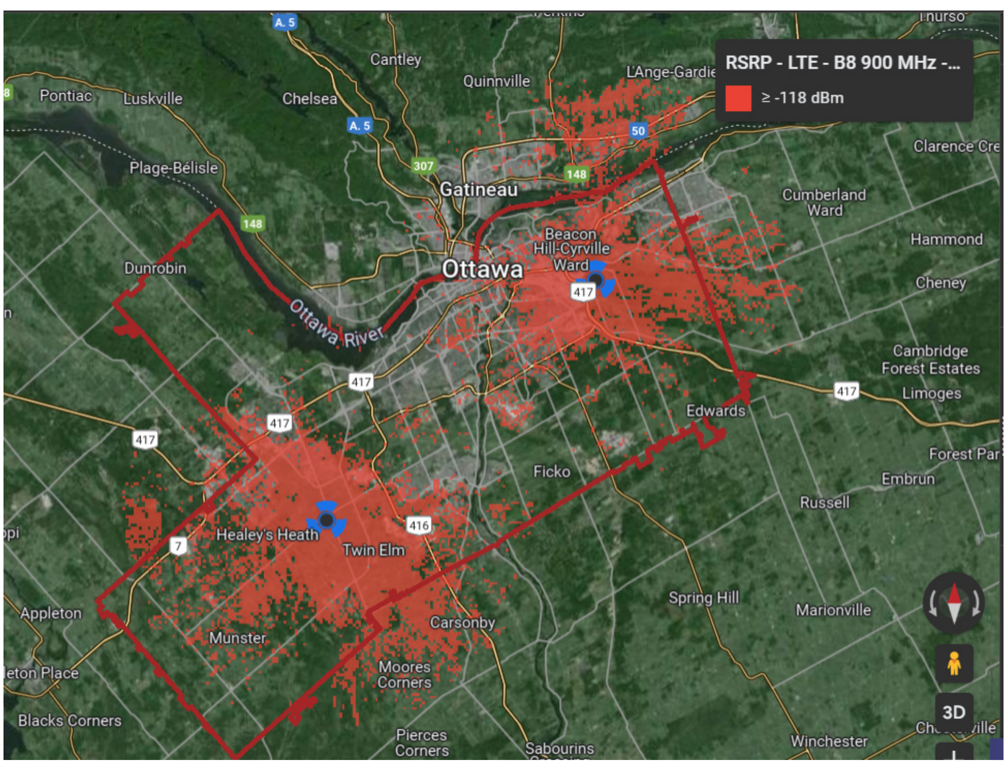


Figure 9 – Coverage Prediction at 38-metre antenna centre line

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.

