Gatineau Corridor End-of-Life Study

December 2022

Connecting Today.
Powering Tomorrow.

Disclaimer

This document and the information contained herein is provided for informational purposes only. The IESO has prepared this document based on information currently available to the IESO and reasonable assumptions associated therewith, including relating to electricity supply and demand. The information, statements and conclusions contained in this report are subject to risks, uncertainties and other factors that could cause actual results or circumstances to differ materially from the information, statements and assumptions contained herein. The IESO provides no guarantee, representation, or warranty, express or implied, with respect to any statement or information contained herein and disclaims any liability in connection therewith. Readers are cautioned not to place undue reliance on forward-looking information contained in this report as actual results could differ materially from the plans, expectations, estimates, intentions and statements expressed in this report. The IESO undertakes no obligation to revise or update any information contained in this report as a result of new information, future events or otherwise. In the event there is any conflict or inconsistency between this document and the IESO market rules, any IESO contract, any legislation or regulation, or any request for proposals or other procurement document, the terms in the market rules, or the subject contract, legislation, regulation, or procurement document, as applicable, govern.

Table of Contents

List of Abbreviations

Abbreviation	Description
APO	Annual Planning Outlook
APS	Achievable Potential Study
BESS	Battery Energy Storage System
CCGT	Combined Cycle Gas Turbine
CDM	Conservation and Demand Management
DER	Distributed Energy Resources
ENS	Energy Not Served
EOL	End of Life
FIDS	Flow into Dobbin and Sidney interface
FIO	Flow into Ottawa interface
HONI	Hydro One Networks Inc.
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
LDC	Local Distribution Company
LMC	Load Meeting Capability
MTS	Municipal Transformer Station
MW	Megawatt
NERC	North American Electric Reliability Corporation
NPCC	Northeast Power Coordinating Council
NREL	National Renewable Energy Laboratory
NWA	Non-wires Alternative
OEB	Ontario Energy Board
ORTAC	Ontario Resource Transmission Assessment Criteria
RAS	Remedial Action Scheme
SCGT	Simple Cycle Gas Turbine
TS	Transformer Station

1. Executive Summary

The Gatineau Corridor End-of-Life Study examines transmission equipment reaching end-of-life (EOL) in the Gatineau transmission corridor along with forecast reliability concerns in the areas supplied by those transmission circuits, Ottawa and Peterborough to Quinte West. Consideration of replacement options for significant EOL transmission facilities through an IESO-led integrated planning process can ensure assets are renewed in a cost-effective manner that aligns with the evolution of the electricity system (e.g. decarbonisation of the electricity sector and the economy) and reflects potential new or emerging needs that have arisen in an area since the assets were first installed. The reliability issues identified through the study include:

- Approximately 800 km of the 230 kV circuits on the Gatineau Corridor (Oshawa to Ottawa) are expected to reach end-of-life over the next 5 to 10 years
- The Load Meeting Capability (LMC) for the Ottawa area is forecast to be exceeded in the mid 2020's
- The LMC for the Peterborough to Quinte West area is insufficient today

To minimize cost, minimize land-use impacts, mitigate forecast risk, preserve options to increase system capability in the future and due to lack of cost effective stand-alone resource or energy efficiency alternatives, the following integrated solution package is recommended to address the transmission equipment EOL needs and accommodate the demand forecast for the Ottawa and the Peterborough to Quinte West areas over the long-term:

- Refurbish all 800 km of 230 kV circuits on the Gatineau Corridor identified as nearing EOL
- Build a new double circuit 230 kV transmission line into Dobbin TS (in Peterborough) from either Cherrywood TS (in Pickering) or Clarington TS (in Oshawa) with a planned in-service of 2029
- Pursue up to 230 MW of additional system cost-effective energy efficiency in the Ottawa area over the 20 year planning horizon, while monitoring demand growth and resource acquisition activities in the Ottawa zone
- Update and expand the use of remedial action schemes (RAS) in the Peterborough and Ottawa areas to meet planning standards and further improve both areas' LMCs

This solution package represents the lowest cost option, with transmission reinforcements estimated to cost approximately $650 M. The transmission reinforcements ensure reliability in the Peterborough to Quinte West area is sufficient for the next 20 years and reliability in the Ottawa area is sufficient until 2037. If the 230 MW of additional energy efficiency is implemented, Ottawa area's reliability would also be sufficient over the 20 year planning horizon. The solution package maintains the capacity of the existing circuits being refurbished and avoids the need to address localized issues that would result from retiring the circuits (i.e. reconfiguration of stations and short line builds in the Ottawa area).

2. Introduction

2.1 Power System Planning in Ontario

The Independent Electricity System Operator (IESO) is responsible for conducting independent planning for electricity generation, demand management, conservation and transmission in the Province of Ontario. In carrying out this mandate, the IESO undertakes planning activities to ensure that the province has, and will continue to have, an adequate and reliable supply of resources and transmission to meet Ontario's electricity needs.

The IESO's planning generally consists of regional planning and bulk system planning. These are two separate but inter-related planning activities. Regional planning is carried out according to a regional planning process endorsed by the Ontario Energy Board (OEB). Regional planning produces plans that address system issues that are local in nature, within 21 planning regions covering the province. Bulk System Planning is carried out by the IESO to address system issues which are more provincial in nature, such as the province-wide need for generation capacity, and transmission system solutions to enable transporting power reliably and economically across the province. Also covered are regulatory compliance studies and reporting requirements, such as required by the North American Electric Reliability Corporation (NERC) reliability standards and the Northeast Power Coordinating Council (NPCC) criteria.

2.2 Gatineau Corridor End-of-Life Study

The Gatineau Corridor End-of-Life Study examines transmission equipment reaching end-of-life (EOL) in the Gatineau transmission corridor along with forecast reliability concerns in the areas of Ottawa and Peterborough to Quinte West which are supplied by the circuits located within the corridor. Consideration of replacement options for EOL transmission facilities through an integrated planning process can ensure assets are renewed in a cost-effective manner that aligns with the evolution of the electricity system (e.g. decarbonisation of the electricity sector and the economy) and new or emerging issues that have arisen in an area since the assets were originally constructed.

2.3 Gatineau Corridor and Key Areas of Interest

Gatineau Corridor

The Gatineau corridor is a 300 km long transmission corridor that runs from Durham region to Peterborough and onto Ottawa. The Gatineau corridor was originally constructed in the late 1920's to early 1930's primarily to transfer power from hydro electric facilities in eastern Ontario and Quebec to the Toronto load centre. The Gatineau corridor consists of five (5) 230 kV transmission lines (P15C/C27P, T22C, T32H/C25H, T33E/E34M, and T31H/H27H), and have a combined length of 1,300 line-kms. Today, the corridor serves a number of purposes which include facilitating generation, transferring bulk system flows across eastern Ontario, and supplying loads in the Peterborough to Quinte West and Ottawa areas.

Peterborough to Quinte West Area

The Peterborough to Quinte West area is located in eastern Ontario and includes Peterborough County, Northumberland County, Prince Edward County, and the City of Quinte West. The electricity demand of this area is a mix of residential, commercial and industrial loads, encompassing diverse economic activities ranging from educational institutions, large business parks, health care, national defence bases, manufacturing and industrial processes.

This area is supplied by a number of 230 and 115 kV transmission lines coming from the directions of Durham region and the County of Lennox and Addington. The area is served by four supply stations which include Otonabee TS, Dobbin TS, Port Hope TS, and Sidney TS. While Otonabee TS is in close proximity to Dobbin TS which is the other supply station in Peterborough, the upstream electricity system serving Otonabee TS is distinct from the system serving the other three stations. When describing system capability and demand forecasts in this report, the definition of the Peterborough to Quinte West area excludes Otonabee TS.

Electricity demand in this summer peaking Peterborough to Quinte West area has been fairly constant and has historically reached approximately 310 MW. There is approximately 300 MW of transmission connected hydro-electric generation located in the Greater Madawaska and Renfrew areas supporting the load in Peterborough to Quinte West.

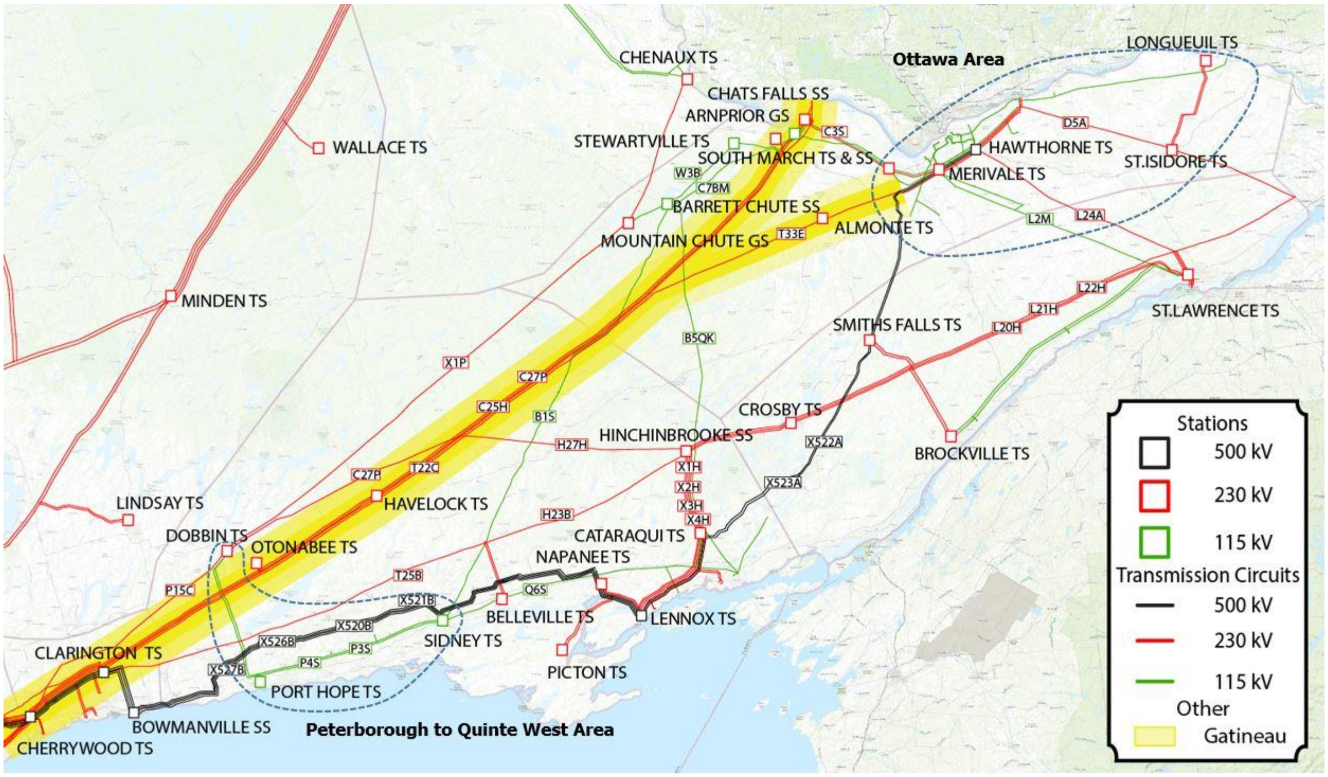
Ottawa Area

The City of Ottawa is the second largest city in Ontario with a population of approximately 1 million people. The city has seen its population grow steadily by approximately 1.5% annually since 2015, and with that has also seen a steady growth of its developed lands. This development is primarily focused in five areas: the downtown core, Nepean & Riverside South, South Kanata & Stittsville, the Village of Richmond, and Orleans. This growth is primarily being seen through the development of new mixed commercial/residential communities, intensification of existing communities, and major projects like the Ottawa Light Rail Transit system. In rural Ottawa, the economy contributes over $1 billion to the GDP. Rural economic activity includes such things as agriculture, retail sales, construction, forestry and mining (aggregates), tourism, manufacturing, personal and business services, and transportation.

Ottawa is supplied by a number of 500, 230 and 115 kV transmission lines coming from the directions of Peterborough County and the County of Lennox and Addington. Electricity demand in this summer peaking area has been steadily growing and has historically reached approximately 1,800 MW. There are a number of different electricity supply resources in the surrounding area that help support the Ottawa load, including approximately 600 MW of hydro-electric generation located on the Madawaska and Ottawa rivers, 70 MW of gas generation located in the city, and three interties with Quebec system.

A map of the area highlighting the Gatineau corridor and the areas of Peterborough to Quinte West and Ottawa are shown in Figure 1.

Figure 1 | Map of Gatineau Corridor, Highlighting Areas of Interest



3. Planning for Transmission Asset End-of-Life in the Gatineau Corridor

3.1 Transmission Asset End-of-Life

Consideration of end-of-life (EOL) transmission asset replacement needs is an integral part of transmission planning. When an asset reaches EOL, a decision must be made to either replace it ("like-for-like" or "right-size") or, in some cases, decommission it to meet safety, reliability, environmental, and customer requirements. While the length of time varies, many transmission assets remain in use and deliver value for 40 years or more. Over such a long period of time, the functional requirements of the transmission system could change, as customer needs, system conditions, sector trends, and government policy evolve. Coordination of transmission asset replacement needs with other forecast reliability and security needs over the long-term is critical to maximizing the benefits and value of transmission system investments.

End-of-Life

EOL represents the state of having a high likelihood of failure, or loss of an asset's ability to provide the intended functionality, wherein the failure or loss of functionality would cause unacceptable consequences. EOL is determined by the asset owner's risk-based assessments, taking into account such factors as reliability, loss of load, environmental considerations, and safety.

EOL is different from the "useful life" of asset which is an accounting estimate of the number of years it is likely to remain in service considering factors such as manufacturer guidelines, and historical asset performance, failure and retirement data.

As assets age and begin to approach their "useful life", assessments are carried out to determine their overall condition by examining asset-specific health metrics, along with performance history. Based on the results, equipment is scheduled to be replaced when it reaches EOL.

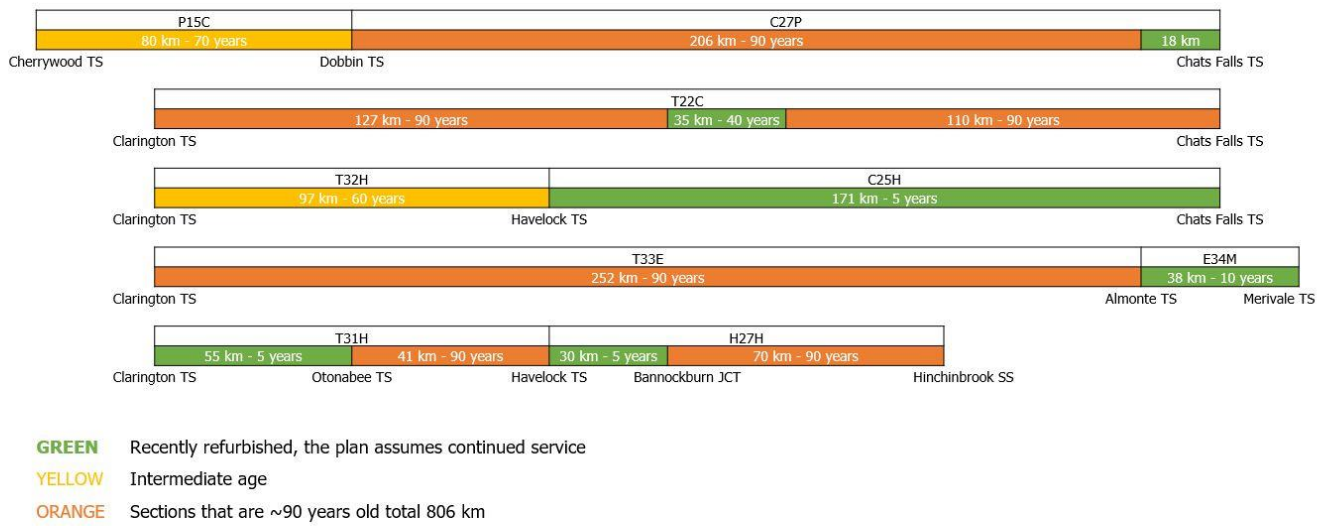
3.2 Gatineau Corridor Transmission Asset End-of-Life

The Gatineau Corridor was originally constructed in the late 1920's to early 1930's. At over 90 years since its original construction, large portions of corridor and specifically the transmission line conductors are nearing EOL, and in some instances have already been partially refurbished to maintain safety and reliability of the transmission system.

Transmission line conductors have a "useful life" of approximately 90 years. The facility owner, Hydro One Networks Inc. (HONI) has identified that the conductors on transmission lines C27P, T22C and T33E are nearing EOL based on asset condition assessments and require replacement before 2028. A decision to either refurbish the EOL facilities "like-for-like" or decommission and replace them with new cost effective facilities that provide additional value must be made now, as new transmission lines typically take 7 years to design, approve and construct.

While HONI has only identified the three transmission lines (C27P, T22C and T33E) as nearing EOL, other transmission lines in the corridor were examined in this study to identify potential candidates for right-sizing or decommissioning. Asset demographic age information for the Gatineau corridor transmission lines are illustrated in Figure 2.

Figure 2 | Age of Gatineau Corridor Transmission Line Conductors



3.3 Potential Opportunities for Right-sizing or Decommissioning

As noted earlier, while HONI has only identified the three transmission lines, C27P, T22C and T33E as nearing EOL, all transmission lines in the corridor were screened to identify potential candidates for right-sizing or decommissioning. The screening considered various qualitative factors such as the criticality of the facility on reliability, stranding recently refurbished facilities, and potential for other cost effective alternatives. The screening identified transmission lines T22C and T33E as potential candidates for decommissioning, as alternatives exist that are potentially more cost effective and/or provides greater system value. The transmission lines C27P, T32H, T31H, and H27H are recommended to be refurbished when they reach EOL as cost effective alternatives are not evident. The last remaining circuit in the corridor P15C, is essential to supplying Peterborough to Quinte West and also the eastern Ontario system. For this reason, the circuit P15C can either be refurbished or upgraded to help accommodate the forecast demand for Peterborough to Quinte West and Ottawa areas. A summary of the considerations for each transmission line is provided in

Table 1.

Table 1 | Opportunities for Right-sizing or Decommissioning in the Gatineau Corridor

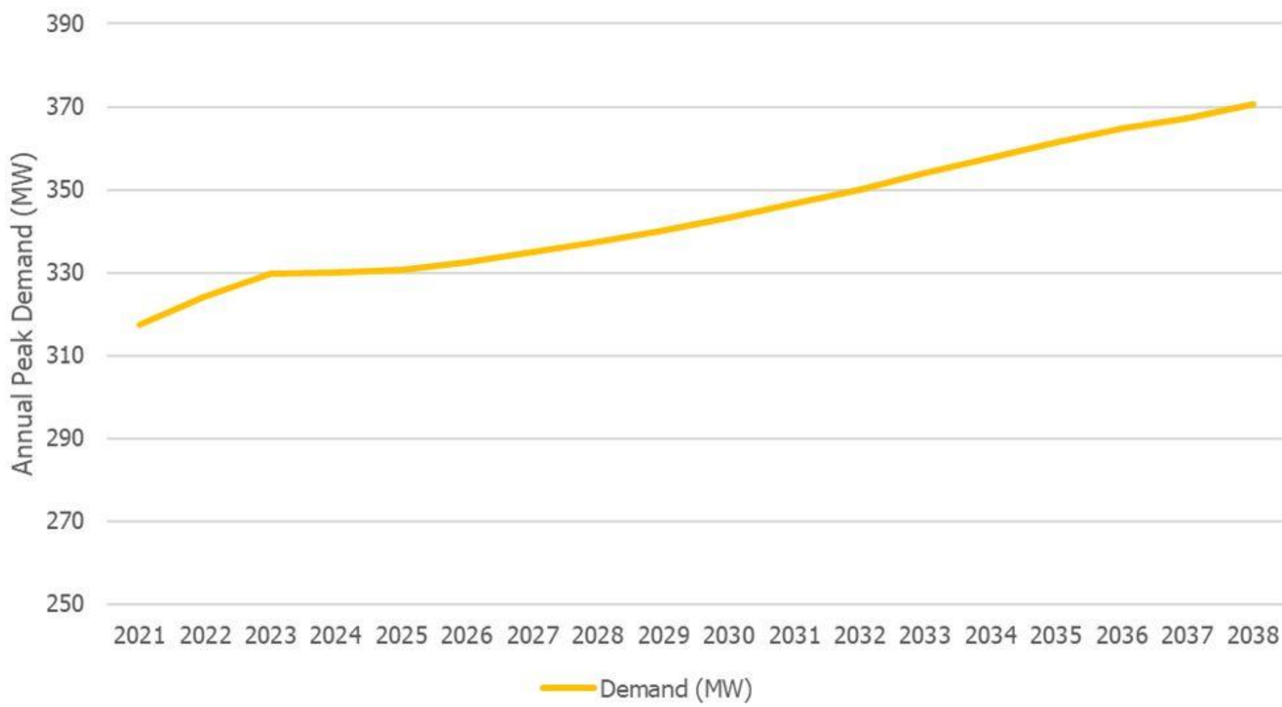
Transmission Line	Considerations	Opportunity for Right-sizing or Decommissioning
P15C/C27P	• The transmission lines P15C and C27P are critical supply circuits for the Peterborough to Quinte West area, P15C is a limiting constraint for the area's load meeting capability, as well as an upstream constraint for Ottawa's load meeting capability • The transmission line P15C runs between Pickering and Peterborough, passing by northern part of Durham region where load growth is expected most in the future • The transmission line C27P provides transmission connection for the 85 MW hydro-electric Arnprior Generating Station; if C27P were to be decommissioned, a portion of C27P would still need to maintained (~15 km) • The vast majority of the C27P transmission line is approaching its "useful life" or has been identified as nearing EOL	P15C: Opportunity for upgrading C27P: No
T22C	• The transmission line T22C is critical in supporting the Ottawa area during certain transmission outage conditions • The transmission line T22C provides transmission connection for Otonabee TS; if T22C were to be decommissioned, supply to Otonabee TS would need to reconfigured to one of the remaining circuits in the corridor • The majority of the transmission line has been identified as nearing EOL	T22C: Opportunity for decommissioning and replacing with a new transmission line that can offer additional system value
T32H/C25H	• The transmission line T32H/C25H is critical in supporting the Ottawa area during certain transmission outage conditions • The transmission lines T32H/C25H are critical supply circuits for Havelock • A portion of the transmission line (60%) was recently refurbished, and the remaining portion of the transmission line still has 30 years before reaching its average "useful life".	T32H/C25H: No
T33E/E34M	• The transmission line T33E/E34M is critical in supporting the Ottawa area during certain transmission outage conditions • The transmission lines T33E/E34M supply Almonte TS, Terry Fox TS, and Cambrian MTS; if T33E were to be decommissioned, a portion of T33E would still need to be maintained (~55km) and reconnected to one of the remaining circuits in the corridor • The entire T33E has been identified as nearing EOL	T33E: Opportunity for decommissioning and replacing with a new transmission line that can offer additional system value E34M: No
T31H/H27H	• The transmission line T31H/H27H helps support the loads in the areas of Lennox and Addington county, City of Kingston and Hinchinbrooke Township during certain transmission outage conditions • The transmission lines T31H/H27H are critical supply circuits for Havelock • A portion of the transmission line (40%) was recently refurbished, and the remaining portion of the transmission line has been identified as nearing EOL	T31H: No H27H: No

4. Demand Forecasts

4.1 Peterborough to Quinte West Area Demand

The Peterborough to Quinte West electricity demand is a mix of residential, commercial and industrial loads, encompassing diverse economic activities including educational institutions, large business parks, manufacturing and Canadian Forces bases. As shown in Figure 3, loads in this summer-peaking area are forecast to grow from 310 MW to 370 MW over the next 20 years.