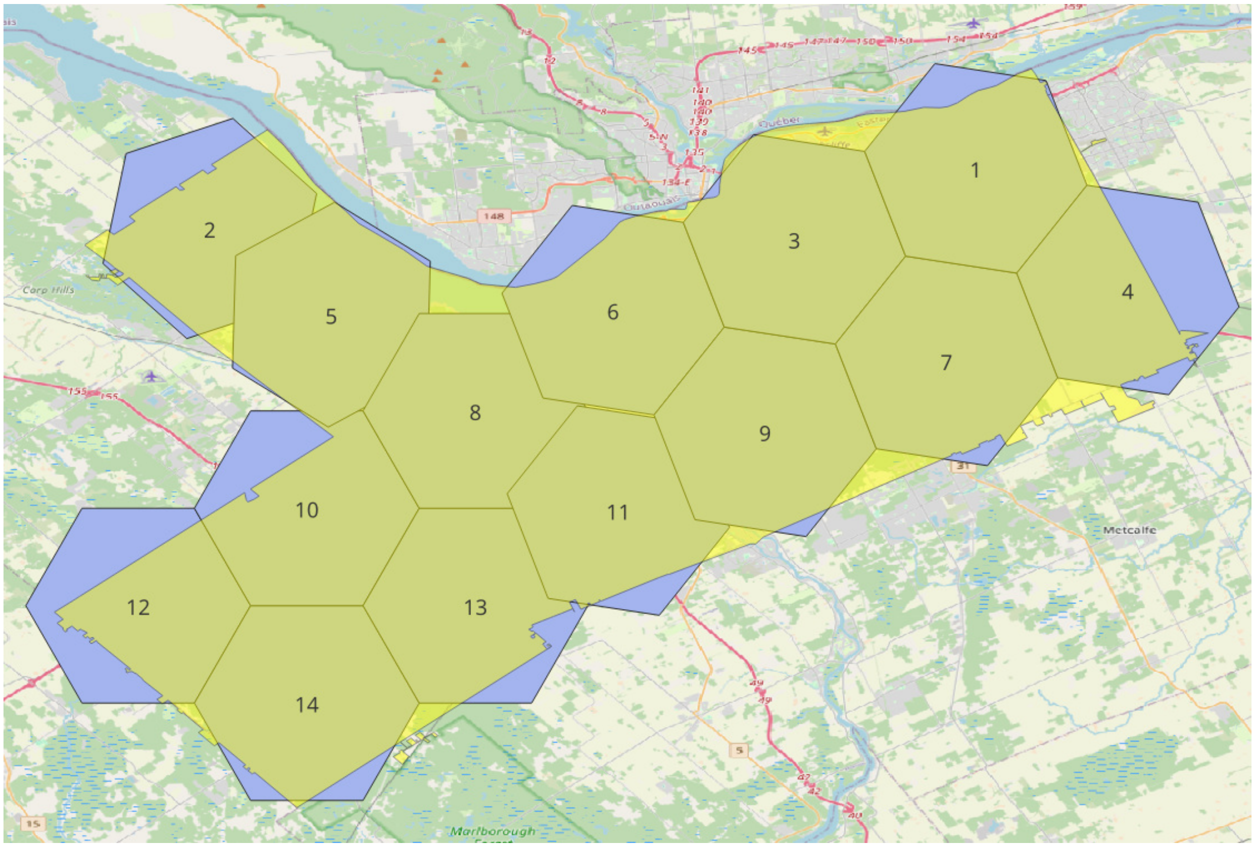


Figure 10 – Hexagonal Cell Placement

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.

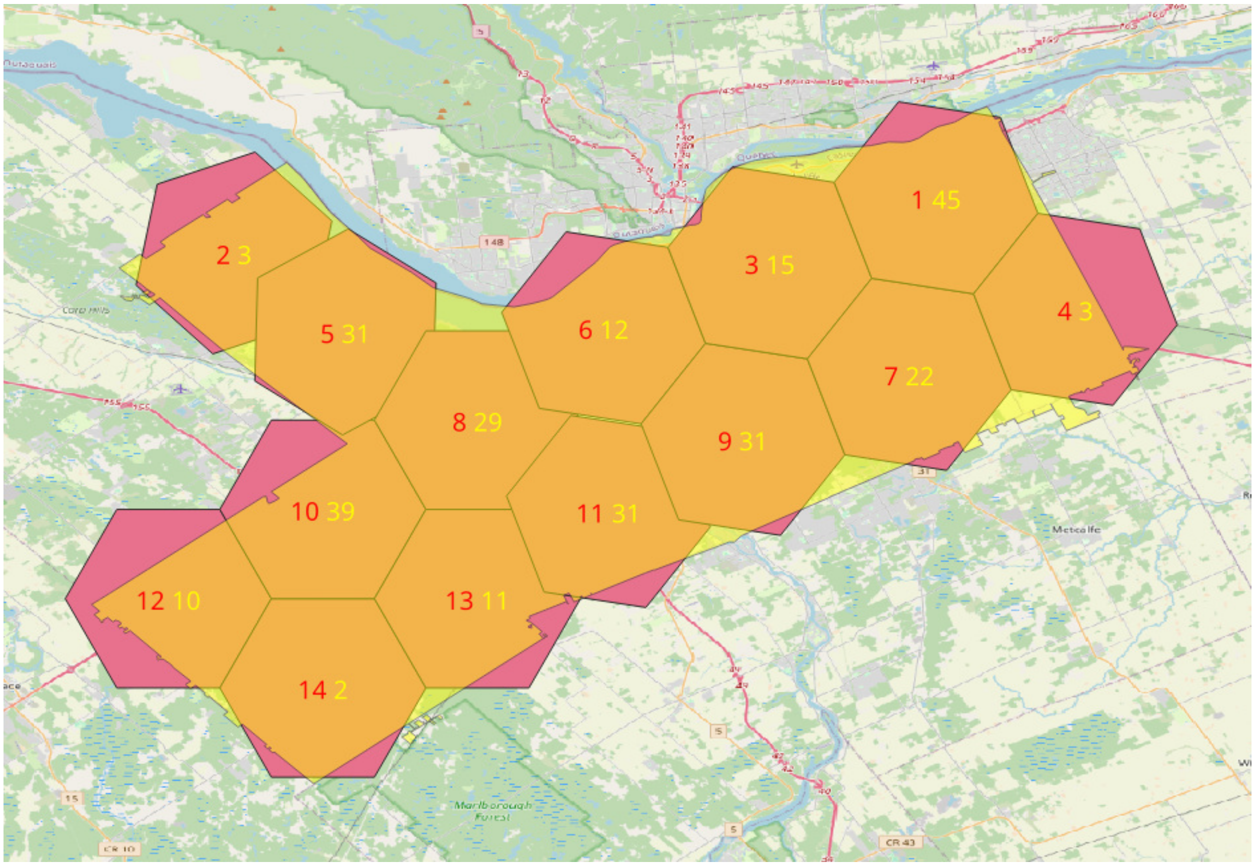


Figure 11 – predicted DA assets per hexagonal cell

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.

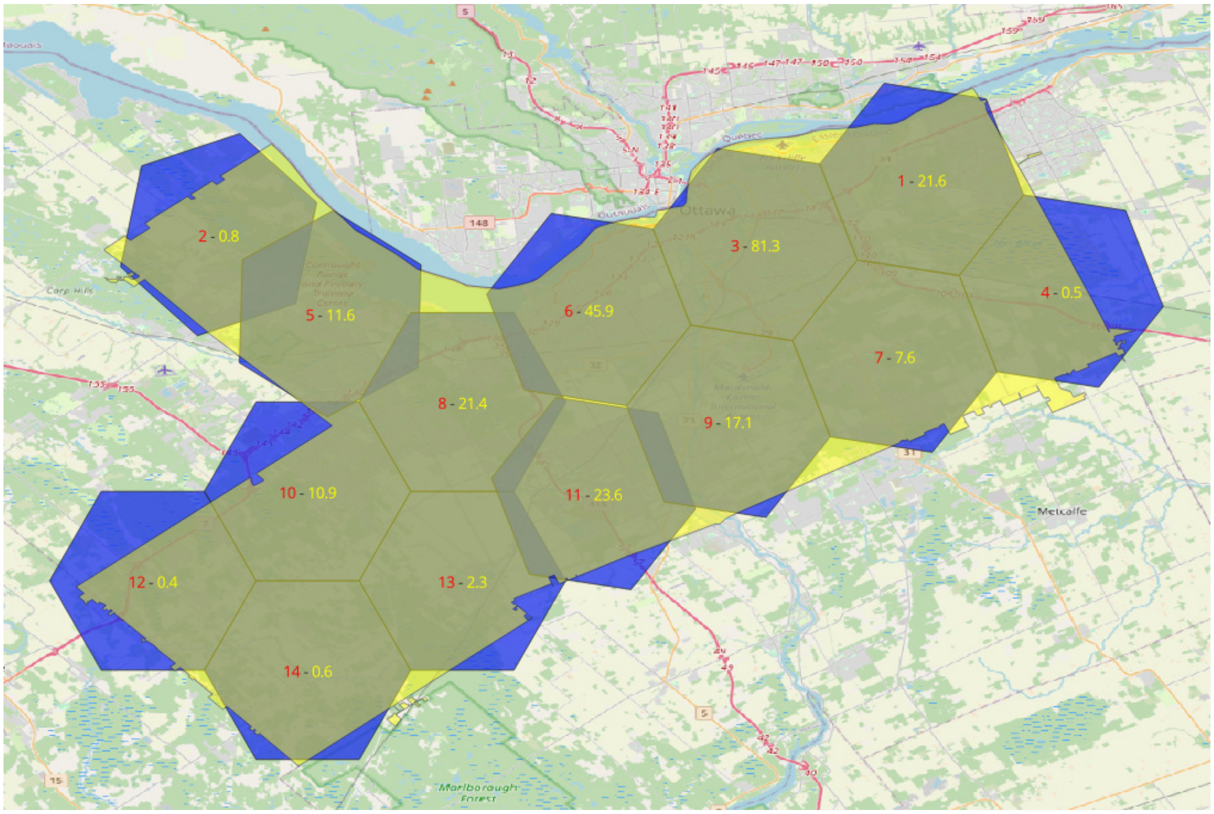


Figure 12 – AMI AP's per cell

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)

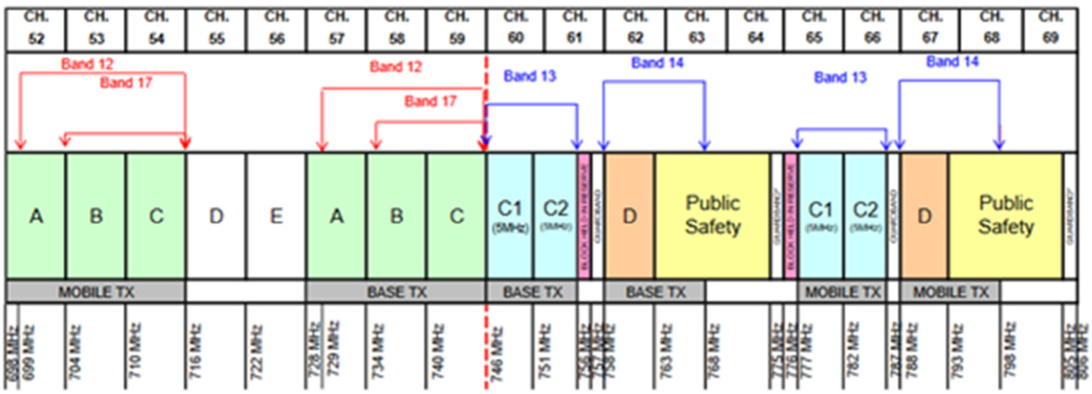
Spectrum licensing services can be found at the following link: Spectrum Licensing Services (canada.ca). Here, it is possible to browse existing and available licences and to apply for licences.

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

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.