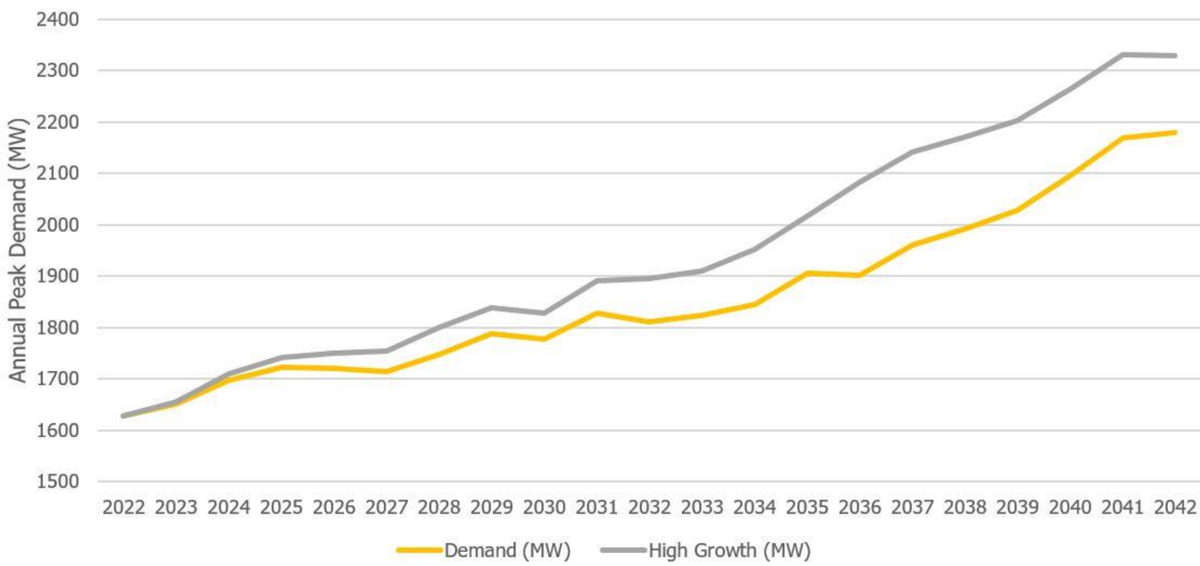
Figure 3 | Peterborough to Quinte West Demand Forecast



4.2 Ottawa Area Demand

The Ottawa electricity load growth is primarily being seen through the development of new mixed commercial/residential communities, intensification of existing communities, and major projects like the Ottawa Light Rail Transit system. As shown in Figure 4, loads in this summer-peaking area are forecast to grow from approximately 1650 MW to 2200 MW and 2350 MW over the next 20 years under the reference forecast and high growth scenario respectively.

Figure 4 |Ottawa Demand Forecast



Energy Evolution - Ottawa's Community Energy Transition Strategy

Energy Evolution[1] is the action plan for how Ottawa will meet its targets to reduce greenhouse gas emissions to zero by 2040 within the corporation, and by 2050 Ottawa-wide. Its vision is to transform Ottawa into a thriving city powered by clean, renewable energy. To achieve Ottawa's emission reduction targets will require:

- Significantly reduce energy demand for existing end-uses
- Phase out fossil fuels
- Increase use of renewable resources

Some of the identified actions to help achieve these targets will have an interdependency with planning the electricity system supplying the City of Ottawa, such as electrification of personal and commercial vehicles, electrification of heating, and new renewable resources.

The Energy Evolution strategy was approved by Ottawa's City Council on October 28, 2020. The impact of Energy Evolution on the peak electricity demand has yet to be quantified and is not included in the demand forecast shown in Figure 4. The IESO will work with the City of Ottawa and the Greater Ottawa regional planning working group during the next cycle of regional planning for Greater Ottawa (expected to commence in Q4 2022), to determine the how the strategy would impact the development of planning forecasts and scenarios, and what additional planning activities are necessary to support the City of Ottawa's Energy Evolution strategy. It's anticipated that to achieve energy evolution targets, Ottawa demand would grow beyond the high growth scenario and this uncertainty was considered when evaluating options.

---

[1] More information regarding Energy Evolution is available on the City of Ottawa's website (link)

5. Supply Capability to Focus Areas

Supply capability to the areas of Peterborough to Quinte West and Ottawa is provided by a number of internal generation resources, as well as external resources accessed through the 500 kV and 230 kV transmission system (connecting the area to the rest of the Ontario)[2].

Planning of the transmission system focuses on ensuring that the system will operate reliably over a broad spectrum of system conditions and following a wide range of probable system contingencies. These planning events and performance requirements are established through a number of planning criteria and standards by the North American Electric Reliability Corporation (NERC), the Northeast Power Coordinating Council (NPCC), and the IESO. The planning events examined are aimed to stress the transmission system (i.e. adjusting hydro-electric generation output for drought conditions, adjusting the load forecast for extreme weather, loss of one or more transmission and/or generation elements, etc.), and the performance requirements are intended to set a baseline for designing the electricity system.

As Ontario's electricity grid is made up of a variety of different energy resource types, it's important to note that the capability of each resource type at the time of peak loading conditions will vary. Variable generators such as wind and solar are modelled to historical output coincident with the time of peak. Hydro-electric generators are modelled to their historical output available during drought conditions.

5.1 Peterborough to Quinte West Supply

5.1.1 Peterborough to Quinte West Internal Resources

Transmission-connected resources currently comprise of mostly hydro-electric generation along the Madawaska and Ottawa rivers. These resources represent a combined total of 300 MW of installed generation capacity[3], however the generation output is expected to be closer to 40 MW during drought conditions.

5.1.2 Peterborough to Quinte West Load Meeting Capability

Supply to Peterborough to Quinte West is also provided through the Flow into Dobbin and Sidney (FIDS) transmission interface which is bounded by two 115 kV circuits from Cataraqui TS (Q6S) and from Barrett Chute TS (B1S), and two 230 kV circuits in the Gatineau Corridor (P15C and C27P), providing supply from broader provincial resources.

[2] The mixture of resources used to supply the region's and the province's energy needs at any time is determined by the real-time energy market.

[3] The region also has a significant number of distribution connected resources, mainly solar. The impact of these distributed resources has been considered as part of the reference load forecast.

The FIDS interface is thermally limited by 230 kV circuit P15C from Cherrywood TS to Dobbin TS in the summer. Generally, losing one or more of the interface circuits will lead to overloads of the remaining circuit(s). In the existing system, the load meeting capability of Peterborough to Quinte west area is limited to 270 MW today, the limiting phenomena is illustrated in Table 2.

Table 2 | Peterborough to Quinte West Load Meeting Capability

Transmission Equipment Out of Service	Phenomena	Peterborough to Quinte West LMC
Q6S	Thermal overload on P15C	270 MW
P15C	Thermal overload on Q6S	280 MW

5.2 Ottawa Supply

5.2.1 Ottawa Internal Resources

Transmission-connected resources currently comprise of a significant amount of hydro-electric generation along the Madawaska and Ottawa rivers, one natural-gas generation plant in the City of Ottawa, and one wind generator to the east of the city. These resources represent a combined total of 800 MW of installed generation capacity[4]. Over the next 20 years, contracts for the natural gas-fired and wind generators are expected to expire, which needs to be considered when identifying local supply needs.

5.2.2 Ottawa Load Meeting Capability

Supply to Ottawa is also provided through the Flow into Ottawa (FIO) transmission interface, defined as two 500 kV circuits from Lennox TS (X522A, X523A), and four 230 kV transmission circuits from Beauharnois (B5D), St. Lawrence TS (L24A), Chats Falls TS (C3S) and Almonte TS (E34M), providing supply from broader provincial resources.

Under normal operating conditions, the Ottawa load is primarily supplied by the two 500 kV circuits from Lennox TS. However, when these two primary supply circuits are unavailable, the Ottawa load relies on the 230 kV electricity system to supply the load. The FIO interface is thermally limited by the 230 kV circuit L24A from St. Lawrence TS to Hawthorne TS, and the upstream 230 kV circuit P15C from Cherrywood TS to Dobbin TS. In the existing system, the load meeting capability of Ottawa is limited to 1700 MW today due to thermal limitations. While not the most limiting, Ottawa's load meeting capability is also limited by voltage instability. Information regarding Ottawa's load meeting capability and limiting phenomena is shown in Table 3.

[4] The region also has a significant number of distribution connected resources, mainly hydro-electric and solar. The impact of these distributed resources has been considered as part of the reference load forecast.

Ottawa is also interconnected with Quebec through three (3) 230 kV interconnections and three (3) 115 kV interconnections. The six interties facilitate mostly economic energy transactions between Ontario and Quebec through the Ontario electricity market. The current interties between Quebec and Ontario have a combined capacity of 2,775 MW; however, transmission constraints in Ontario limit the available transfer capability between the two areas[5]. Real-time transactions with Quebec have reached a maximum of about 1,800 MW.

Table 3 | Ottawa Load Meeting Capability

Transmission Equipment Out of Service	Phenomena	Ottawa LMC
Loss of X522A & X523A	Thermal overload on P15C	1700
Loss of X522A & X523A	Voltage Instability	1800

[5] More information about the Ontario-Quebec interconnection is available in the IESO's 2017 report – "Ontario-Quebec Interconnection Capability: A Technical Review" (link)

6. Need for Additional Supply

The IESO has conducted an assessment of the system's capability to supply the areas of Peterborough to Quinte West and Ottawa. Planning criteria were applied in accordance with North American Electric Reliability Corporation standards and the Northeast Power Coordinating Council reliability directories to determine system capacity needs. In the context of the bulk system, adequacy is defined as the ability to supply regional demand, while respecting transfer capability limits across the bulk system and interconnections.

This assessment considered both the contribution of existing internal generation and resources external to the area.

6.1 Capacity Requirement

A deterministic approach was used to evaluate the need for additional capacity behind the Flow into Dobbin and Sidney, and Flow into Ottawa interfaces. A need was identified where the annual coincident load forecast exceeded the interface transfer limits and the total capacity of internal transmission-connected generation.

6.1.1 Flow into Dobbin and Sidney

Based on this assessment, to supply Peterborough to Quinte West there is a capacity need of 100 MW in the summer by 2035. The capacity need is an existing issue, that arises during periods of high demand coinciding with low water conditions. The annual capacity requirement for FIDS is shown in Figure 5.

In addition to the annual capacity shortfall, the estimated frequency, duration, and magnitude of unserved energy events were also investigated and used to inform options development. Figure 6 contains heat maps to visually demonstrate these characteristics. Each cell in the heat map indicates the expected frequency, of all hours of unserved energy, that may occur in that specific hour or month. By 2035, unserved energy is expected to occur mostly in the months of April through October, with the largest impact observed during the summer peaks.

There is a significant amount of distribution connected solar generation within the Peterborough to Quinte West area. The effects of the solar generation can be seen in the heat maps, as the solar generation helps offset the demand during the hours of 8:00 AM to 5:00 PM and reduces the energy needs during those hours.

Figure 5 | Flow into Dobbin and Sidney Capacity Requirement

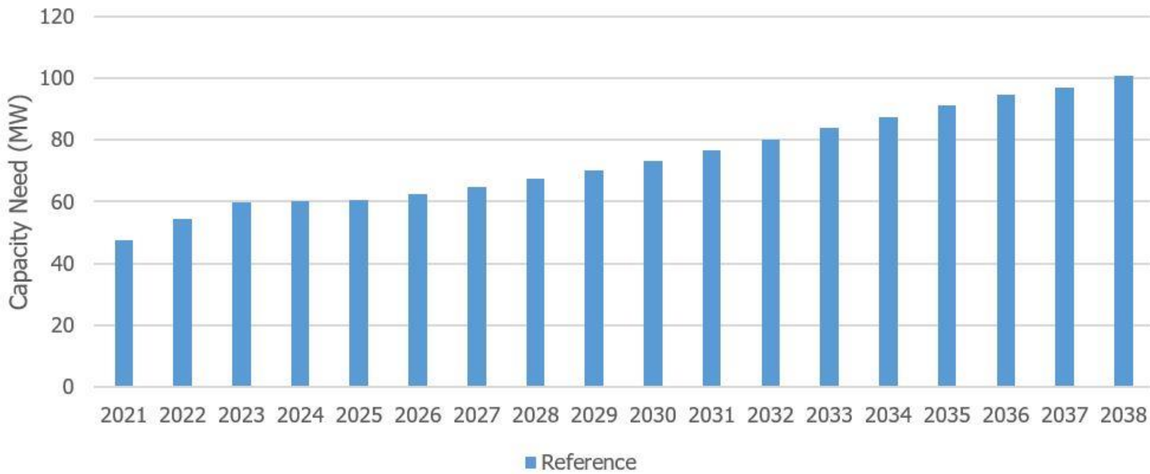


Figure 6 | Heat Maps Showing Possible Energy Need behind FIDS in 2035

Need (MW)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
89	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
78	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
67	0%	0%	0%	0%	0%	0%	1%	2%	1%	0%	0%	0%
56	0%	0%	0%	0%	0%	1%	2%	3%	1%	0%	0%	0%
44	0%	0%	0%	1%	0%	2%	4%	5%	3%	1%	0%	0%
33	0%	0%	0%	3%	3%	3%	6%	7%	5%	2%	0%	0%
22	0%	0%	0%	4%	6%	6%	9%	9%	7%	3%	0%	0%
11	0%	0%	0%	7%	10%	9%	12%	14%	10%	4%	0%	0%
0	1%	1%	0%	10%	15%	14%	16%	21%	15%	7%	0%	0%

Month

Need (MW)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
100	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
89	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
78	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%
67	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%	0%
56	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	2%	2%	1%	0%	0%	0%
44	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%	5%	4%	2%	1%	0%	0%
33	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	6%	7%	6%	5%	2%	1%	0%
22	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	8%	9%	9%	8%	4%	2%	0%
11	1%	0%	0%	1%	2%	4%	4%	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%	9%	10%	10%	9%	7%	5%	0%
0	3%	2%	2%	3%	6%	8%	7%	1%	0%	0%	0%	0%	0%	0%	0%	1%	5%	11%	11%	10%	10%	9%	8%	0%

Hour Ending

6.1.2 Flow into Ottawa

Based on this assessment, a capacity need first emerges in 2025 and grows to 475 MW in the summer by 2042 under the reference scenario. Under the high growth scenario, the capacity need increases to 625 MW by 2042. When considering generation coming off contract, the capacity need becomes 550 MW and 700 MW respectively (approximately 75 MW of transmission connected generation coming off contract during the 20 year planning horizon). The annual capacity requirement is shown in Figure 7. In addition to the annual capacity shortfall, the estimated frequency, duration, and magnitude of unserved energy events were also investigated and used to inform options development. Figure 8 contains heat maps to visually demonstrate these characteristics. While Ottawa is a summer peaking area today, its expected that Ottawa will gradually shift to being winter peaking over the next 20 years due to decarbonisation efforts.

Figure 7 - Flow into Ottawa Capacity Requirement

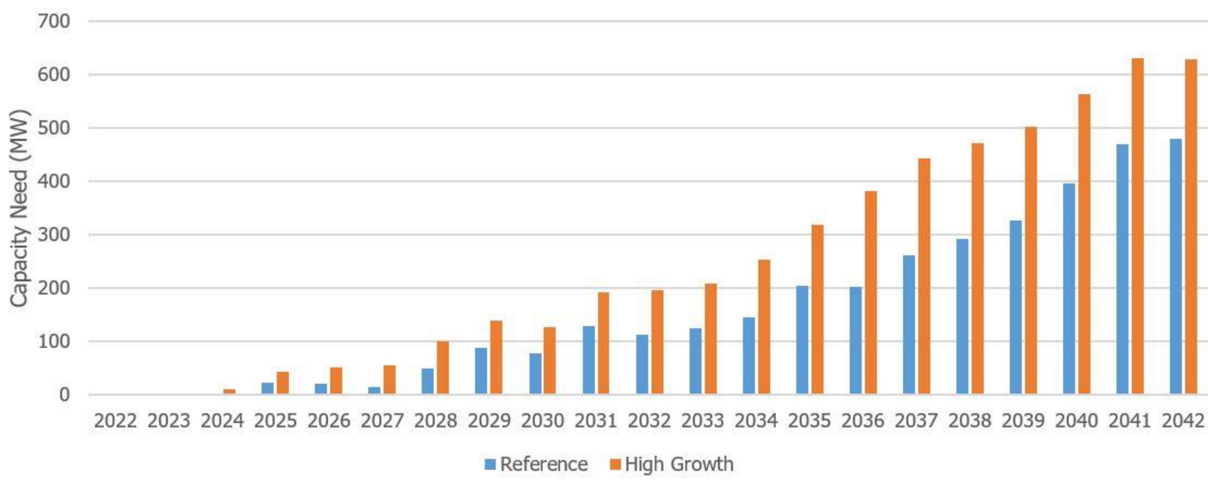


Figure 8 |Heat Maps Showing Possible Energy Need behind FIO in 2035

Need (MW)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
215	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
191	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%
167	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	0%
143	0%	0%	0%	0%	0%	0%	0%	12%	0%	0%	0%	0%
119	2%	0%	0%	0%	0%	0%	0%	20%	0%	0%	0%	0%
96	3%	0%	0%	0%	0%	0%	0%	24%	0%	0%	0%	0%
72	7%	5%	0%	0%	0%	0%	2%	25%	0%	0%	0%	0%
48	15%	10%	0%	0%	0%	0%	5%	31%	0%	0%	0%	0%
24	20%	12%	0%	0%	0%	0%	10%	36%	0%	0%	0%	0%
0	29%	15%	0%	0%	0%	0%	15%	41%	0%	0%	0%	0%

Month

Need (MW)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
215	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
191	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%
167	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	3%	2%	0%	0%	0%	0%	0%	0%	0%
143	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	3%	3%	2%	2%	0%	0%	0%	0%	0%	0%
119	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	3%	3%	5%	3%	3%	0%	0%	0%	0%	0%	0%
96	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	3%	3%	3%	5%	7%	3%	0%	0%	0%	0%	0%	0%
72	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	3%	3%	3%	7%	12%	7%	2%	0%	0%	0%	0%	0%
48	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	3%	3%	5%	8%	15%	15%	7%	0%	0%	0%	0%	0%
24	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	3%	3%	3%	7%	10%	20%	17%	10%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	3%	3%	5%	7%	14%	22%	22%	14%	7%	0%	0%	0%	0%

Hour Ending

7. Analysis of Alternatives

This study compares alternatives to meeting the identified near-, mid-, to long-term supply capacity requirements for the areas of Peterborough to Quinte West and Ottawa. The alternatives considered include both traditional transmission wires type reinforcements aimed at improving the FIDS and FIO interface transfer limits as well as non-wire alternatives (NWAs) such as generation, battery energy storage systems (BESS), demand response, etc.

Non-wire Alternatives

For each need where NWAs are potentially suitable, the demand profiling methodology is used to characterize the need and inform options analysis. The development of NWAs takes into consideration a number of factors, such as:

- Maximizing the use of existing infrastructure and resources in the region (e.g., merchant generation, generators with expiring contracts, etc.) to defer transmission and/or generation investment.
- New generation and/or storage with the attributes that most closely meet the need, or integrated solutions in combination with demand response or energy efficiency measures.
- New transmission facilities to deliver provincial resources.

NWA selection is based on capacity (MW) and energy requirements (MWh). The need characteristics are quantified by capacity factors and the energy-not-served (ENS) profile which is the forecast hourly demand above the load meeting capability that can be served by the existing power system in a specified area. The ENS profile is not static over the planning horizon, allowing NWAs to be installed in modular and discrete blocks as demand grows. Transmission solutions and non-energy-limited resources can primarily be sized based on the power capacity requirements alone, however energy-limited resources must also consider the energy requirement and temporal patterns. For example, BESS must be sized such that the energy reservoir has enough storage capability to withdraw enough energy overnight, and inject it the next day with enough capacity to meet demand.

The capacity and energy requirements evolve as demand grows and influences the feasibility and economics of various NWAs. In general, potential options that are known to satisfy technical requirements and have the lowest cost tend to be screened for suitability first. The NWA should aim to cost-effectively meet the need on an equivalent dollar and reliability basis. Calculating the levelized unit capacity cost provides a means of assessing alternative options for planning purposes and is generally used as a screening tool to shortlist resources for more detailed analysis. The calculation considers factors such as overnight capital costs, fixed operating, maintenance and administrative (OM&A) costs, variable OM&A costs, etc.) amortized across the NWAs lifetime.

Cost estimates for NWAs are based on benchmark capital and operating cost characteristics for each resource type and size. Generally speaking, the most cost-effective transmission-connected options for meeting local needs are resources with costs on par with simple cycle gas turbines (SCGT) generators or BESS, depending on the relative size of the facility and the capacity factor. New natural gas-fired generation was considered in the economic analysis for illustrative purposes to represent the cost of new generation. BESS are also becoming cost competitive due to declining technology costs and the expectation of carbon prices increasing in line with federal policy.

NWAs also provide bulk system capacity and energy benefits and are taken into consideration as part of the cost analysis. Bulk system capacity benefits are considered in each year capacity is required and is based on the capacity auction reference price. The reference price is the estimated Net Cost of New Entry (Net CONE) of the anticipated lowest cost marginal resource in Ontario that would be developed when new generation is required. Bulk system energy benefits are considered for any instance where the NWA displaces higher marginal cost resources.

Energy Efficiency

Energy efficiency is a low cost resource that offers tremendous benefits for individuals, businesses and the power system as a whole. Energy-efficiency programs help reduce the need for new investments in power plants and transmission lines.

The IESO offers a number of Conservation and Demand Management (CDM) programs as part of the 2021-2024 CDM Framework under the Save on Energy brand. In order to address regional and local system needs, the IESO can also assess the potential for savings opportunities incremental to these current initiatives that are cost effective based on system benefits and can be leveraged to help defer or compliment wires infrastructure and ensure system reliability.

As described in Section 6, a capacity requirement exists in Peterborough to Quinte West area today and is forecast to appear in the Ottawa area by 2025. As the timing of the needs are in the near-term and with the magnitude of the needs being substantial (upwards of 100 MW within the first 10 years), incremental energy efficiency was considered in this assessment as a potential compliment to other solutions, not as a stand-alone solution.

7.1 Alternatives Considered

In total there were six packages of solutions put together to form the basis of the alternatives considered. Each package comprises of a combination of solutions described in this report. The packages are shown in Table 4**Error! Reference source not found.**.

Table 4 | Gatineau Corridor EOL Study Solution Packages

	T22C & T33E	Peterborough to Quinte West Area Improvements	Peterborough to Quinte West LMC	Ottawa Area Improvements	Ottawa LMC	Cost (2021 $M)
1	Refurbish	Two 230 kV circuits from Dobbin TS to Clarington TS/Cherrywood TS	440 MW	Pursue targeted energy efficiency	1950 MW	$600M-$650M
2	Retire	Two 230 kV circuits from Dobbin TS to Clarington TS/Cherrywood TS	440 MW	Two 230 kV circuits from St. Lawrence TS to Merivale TS Pursue targeted energy efficiency	2050 MW	$725M-$775M
3	Retire	Two 230 kV circuits from Dobbin TS to Clarington TS/Cherrywood TS	440 MW	One 500 kV circuit from St. Lawrence TS to Hawthorne TS	2150 MW	$875M-$925M
4	Refurbish	175 MW resource at/near Dobbin TS	390 MW	Pursue targeted energy efficiency	1950 MW	$1,150M-$2,000M
5	Retire	Two 230 kV circuits from Dobbin TS to Clarington TS/Cherrywood TS	440 MW	480 MW resource at/near Hawthorne TS	2180 MW	$875M-$1,725M
6	Retire	225 MW resource at/near Dobbin TS	390 MW	480 MW resource at/near Hawthorne TS	2180 MW	$2,150M-$4,150M

Transmission Reinforcement into Peterborough

Transmission reinforcement into Peterborough involves a new transmission line between Dobbin TS in Peterborough and either Cherrywood TS in Pickering or Clarington TS in Oshawa. With four (4) 230 kV transmission circuits interconnecting Cherrywood TS and Clarington TS, and the presence of 500-230 kV auto-transformation at both stations, the two stations are quite similar from an electrical supply perspective.