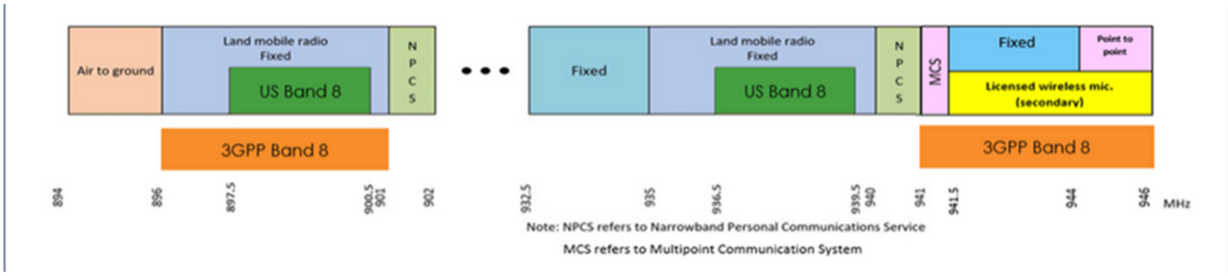


Figure 14 – Proposed Band Plans for 900MHz Radio Access Licensing

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.

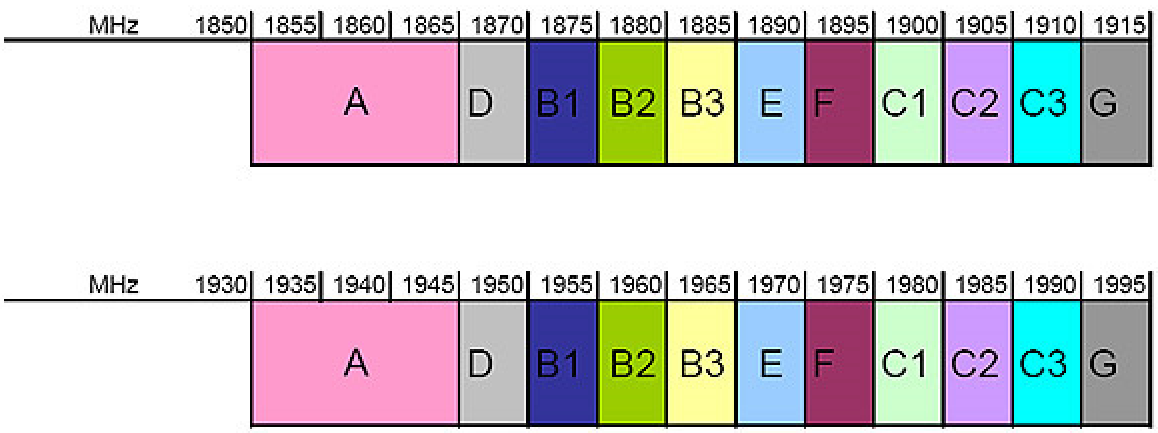


Figure 15 – 1800MHz Band Plan

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.

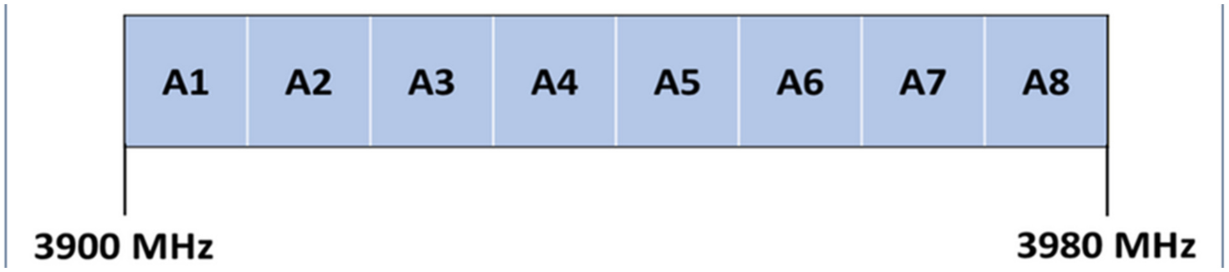


Figure 16 – 3900MHz NCL Licensing Band Plan

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.

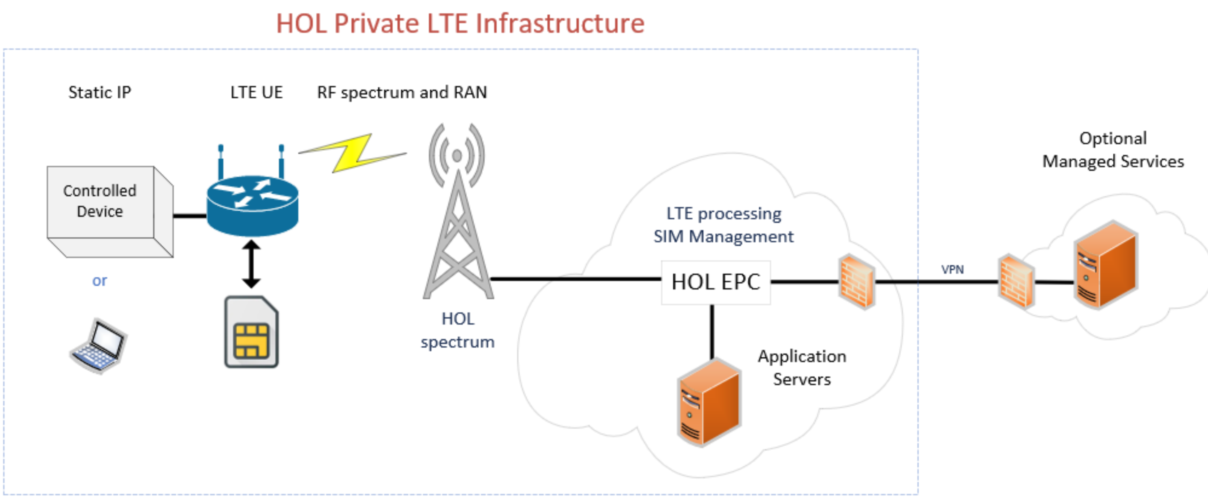


Figure 17 – Private LTE Architecture

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.