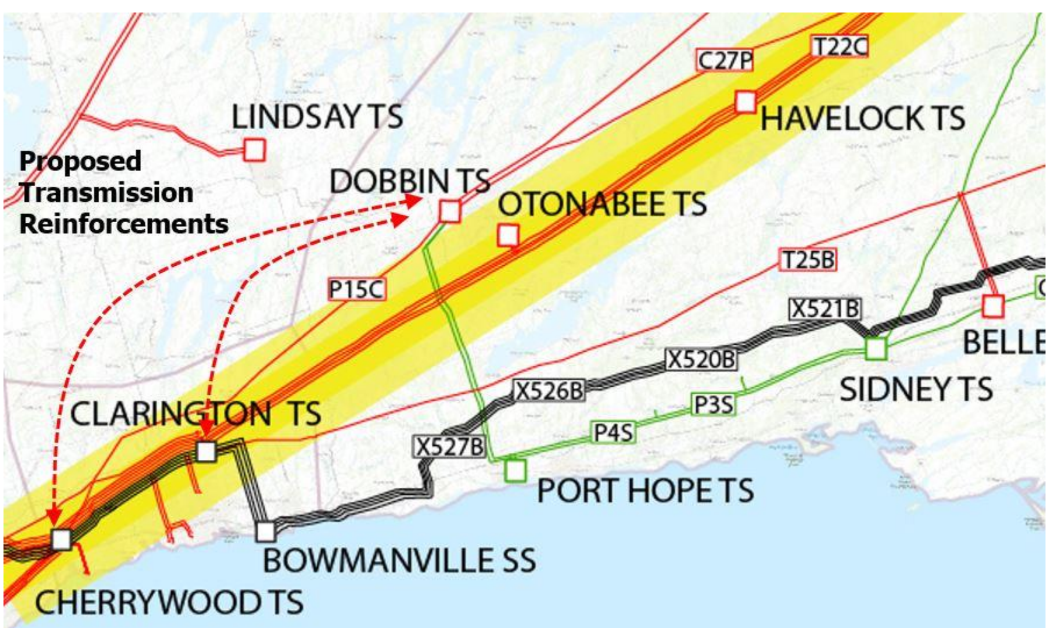
There are different variations to how this transmission reinforcement could be achieved. Each variation comparably increases the Peterborough to Quinte West LMC to approximately 440 MW. This improved capability sufficiently accommodates the 20-year planning forecast which reaches a maximum of 370 MW. As such, in addition to accommodating the planning forecast, the transmission reinforcement alternative provides additional flexibility and resiliency in meeting future changes in demand. The transmission reinforcement into Peterborough also mitigates the upstream thermal constraints limiting Ottawa for the duration of the 20-year planning forecast.

The variations of this transmission reinforcement include:

- Rebuild an existing single circuit 230 kV line from Cherrywood TS (Pickering) to Dobbin TS (Peterborough) into a double circuit 230 kV line
- Build a new double circuit 230 kV transmission line from Cherrywood (Pickering) TS to Dobbin TS
- Build a new double circuit 230 kV transmission line from Clarington TS (Oshawa) to Dobbin TS

A map showing the transmission reinforcement to Peterborough is shown in Figure 9.

Figure 9 | Map of Proposed Transmission Reinforcement Options into Peterborough



As the variations are currently comparable from a cost, scope[6], and capability perspective, each variation should be further examined during the project development and project approval stages led by the transmitter[7] in order to select the preferred variation.

Resource in Peterborough to Quinte West

A new resource located in the Peterborough to Quinte West area was considered as a NWA to the transmission reinforcement into Peterborough. The resource requirements can range depending on whether the transmission lines T22C and T33E are refurbished or decommissioned. Decommissioning the transmission lines will increase the flows from GTA east to Ottawa and through the P15C and C27P transmission lines. The analysis identified a SCGT facility (175 MW) as the most feasible non-wire alternative if T22C/T33E are refurbished. Alternatively, the analysis identified a CCGT (225 MW) as the most feasible non-wire alternative if T22C/T33E are decommissioned. Additional alternatives involving hybrid BESS and wind were also examined. A BESS solution would be deployed modularly in discrete blocks as demand grows.

Refurbishment of T22C and T33E into Ottawa

This option involves refurbishing the EOL transmission lines T22C from Clarington TS to Chats Falls TS, and T33E from Clarington TS to Almonte TS. While this option appears to maintain the existing transmission supply to Ottawa, the LMC for Ottawa is improved to 1950 MW through the addition of a new RAS, and the mitigation of the upstream thermal limitations on P15C through either the transmission reinforcement into Peterborough or a new resource in the Peterborough to Quinte West area. A new LMC of 1950 MW accommodates the forecast demand in Ottawa up to year 2037 based on the reference forecast.

Transmission Reinforcement into Ottawa

The transmission reinforcement into Ottawa involves a new transmission line between St. Lawrence TS in Cornwall and either Merivale TS (230 kV transmission line) or Hawthorne TS (500 kV transmission line) which are both in Ottawa. The two variations to how this transmission reinforcement can be achieved are comparable as they both strengthen the tie between the Ottawa area and the Cornwall area which has a sizeable amount of hydro-electric generation. The variations of this transmission reinforcement include:

- Build a new double circuit 230 kV transmission line from St. Lawrence TS (Cornwall) to Merivale TS (Ottawa)
- Build a new single circuit 500 kV transmission line from St. Lawrence TS (Cornwall) to Hawthorne TS (Ottawa)

---

[6] A new transmission line originating from Cherrywood TS is assumed to repurpose existing breaker positions at Cherrywood TS currently serving Pickering GS which is planned for retirement between 2024-2026.

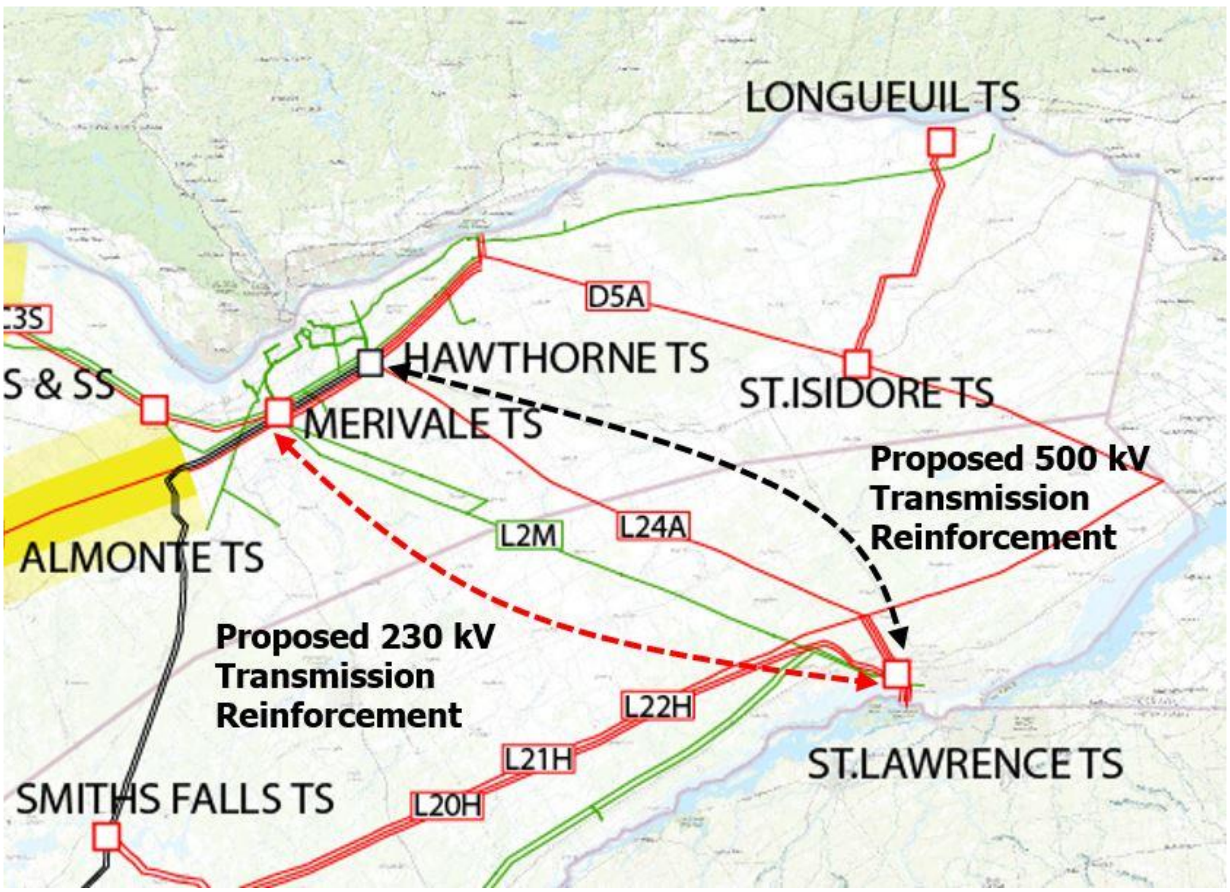
[7] New transmission lines in Ontario are subject to the Environmental Assessments ("EA") Process where line routing will be assessed and evaluated, interested parties will have an opportunity to provide input on line routing to the transmitter as part of the EA (Ontario Government Website link)

Both variations enable the opportunity for decommissioning the two EOL transmission lines T22C and T33E. The variations are quite comparable to each other, the 500 kV transmission line option offers an incremental capacity improvement of 100 MW at an incremental cost of approximately $150M.

A new 230 kV transmission line into Merivale TS will increase the Ottawa LMC to 2050 MW which will accommodate the forecasted demand in Ottawa up to year 2039, while a new 500 kV transmission line into Hawthorne TS increases the Ottawa LMC to 2150 MW which will accommodate the forecasted demand in Ottawa up to year 2041.

A map showing the Ottawa transmission reinforcements is shown in Figure 10.

Figure 10 | Map of Transmission Reinforcement Options for Ottawa



Resource in Ottawa

A new resource located in the Ottawa area was considered as a NWA to the refurbishment of T22C/T33E or the transmission reinforcement into Ottawa. The analysis identified a SCGT facility (480 MW) as the most feasible non-wire alternative. Additional alternatives involving hybrid BESS and wind were also examined. A BESS solution would be deployed modularly in discrete blocks as demand grows.

Remedial Action Schemes

For all solution packages, a Remedial Action Scheme (RAS) will be relied upon to help accommodate the forecasted demand. RASs (formerly named Special Protection Systems) are utilized to expand the capability of the transmission system and maximize the benefits of the transmission system equipment. The use of RAS's are governed by applicable planning criteria[8]. The two RASs identified, one for Peterborough to Quinte West and another for Ottawa, are both load rejection based schemes that will disconnect up to 150 MW when two or more power system elements are out of service (i.e. two transmission circuits are unavailable). Load rejection or load shedding schemes exists in both areas today, however the schemes will require modifications/updates to accommodate the forecasted demand.

7.2 Energy Efficiency

As discussed earlier, incremental energy efficiency was considered in this assessment as a compliment to other solutions. This section aims to quantify the energy efficiency opportunities in Ottawa.

In 2019, the IESO and the Ontario Energy Board completed the first integrated electricity and natural gas achievable potential study in Ontario (2019 APS)[9]. The main objective of the APS was to identify and quantify energy savings (electricity and natural gas) potential, GHG emission reductions and associated costs from demand side resources for the period from 2019-2038. The study shows a significant and sustained potential for energy efficiency across all sectors and is used to inform:

- future energy efficiency policy and/or frameworks;
- program design and implementation; and
- assessments of Conservation and Demand Management (CDM) non-wires potential in regional planning.

The APS study is used to determine an estimate of the remaining system cost-effective energy efficiency potential for planning study areas when accounting for existing provincial programs, federal program and savings from codes and standards.

In order to determine which needs should be evaluated for the use of energy efficiency as a solution, a screening mechanism was applied, in accordance with the IESO's standard criteria which includes consideration of factors such as the timing and magnitude of the need, its size relative to total forecasted demand, and coincidence with provincial system peak. The potential for energy efficiency to help address the identified needs was assessed for the Ottawa area supply capacity need, but not the Peterborough to Quinte West need, due to the timing and magnitude of the need identified.

---

[8] Usage of RAS is governed by IESO's Ontario Resource Transmission Assessment Criteria (link), NERC's Transmission System Planning Performance Requirements – (link), and NPCC's Directory # 1 Design and Operation of the Bulk Power System (link).

[9] More information about the 2019 Conservation Achievable Potential Study is available on the IESO website (link)

7.2.1 Energy Efficiency Potential in Ottawa

As part of the analysis developed for the 2020 Integrated Regional Resource Plan for the Ottawa sub-region, the IESO estimated that energy efficiency has the potential to reduce demand by approximate 1% per year on average in the Ottawa zone based on the 2019 APS results. These opportunities are reduced in the near term by existing CDM commitments while new opportunities increase in the medium term, following conclusion of the 2021-2024 CDM framework. The cumulative maximum achievable potential savings is shown in Figure 11 and Figure 12.

Note that the portion of the maximum achievable potential that is committed is included in the planning forecast shown in Figure 4.

Figure 11 | Cumulative Maximum Achievable Zonal Potential as a Share of Consumption

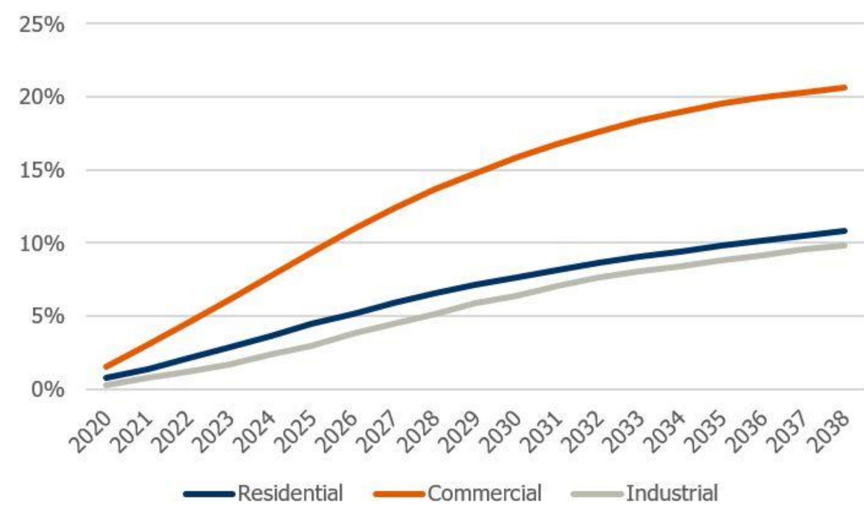
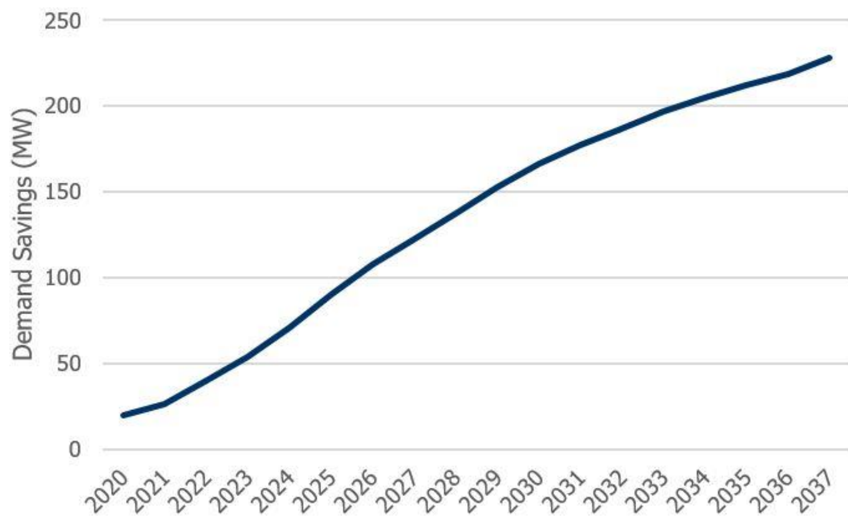


Figure 12 | Cumulative Maximum Achievable Zonal Potential as a Share of Consumption Net of Committed Savings

Uncommitted cumulative CDM potential that is cost effective based on avoided provincial system energy and capacity costs for stations within the FIO interface is presented in Figure 13. The estimated cost to deliver these savings is $587 million dollars over the forecast period.

Figure 13 | Uncommitted CDM Potential in Ottawa



Ongoing Energy Efficiency Activities in Ottawa

The IESO is currently delivering province-wide Save on Energy-branded CDM programs in the Ottawa area as part of the 2021-2024 CDM Framework to encourage the adoption of energy efficiency process and technologies in businesses and communities.

Additionally, as part of the 2021-2024 CDM Framework,[10] the IESO was directed to deliver a new competitive program to target additional CDM incremental to the province-wide programs to address regional and/or local system needs. The Local Initiative Program,[11] is now one tool that is available to target the delivery of additional CDM savings at specific areas of the province with identified system needs. The IESO is currently working with Hydro Ottawa to develop a Local Initiative Program procurement in order to begin targeting incremental savings opportunities described above and previously highlighted in the 2020 Ottawa IRRP.

As part of the 2021-2024 CDM Framework Mid-Term Review[12] published in December 2022, the IESO reviewed the scale of the opportunity for CDM to be targeted to address regional or local needs, available tools for targeting CDM, and the opportunities for LDCs to building on IESO CDM programs where they can add value to the distribution system. Based on accelerated findings, the Minister of Energy approved a number of IESO recommendations in October 2022, including Local Initiative Program enhancements to reduce barriers to participation and to add flexibility for incentives for DER solutions. The IESO should continue to explore opportunities to target savings in the Ottawa and Peterborough to Quinte regions in order to help address these emerging bulk and regional system needs.

---

[10] More information about the 2021-2024 CDM Framework is available on the IESO website (link).

[11] More information about the Local Initiative Program is available on the IESO website (link).

[12] More information about the 2021-2024 CDM Framework Mid-Term Review is available on the IESO website (link).

7.3 Comparison of Alternatives

7.3.1 Technical Comparison

A transmission reinforcement to Dobbin TS in Peterborough, regardless of whether the transmission line comes from Cherrywood TS in Pickering or Clarington TS in Oshawa, accommodates the 20-year long-term forecast for Peterborough to Quinte West. In addition, the transmission reinforcement provides an additional 70 MW of supply capacity for the area beyond the current demand forecast. This margin will allow for additional growth beyond the forecast and enables the area to better respond to demand forecast changes (i.e. greater penetration of electrification, industrial/manufacturing growth).

Furthermore, the current limiting constraint to Ottawa's LMC is the upstream thermal overload of P15C. The transmission reinforcement to Dobbin TS in Peterborough not only addresses the Peterborough to Quinte West need, but also addresses this upstream thermal limitation for Ottawa.

Lastly, if the proposed transmission reinforcement originates from Cherrywood TS in Pickering, the new transmission line may potentially benefit new load connections in the northern areas of Pickering, Whitby, and Oshawa around and north of highway 407 further into the future.

In comparison, the resource alternative to address this upstream thermal overload will require a resource between 175 and 225 MW, which will need to run frequently (30% of hours by year 10 of the forecast and 80% of hours by year 20 of the forecast). The analysis considered a CCGT facility and hybrid storage facility (BESS with wind) as the most feasible NWA alternatives due to the energy requirements.

With the upstream thermal overload of P15C resolved, either by the transmission reinforcement to Dobbin TS or the resource alternative, the focus becomes addressing the voltage instability issue and the forecast capacity requirements in Ottawa. Refurbishing the EOL transmission lines T22C and T33E mostly maintains the status quo. The improvement in the LMC to 1950 MW is mostly attributed to mitigating the upstream thermal overload of P15C and the addition of a load rejection RAS in Ottawa.

The second transmission alternative, building a new double circuit 230 kV transmission line from St. Lawrence TS in Cornwall to Merivale TS in Ottawa provides a small improvement to the voltage instability issue and increases the Ottawa LMC to 2050 MW. While this alternative introduces a new 230 kV supply into west Ottawa which would help in the resiliency of supplying west Ottawa loads, by not refurbishing T22C and T33E, part of that improvement is counteracted by the decommissioning.

The third transmission alternative, building a new single circuit 500 kV transmission line from St. Lawrence TS in Cornwall to Hawthorne TS in Ottawa, provides another small improvement to the voltage instability issue and increases the Ottawa LMC to 2150 MW.

The three transmission alternatives result in varying Ottawa LMCs of 1950, 2050, and 2150 MW. With the three alternatives, the improvement in LMC will be able to accommodate the reference Ottawa demand forecast up to year 2037, 2039, and 2041 respectively. While the alternative to refurbish T22C and T33E results in the lowest Ottawa LMC out of the three, maintaining the status quo helps preserve the capacity that T22C and T33E provides to Ottawa, which in the future can be combined with a new transmission line reinforcing Ottawa that may be needed in the future to accommodate a high growth scenario (i.e. such as electrification).

The resource alternative is sized to meet the demand forecast. Depending on the technology, if a BESS were implemented, the resource could also be installed in modules as the demand grows.

7.3.2 Cost Comparison

The IESO compared the net present value (NPV 2021$) of total costs and benefits for various alternatives required to address the Peterborough to Quinte West and Ottawa supply capacity requirements.

This economic evaluation was based on available cost estimates for similar sized resources and planning estimates for the proposed transmission facilities constructed based on similar past projects. The costs for each solution package are summarized in Table 4. More information regarding cost assumptions is described in Appendix D.

The three transmission only packages (1 through 3) are very comparable in cost, with incremental steps in cost resulting in incremental steps in supply capacity for Ottawa.

The three other packages (4 through 6) represent a hybrid comprising of both transmission and resources (SCGT/CCGT, BESS, and wind) and also an all resources based solution (SCGT/CCGT, BESS, and wind). The wide range in costs shown here reflects the cost difference between a SCGT/CCGT and a BESS and wind combination.

As mentioned earlier, both NWSs and EE provide bulk system capacity and energy benefits and have been taken into consideration as part of the cost analysis.

Based on the technical and cost comparison presented in this section, the IESO recommends solution package #1 to address the EOL needs in the Gatineau corridor and the supply capacity needs in Peterborough to Quinte West and Ottawa. This is further described in section 10 of the report.

8. Linkages with Regional Planning

Bulk system planning as shown in Figure 14 is just one form of electricity planning that is undertaken in Ontario, with the others being regional planning and distribution planning.