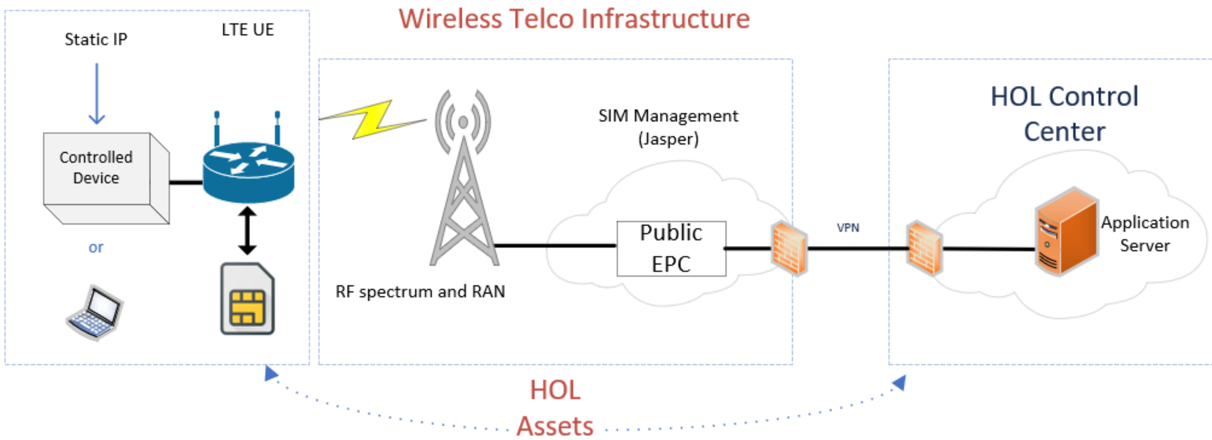


Figure 18 – Public APN Architecture

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.

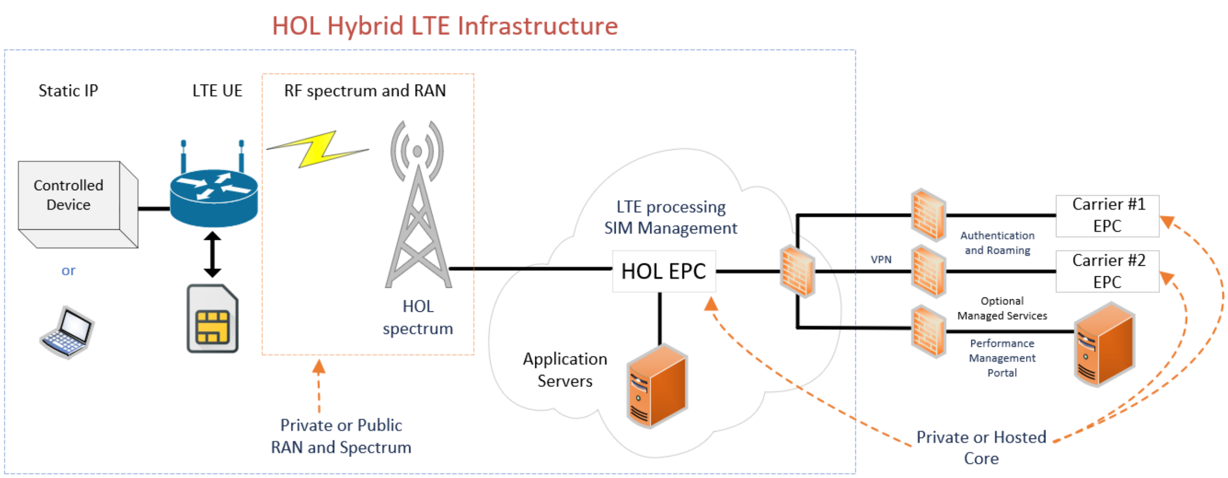


Figure 19 – Hybrid Network Architecture

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.