Figure 14 | Electricity Planning in Ontario

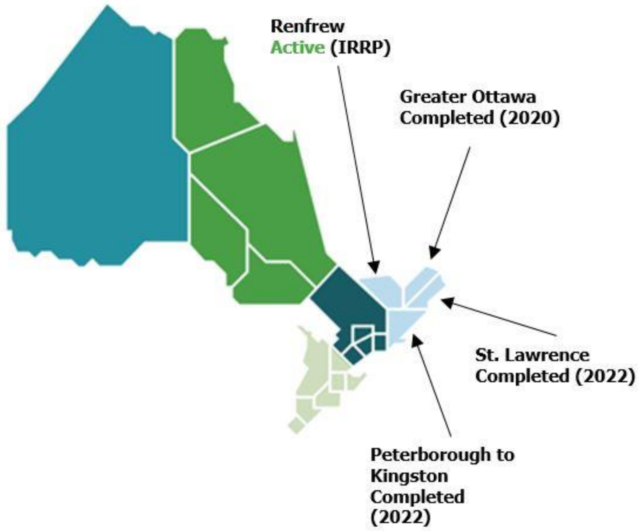
Planning at the bulk system level typically considers the 230 kV and 500 kV network and examines province-wide system issues. In addition to considering major transmission facilities or "wires," bulk system planning assesses the resources needed to adequately supply the province. This type of planning is typically carried out by the IESO pursuant to government policy. Distribution planning, which is carried out by local distribution companies (LDCs), considers specific investments in an LDC's territory at distribution-level voltages.

Regional planning can overlap with bulk system planning and with the distribution planning of LDCs. For example, overlaps can occur at interface points where there may be regional resource options to address a bulk system issue or when a distribution solution addresses the needs of the broader local area or region, making it important for regional planning to be coordinated with both bulk and distribution system planning.

By recognizing the linkages between bulk, regional and distribution system planning, and coordinating the multiple needs identified over the long term, a comprehensive assessment of electricity needs can be carried out to develop integrated solutions that can address multiple needs.

As a result of the Gatineau corridor being approximately 350 km long, it has linkages with a number of different regions in southern Ontario including Greater Toronto Area East, Peterborough to Kingston, Renfrew, and Ottawa. In this section, key linkages to some of these regions are described. A map illustrating the 21 planning regions in Ontario is shown in Figure 15, with the regions in the east highlighted.

Figure 15 | Planning Regions in Eastern Ontario



8.1 Peterborough to Kingston Region

Regional planning for Peterborough to Kingston was most recently completed in May 2022. This was the first cycle of regional planning for Peterborough to Kingston to reach the integrated regional resource planning and regional infrastructure planning stage where a more in depth examination of power system needs was carried out.

The regional studies identified transmission system issues that have linkages with the upstream transmission system and specifically the Gatineau Corridor EOL Study. The recommended option also addresses the voltage issues on the 115 kV system identified in the 2021 Peterborough to Kingston IRRP[13].

In addition to the coordinated approach to issue identification, the regional planning activities allowed the IESO to obtain very detailed load forecasts that were developed by the Peterborough to Kingston regional planning working group along with valuable insight from the local distributors. The Peterborough to Kingston regional planning load forecast directly informed the load forecast used for the Peterborough to Quinte West area in the Gatineau Corridor End-of-Life study.

8.2 Greater Ottawa Region

Regional planning for Greater Ottawa was most recently completed in December 2020. Through those regional studies, capacity issues with the bulk transmission supply to the Ottawa 115 kV system were identified. This led to a series of near-term actions being recommended through the Ottawa Area IRRP which included:

---

[13]More information about these transmission issues are available in section 6 of the Peterborough to Kingston IRRP (link).

- Advancing the EOL replacement of the 230-115 kV auto-transformer T22 at Merivale TS which will result in a slightly higher supply capacity
- Triggering of a broader Ottawa 115 kV System Study to be carried out by the IESO (study ongoing)
- Pursue system cost effective energy efficiency in the Ottawa 115 kV system area

In recent months, through discussion with the Greater Ottawa regional planning working group, the IESO was informed of substantial load growth emerging in various areas across the City of Ottawa. The size and aggressive timing of the load growth resulted in the working group's decision to trigger the next cycle of regional planning early (expected to commence in Q4 2022).

Through the next cycle of regional planning, a new detailed 20-year planning forecast will be developed to assess transmission system supplying Greater Ottawa. Further, as described earlier in section 4.2, Ottawa's city council approved the Energy Evolution strategy on October 28, 2020. The impact of Energy Evolution on the peak electricity demand has yet to be quantified and has not been incorporated into the various bulk or regional planning forecasts. The impacts of Energy Evolution on electricity demand will be further explored as part of this next cycle of regional planning.

Depending on the outcomes of regional planning, additional reinforcements to the bulk transmission system may need to be triggered earlier then currently forecast.

8.3 Greater Toronto Area East

One of the alternatives to addressing the supply capacity issues for Peterborough to Quinte West involves a new transmission line between Dobbin TS in Peterborough and either Cherrywood TS in Pickering or Clarington TS in Oshawa. As indicated in section 7.3.1 the two stations Clarington TS and Cherrywood TS are electrically quite similar in terms of their ability to provide capacity improvements to the Peterborough to Quinte West areas.

However, the option to terminate at Cherrywood TS may have the added benefit of improving the load meeting capability of the local area, namely northern Pickering and Whitby. Based on recent discussion between the IESO and Elexicon Energy, the LDC for this area, updated growth forecasts may trigger the need for additional supply meeting capability in the mid term.

Although growth rates and preferred alternatives for meeting any ensuing needs have not been established through the regional planning process, the Cherrywood connection option offers additional flexibility by accommodating a greater range of future load growth scenarios.

The IESO will continue discussions with the GTA East regional working group members to determine if there is need to trigger the next cycle of regional planning early.

9. Engagement

The IESO has developed and is transitioning to a formalized process[14] for bulk system planning to enhance transparency and opportunities for purposeful engagement and input. As part of that work, defining how stakeholders can participate in the electricity planning process and be kept informed has been identified as a critical component of the process design. Providing opportunities for input in the transmission planning process enables the views and preferences of communities and stakeholders to be considered in the development of the plan, and helps lay the foundation for successful implementation. The IESO has endeavored to encompass those principles throughout the Gatineau Corridor EOL study work. This section outlines the engagement principles as well as the activities

9.1 Engagement Principles

The IESO's engagement principles[15] help ensure that all interested parties are kept informed and enables opportunities for purposeful engagement to contribute to electricity planning initiatives such as the development of this Gatineau Corridor EOL planning study. The IESO adheres to these principles to ensure inclusiveness, sincerity, respect and fairness in its engagements, striving to build trusting relationships as a result.

Figure 16 | The IESO's Engagement Principles

[14] More information about the bulk planning process is available on the IESO website (link).

[15] More information about the IESO's engagement principles are available on the IESO website (link).

9.2 Engagement Approach

To ensure that the bulk plan reflects the needs of Indigenous communities, community members and interested stakeholders, engagement involved:

- Leveraging the East Ontario Bulk Planning Initiatives[16] engagement webpage on the IESO website to post updated information, engagement opportunities, meeting materials, input received and IESO responses to the feedback;
- Regular communication with communities, stakeholders and interested parties through email, East Ontario Electricity Network updates[17], and IESO weekly Bulletin;
- Public webinars; and
- Targeted outreach throughout plan development with municipalities, customers, Indigenous communities and rights-holders, and those with an identified interest in the Gatineau Corridor area.

The Gatineau Corridor EOL study was initiated prior to the IESO implementing a formalized bulk planning process. However, as part of implementation of the new process, three public webinars (two targeting all interested parties and one specifically targeting Indigenous Communities) were held at the remaining major junctures of plan development to give interested parties an opportunity to understand the scope of the study and provide comments on the proposed recommendations.

The webinars received strong participation with cross-representation of stakeholders and municipal and Indigenous community representatives in attendance, and submitting written feedback during a 21-day comment period.

Comments received during this engagement focused on the following major themes:

- **Forecast Risk in Ottawa:** Interest was expressed in better understanding how the study will ensure that Ottawa is positioned to meet emerging electricity needs, in particular needs driven by the City's decarbonisation plans.
- **Resource Cost Assumptions:** Feedback received indicated that updated market information should be incorporated into the study's cost assumptions. A suggestion was provided that the upcoming procurements may allow the IESO to gain a better sense of the current cost of storage for use in future assessments.
- **Scope of Transmission Alternatives:** Questions from engagement participants indicated a general desire to better understand the scoping of the study, and the associated options analysis. In particular, interested parties wanted to understand why the IESO did not consider various wires and non-wire alternative transmission options as part of the study.
- **Consideration of Emerging Growth in GTA East:** Targeted outreach with Elexicon and Durham Region identified emerging load growth in north Whitby that may trigger new load station development.

Based on the engagement discussions and feedback received, it is clear that interested parties want to ensure that the IESO is incorporating the best available information into the study analysis and

---

[16] More information about East Ontario Bulk Planning Initiatives is available on the IESO website (link).

[17] More information about the East Ontario Electricity Network is available on the IESO website (link).

recommendation so that the final recommendation meets Ontario's future electricity needs and priorities. Section 7 of the report includes the analysis of alternatives.

The bulk planning process is continuing to evolve. The IESO will work to increase transparency and cost discovery around transmission versus generation decision making as resource acquisition mechanisms continue to mature. Outcomes of this engagement will also be incorporated in other related electricity planning work and regional planning processes, such as the next GTA East regional planning cycle.

All background information, including engagement meeting presentations, recorded webinars, detailed feedback submissions, and responses to comments received, are available on the IESO's East Ontario Bulk Planning Initiatives engagement webpage.

9.3 Bringing Communities to the Table

The IESO held meetings with communities to seek input on local planning priorities and initiatives that should be taken into consideration in the development of this bulk plan. At major milestones in the study development process, targeted discussions were held with the upper- and lower-tier municipalities both in the East Ontario planning regions as well as in the adjacent GTA East planning area to discuss study recommendations. These meetings helped to inform electricity needs at the municipal/community-level, develop options and recommended solutions, and further build and strengthen local relationships for ongoing dialogue beyond this bulk process.

9.4 Engaging with Indigenous Communities

As part of the engagement process, the IESO reached out to Indigenous communities in and near the Eastern Ontario planning area throughout the development of the plan. Those invited to participate included: Alderville; Algonquins of Ontario (AOO Consultation Office); Algonquins of Pikwakanagan; Association of Iroquois and Allied Indians; Beausoleil; Chippewas of Georgina Island; Chippewas of Rama; Curve Lake; Haudenosaunee Confederacy Chiefs Council; Haudenosaunee Development Institute; Hiawatha; Huron-Wendat Nation; Mississaugas of Scugog Island; Mohawk Council of Akwesasne; Mohawks of the Bay of Quinte; Ogemawahj Tribal Council; MNO High Land Waters Métis Council; MNO Oshawa and Durham Region Métis Council; MNO Ottawa Region Métis Council; and MNO Peterborough and District Wapiti Métis Council.

A webinar for Indigenous communities was held on April 13, 2022. To ensure the invited communities had ample opportunity to participate, after the webinar concluded the presentation deck was emailed to them along with an invitation and registration information for a general webinar that was held on April 14, 2022. Feedback was received from the Haudenosaunee Development Institute which was posted along with the other received feedback on the IESO's engagement page for Bulk Electricity Planning - East Ontario under the entry for May 5, 2022. A general webinar was held on August 11, 2022, an invitation email was sent to the communities on July 19. A link to the materials for East Ontario planning was included and communities were informed that a feedback/comment period would be open until September 1, 2022.

The IESO remains committed to an ongoing, effective dialogue with communities to help shape long-term planning in regions in Ontario.

10. Conclusions and Recommendations

To minimize cost, minimize land-use impacts, mitigate forecast risk, preserve options to increase system capability in the future and due to lack of cost effective stand-alone resource or energy efficiency alternatives, the solution package #1 from Table 4 is recommended to address the transmission equipment EOL needs and accommodate the demand forecast for the Ottawa and the Peterborough to Quinte West areas over the long-term. Solution package #1 includes:

- Refurbish all 800 km of 230 kV circuits on the Gatineau Corridor identified as nearing EOL
- Build a new double circuit 230 kV transmission line into Dobbin TS (in Peterborough) from either Cherrywood TS (in Pickering) or Clarington TS (in Oshawa) with a planned in-service of 2029
- Pursue up to 230 MW of additional system cost-effective energy efficiency in the Ottawa area over the 20 year planning horizon, while monitoring demand growth and resource acquisition activities in the Ottawa zone
- Update and expand the use of remedial action schemes (RAS) in the Peterborough and Ottawa areas to meet planning standards and further improve both areas' LMCs

This solution package represents the lowest cost option, with transmission reinforcements estimated to cost approximately $650 M. The transmission reinforcements ensure reliability in the Peterborough to Quinte West area is sufficient for the next 20 years and reliability in the Ottawa area is sufficient until 2037. If the 230 MW of additional energy efficiency is implemented, the Ottawa area's reliability would also be sufficient over the long-term. By refurbishing the existing Gatineau transmission lines and maintaining the supply capacity these lines provide Ottawa, this preserves the ability to further expand the LMC of Ottawa in the future with new transmission from Cornwall, when required. While there exists some load forecast uncertainties (high growth scenarios such as electrification of vehicles, heating, etc.) that, if materialized, can result in the need for additional improvements in the Ottawa area, this solution package lays the foundation to build on. Transmission planning in Ottawa will continue with the next cycle of regional planning scheduled to begin in Q4 2022.

Beyond monitoring load growth to trigger future system reinforcements when they are required, there are additional options with shorter lead times which could contribute to meeting Ottawa's supply capacity needs should they arise under a high growth scenario, including use of imports from Quebec, local demand response, BESS, and targeting additional energy efficiency in Ottawa.

Lastly, as presented in this report, the new transmission line into Dobbin TS can originate from either Cherrywood TS in Pickering or Clarington TS in Oshawa. While both routes are comparable in terms of addressing the needs for Peterborough to Quinte West and Ottawa, a new transmission line originating from Cherrywood TS may provide additional benefits for potential load connections in the Pickering and Whitby areas. Regional planning for the GTA East region is currently in-between planning cycles (in-active), however the working group members remain engaged in discussion to help inform the final line routing decision.

Appendix A – Planning Assessment Criteria

In developing this bulk plan, the IESO followed a number of steps including:

- Data gathering, including development of electricity demand forecasts;
- Conducting technical studies to determine electricity needs and the timing of these needs;
- Developing potential options; and
- Preparing a recommended plan including actions for the near and longer term.

Throughout this process, engagement was carried out with stakeholders interested in the area, in the form of public webinars and targeted discussions with the affected communities, local distribution companies and transmitters.

This bulk report documents the inputs, findings and recommendations developed through the process described above and provides recommended actions for the various entities responsible for plan implementation. The report helps ensure that recommendations to address near-term needs are implemented, while maintaining the flexibility to accommodate changing long-term conditions.

The overall objectives of planning are consistent among both regional and bulk planning, which are the following:

- Ensure reliability and service quality;
- Enable economic efficiency; and
- Support sector policy and decision making.

There are various reliability standards which, as the electricity system planner and operator, the IESO is obliged to meet. NERC and NPCC membership requires the bulk system be planned to consider specific operating conditions, such as peak and light load, and a set of contingencies to ensure the bulk system is planned reliably and meets standards. Additionally, the IESO is required to demonstrate its adherence to these standards through compliance reporting.

Reliability standards require the IESO to define its own performance criteria to meet under the conditions and contingencies specified. The Ontario Resource and Transmission Assessment Criteria (ORTAC) define the planning performance criteria for Ontario which are more specific and/or more stringent standards than NERC/NPCC. The IESO also considers operational issues and solutions that simultaneously consider bulk system reliability needs, regional needs, and assets reaching end of life, as appropriate.

The study used the planning criteria in accordance with events and performance as detailed by:

- NERC TPL-001 "Transmission System Planning Performance Requirements" (TPL-001),
- NPCC Regional Reliability Reference Directory #1 "Design and Operation of the Bulk Power System" (Directory #1), and
- IESO Ontario Resource and Transmission Assessment Criteria (ORTAC).

In addition to meeting established criteria and standards, the IESO also seeks to enable economic efficiency and support sector policy. Bulk system planning has a role in ensuring policy objectives can be incorporated with maximum benefit to ratepayers, and in identifying opportunities for improving overall system economics, especially in a competitive environment. This includes seeking economic opportunities, such as reducing losses, congestion, or other service costs, facilitate intertie/trade requirements, and providing timely and relevant information to market participants to enhance their participation and decision making leading to greater market efficiency and competition. It also includes supporting policy implementation affecting the power grid, such as sensitivity analysis of the economic impact of carbon pricing policies on congestion costs, as well as considering community energy plans and goals.

Appendix B – Load Forecast and Supply Need Data

The following datasets are included in this section and are also available in the excel file provided:

- Ottawa peak demand forecasts
  - Table 4 & 5: Total coincident reference and high growth scenarios for summer and winter seasons
- Peterborough to Quinte West peak demand forecasts
  - Table 6: Total coincident reference scenario for summer season

Refer to the excel file provided for the following datasets:

- Table 7: Forecast Ottawa Hourly Load (2022 to 2042)
- Table 8: Forecast Peterborough to Quinte West Hourly Load (2019 to 2037)
- Table 9: Forecast Ottawa Hourly Capacity Need (2022 to 2042)
- Table 10: Forecast Peterborough to Quinte West Hourly Capacity Need (2019 to 2037)

Notes:

The planning forecast for the Ottawa area is aligned with the Ottawa Zone demand forecast from the 2021 Annual Planning Outlook (Ottawa planning area aligns with definition of the Ottawa Zone)[18]

The planning forecast for the Peterborough to Quinte West area is aligned with the Peterborough to Kingston Integrated Regional Resource Plan demand forecast (Peterborough to Quinte West need is more local in nature comprising of a small number of stations)[19]

---

[18] The 2021 Annual Planning Outlook is available on the IESO website (link).

[19] The 2021 Peterborough to Kingston IRRP is available on the IESO website (link).

Table 5 | Total Coincident Winter Ottawa Peak Demand Forecast (MW)

Forecast Scenario	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Reference Scenario	1505	1529	1552	1575	1601	1618	1644	1668	1696	1714	1729	1760	1788	1824	1857	1892	1931	1969	2020	2076
High Growth Scenario	1,505	1,533	1,562	1,591	1,625	1,651	1,686	1,720	1,758	1,790	1,817	1,857	1,893	1,930	1,963	2,008	2,054	2,101	2,142	2,184

Table 6| Total Coincident Summer Ottawa Peak Demand Forecast (MW)

Forecast Scenario	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Reference Scenario	1627	1650	1697	1722	1720	1713	1748	1788	1777	1828	1811	1824	1846	1905	1902	1961	1992	2027	2095	2170
High Growth Scenario	1,627	1,656	1,709	1,742	1,750	1,754	1,801	1,839	1,827	1,891	1,896	1,909	1,952	2,018	2,082	2,142	2,171	2,202	2,264	2,331

Table 7 | Total Coincident Summer Peterborough to Quinte West Peak Demand Forecast (MW)

Forecast Scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Reference Scenario	317	324	330	330	331	333	335	337	340	343	347	350	354	358	361	365	367	371

Appendix C – Assessment of Supply

The IESO assessed supply capacity requirements for Peterborough to Quinte West and Ottawa areas based on the details in the following sections.

Capacity Assessment

A deterministic approach was used to evaluate the need to improve the load meeting capability of the Peterborough to Quinte West and Ottawa areas. A need was identified where the annual coincident load forecast exceeded the total installed capacity of transmission-connected gas generation in winter or summer (discounted by seasonal derates) and the transmission interface transfer limits (FIDS and FIO).

For example, in the Ottawa supply capacity need is identified when the Ottawa demand is larger than the internal generation resources (70 MW, less derates and contract expiry) plus the transmission capacity into the Ottawa area (i.e., on the FIO interface).

The assessment considered the installed capacity of transmission-connected gas generation in winter or summer (discounted by seasonal derates). To be conservative, imports were not considered as part of this assessment (nor exports). The capability of hydro-electric generation is impacted by water levels which varies based on rainfall and snowmelt. The assessment considered the hydro-electric generation at output levels available during 98% of the time historically (i.e. dry conditions).

Appendix D – Economic Assessment Assumptions

The following is a list of the assumptions made in the economic analysis:

1. The NPV of the cash flows is expressed in 2021$ CAD.
2. The USD/CAD exchange rate was assumed to be 0.76.
3. Natural gas price forecast is as per Sproule Outlook @ Dawn used in the 2021 Annual Planning Outlook (APO).
4. The NPV analysis was conducted using a 4% real social discount rate. Sensitivities at 6% and 8% were performed. An annual inflation rate of 2% is assumed.
5. The life of the station upgrades was assumed to be 45 years; the life of the line was assumed to be 70 years; and the life of the generators and BESS was assumed to be 30 years and 15 years respectively. The life of the BESS was based on 3600 cycles, which is assumed to be used to serve the local need first, and then global energy and ancillary services for the rest of the year. Cost of asset replacement were included where necessary to ensure the same NPV study period.
6. Development timelines for transmission was assumed to be 7 years; development timelines for generation and BESS were assumed to be 3 years.
7. A SCGT and CCGT were identified as one of the lowest-cost gas generation resource alternatives, based on escalating values from a previous study independently conducted for the IESO.[20] A sensitivity of +/- 25% was assessed.
8. A BESS was identified as one of the lowest-cost resource alternatives. Total energy storage system costs are composed of capacity and energy costs (i.e. energy storage devices are constrained by their energy reservoir). Costs were based on escalating values from the 2022 NREL Electricity Annual Technology Baseline (ATB)[21]. A sensitivity of +/- 25% was assessed.
9. Sizing of the storage solution was based on meeting the peak capacity and peak energy requirements for the local reliability need, such that the reservoir size is capable of using existing gas resources to sufficiently charge to meet the hours of unserved energy.
10. System capacity value was $570/MW-day (2021$ CAD) based on the estimated Net Cost of New Entry (Net CONE) of the anticipated lowest cost marginal resource that would be developed in Ontario when new generation is required. A sensitivity of +/- 25% assessed.
11. Production costs were determined based on energy requirements to serve the local reliability need, assuming the fixed and variable operating & maintenance costs for the resource.

[20] New natural gas-fired generation was considered in the economic analysis for illustrative purposes to represent the lowest option of new generation.

[21] https://data.openei.org/submissions/4129

12. Carbon pricing assumptions are based on the Ontario Emissions Performance Standards (EPS) program, from $50/t in 2022 to $170/t by 2030, and applied to a new facility's production. A sensitivity of +100% was assessed.
13. The assessment was performed from an electricity consumer perspective and included all costs incurred by project developers, which were assumed to be passed on to consumers.
14. Planning estimates for the various transmission facilities assessed were constructed based on similar past projects with assistance from Hydro One. Transmission line refurbishment for a single circuit transmission line costs were assumed at $500k/km and new transmission line costs were assumed at roughly $3-4M/km.

Appendix E – Sizing Battery Energy Storage Systems

To determine the size requirements of BESS that could serve this local need, the dynamics of the need were investigated in detail to ensure that the potential BESS is able to sequentially charge/inject within the local limitations. The system was sized such that the reservoir would have enough storage capability to charge enough energy (MWh) overnight and inject it the next day, with enough capacity (MW) to shave the peak such that it never exceeds the transmission limit.

To accomplish this, a methodology was derived to size BESS for local needs. In general, the model inputs are the local load profile, local transmission limits to avoid, and local energy available for charging the BESS. These inputs are at the hourly granularity, and typically projected for many future years. The first step of the algorithm is to determine the largest peak power capacity requirement (i.e. the single hour where the local load is highest above the transmission limit) and the largest peak energy requirement (i.e. the largest amount of energy required to shave the biggest peak) for the year.

Independent Electricity
System Operator
1600-120 Adelaide Street West
1T1

Phone: 905.403.6900
Toll-free: 1.888.448.7777
E-mail: customer.relations@ieso.ca

ieso.ca

@IESO_Tweets
linkedin.com/company/IESO

Connecting Today.
Powering Tomorrow.