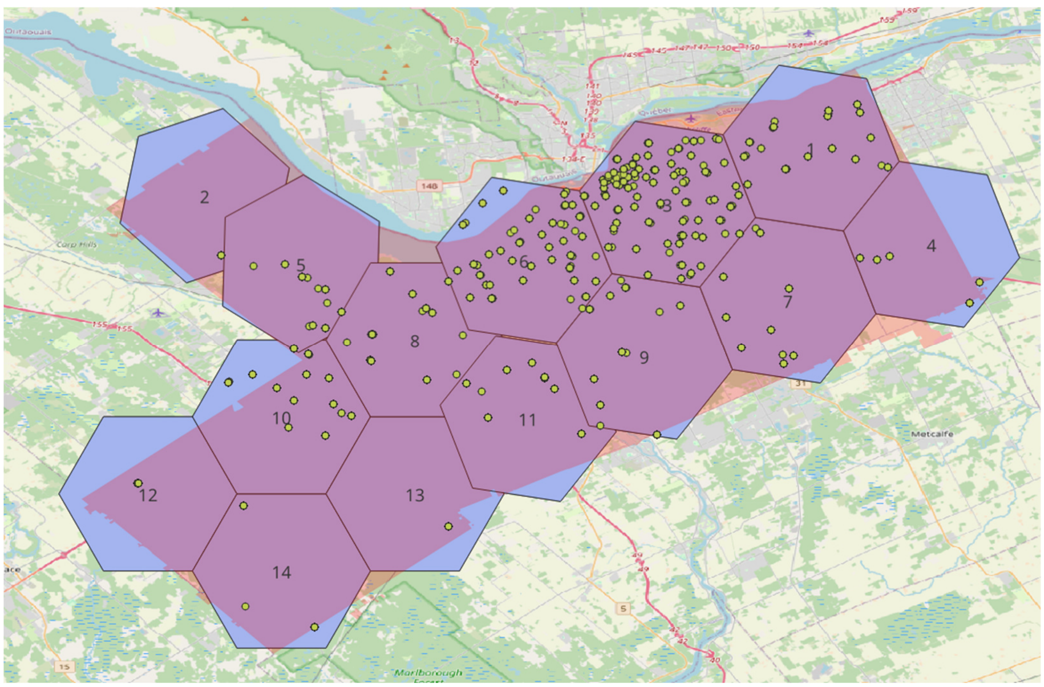


Figure 20 – Possible colocation opportunity locations (>25m heights)

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.

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.

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:

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

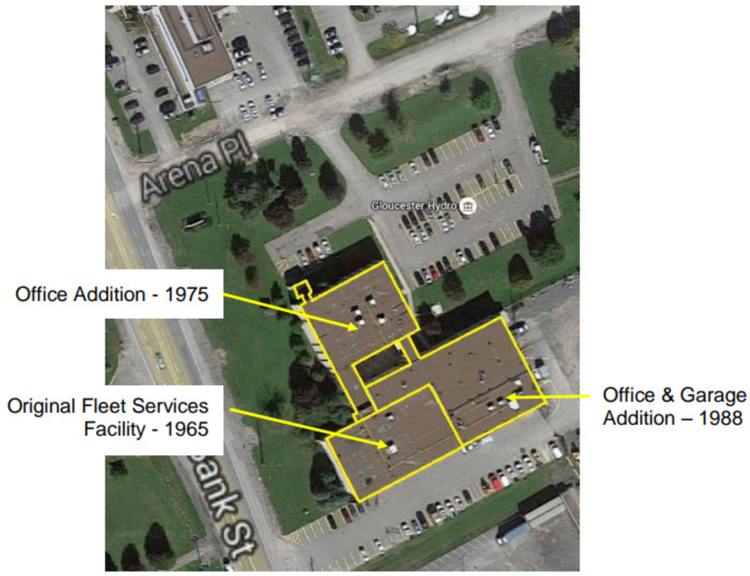
Location	Year Built	Asset Cost	Net Book Value (Dec. 31/23)	Function	Size (sq.ft.)
2711 Hunt Club Rd.	2019	$76.7M	$66.1M	Head Office, Administration, Operations and Storage	185,516
4565 Bank St.	Original Fleet Office - 1965 Office Addition - 1975 Office & Garage addition - 1988	$7.0M*	$4.4M*	Training, 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:

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

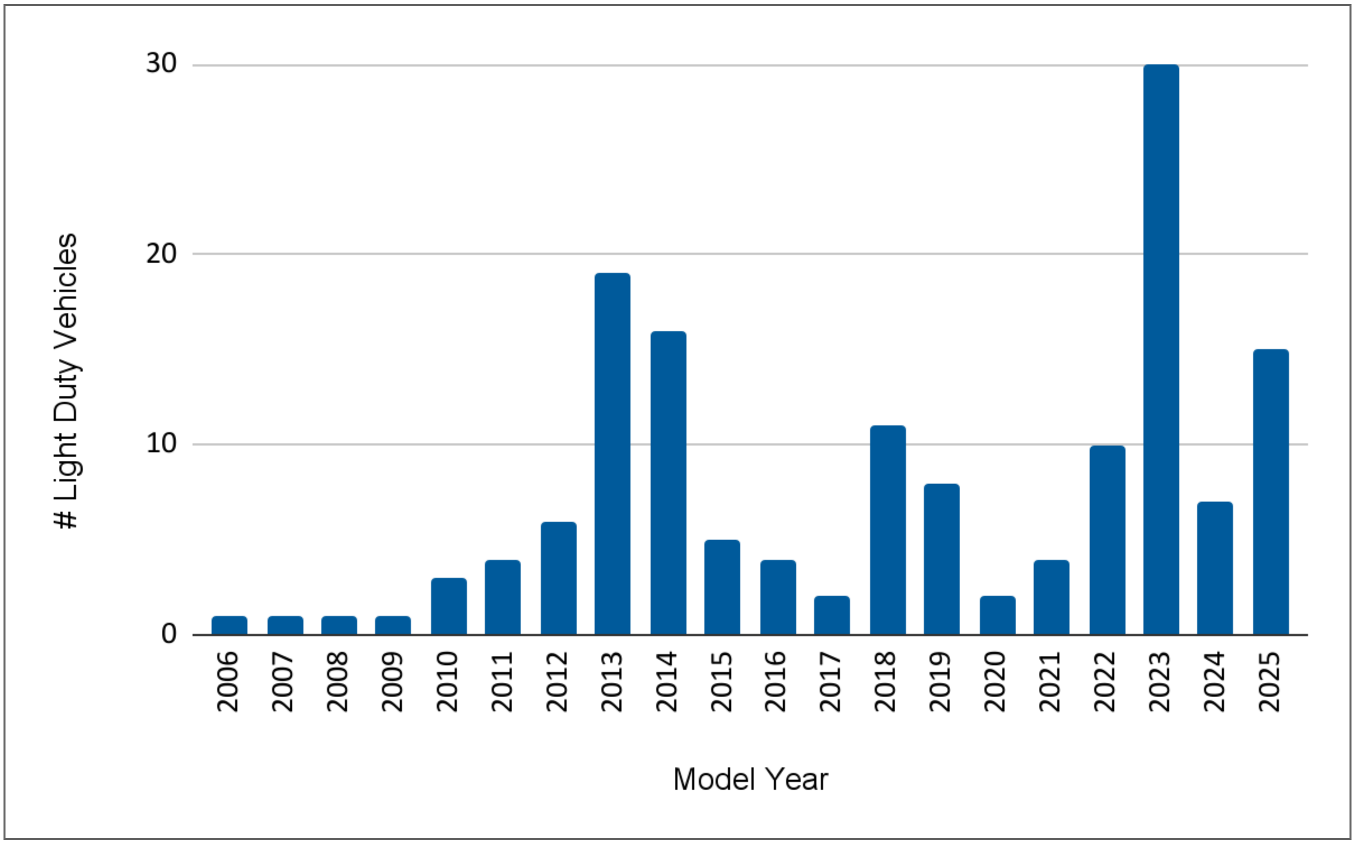
Table 44 - Vehicle Unit Price Increases 2021 vs. 2024

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.

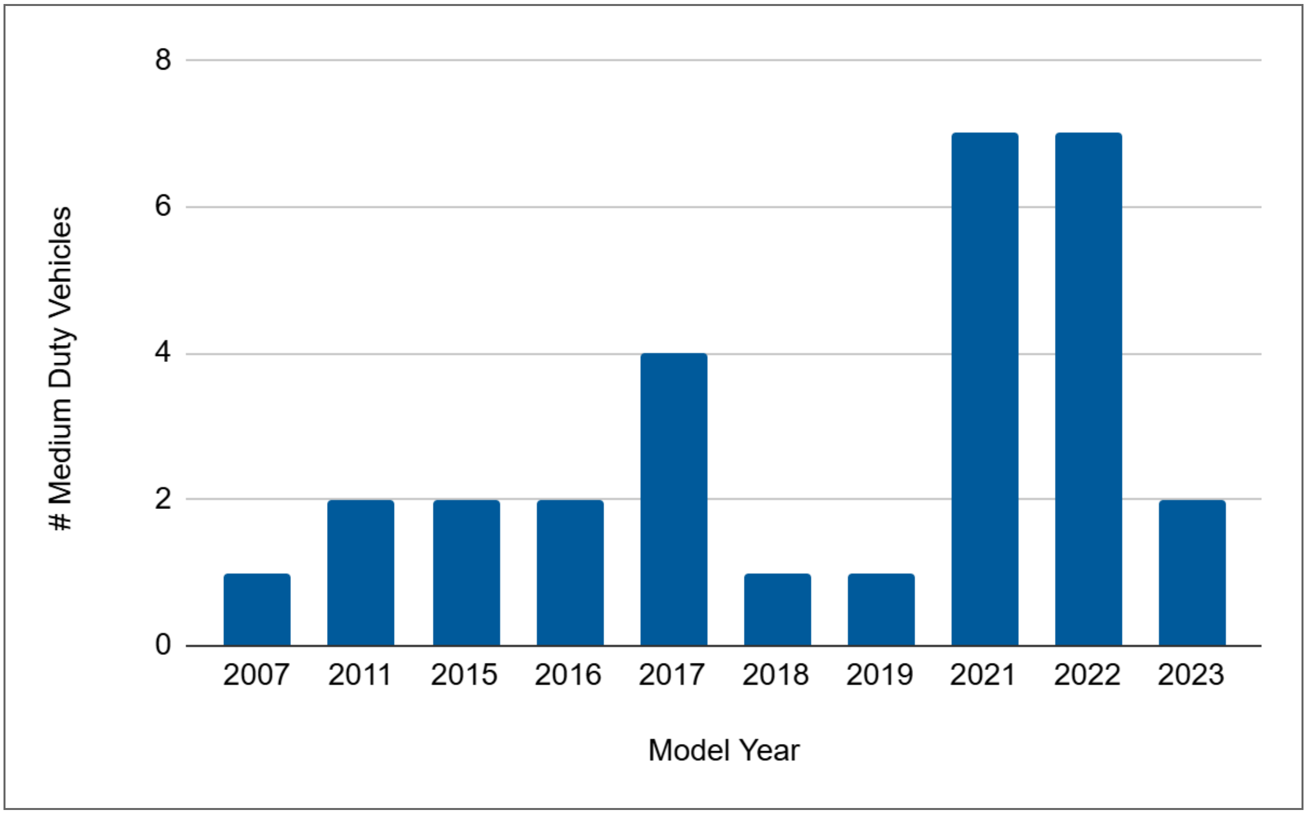
Figure 6 - Number of Light Duty Vehicles by Model Year[8]



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.

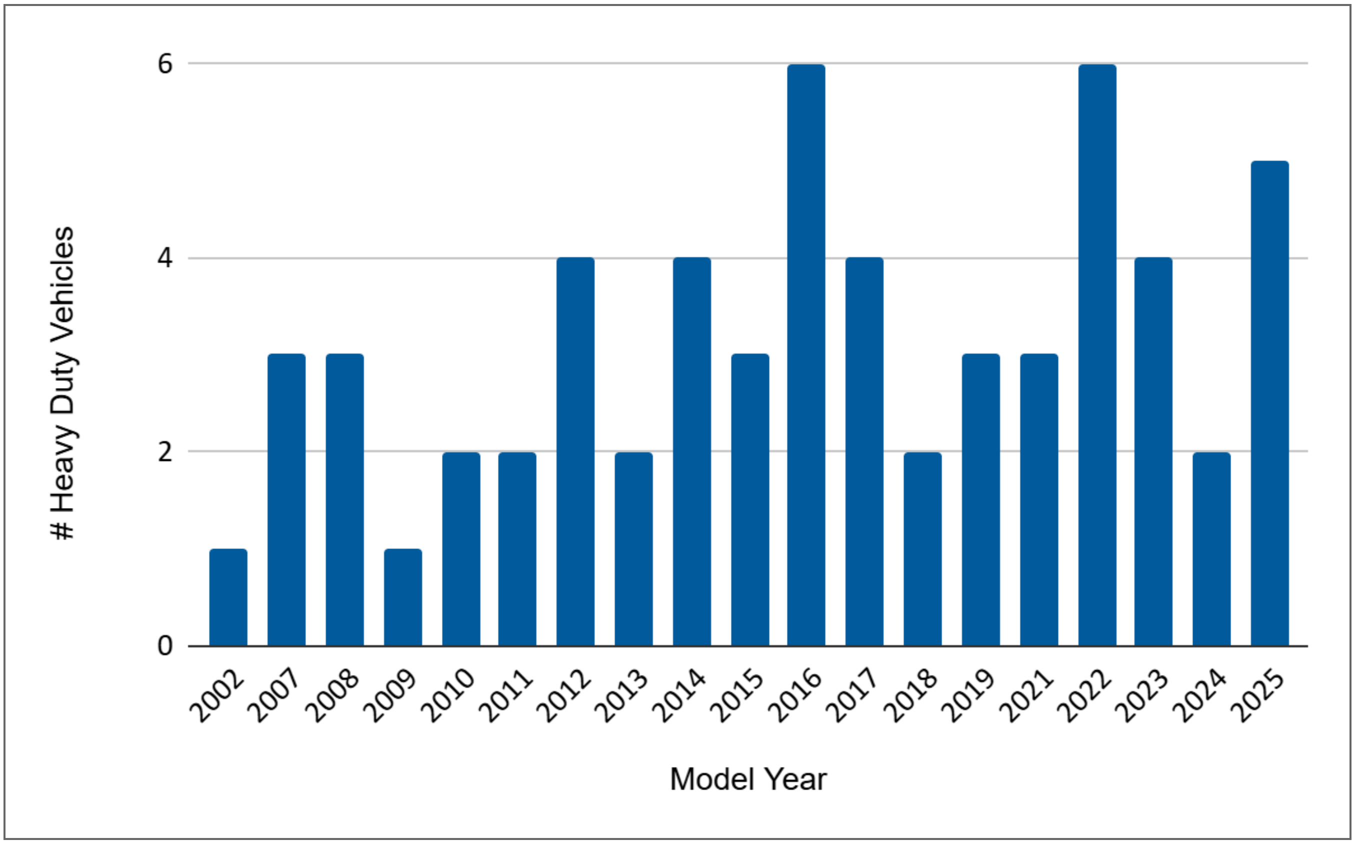
Figure 7 - Number of Medium Duty Vehicles by Model Year[9]



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