Ottawa Sub-Region:

Integrated Regional Resource Plan

Part of the Greater Ottawa Regional Planning Region

March 4, 2020

Connecting Today.
Powering Tomorrow.

Integrated Regional Resource Plan

Ottawa Sub-Region

This Integrated Regional Resource Plan (IRRP) was prepared by the Independent Electricity System Operator (IESO) pursuant to the terms of its Ontario Energy Board license, EI-2013-0066.

The IESO prepared the IRRP on behalf of the Ottawa Sub-Region Working Group (Working Group), which included the following members:

- Independent Electricity System Operator
- Hydro Ottawa Limited
- Hydro One Networks Inc. (Distribution)
- Hydro One Networks Inc. (Transmission)

The Working Group developed a plan that considers the potential for long-term electricity demand growth and varying supply conditions in the Ottawa Sub-Region, and maintains the flexibility to accommodate changes to key conditions over time.

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Abbreviations	Descriptions
2019 APS	Achievable Potential Study
A	Amp
ACSR	Aluminum Conductor Steel-Reinforced Conductors
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CFF	Conservation First Framework
CHP	Combined Heat and Power
City	City of Ottawa
DER	Distributed Energy Resource
DESN	Dual Element Spot Network
DG	Distributed Generation
DR	Demand Response
EE	Energy Efficiency
FIT	Feed-in Tariff
GS	Generating Stations
Hydro One or Hydro One Transmission	Hydro One Networks Inc.
Hydro Ottawa	Hydro Ottawa Limited
ICG	IESO Controlled Grid
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
LDC	Local Distribution Company
LMC	Load Meeting Capability

Abbreviations	Descriptions
LTE	Long-Term Emergency ratings
LTR	Limited Time Rating
MS	Municipal Station
MVA	Mega Volt Amp
MW	Megawatt
NERC	North American Electric Reliability Corporation
NPCC	Northeast Power Coordinating Council
OEB or Board	Ontario Energy Board
ORTAC	Ontario Resource and Transmission Assessment Criteria
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
SCGT	Simple Cycle Gas Turbine
SIA	System Impact Assessment
STE	Short-Term Emergency ratings
sub-region	Ottawa Sub-Region
TS	Transformer Station
TWh	Terawatt-Hours
Working Group	Technical Working Group for Ottawa Sub-Region IRRP

1 Introduction

This Integrated Regional Resource Plan (IRRP) documents the studies, conclusions, recommendations and actions required to address the electricity needs of the Ottawa Sub-Region (sub-region) over the next 20 years. It was prepared by the Independent Electricity System Operator (IESO) on behalf of a technical working group (Working Group) composed of the IESO, Hydro Ottawa Limited (Hydro Ottawa), Hydro One Distribution, and Hydro One Transmission. Hydro Ottawa, a municipally-owned utility which operates in the City of Ottawa (City) and in the Village of Casselman, and Hydro One Distribution are local distribution companies (LDCs) that serve customers in the sub-region. Hydro One is the transmission asset owner in the sub-region.

In Ontario, planning to meet the electrical supply and reliability needs of a large area or region is carried out through regional electricity planning, a process that was formalized by the Ontario Energy Board (OEB) in 2013. In accordance with this process, transmitters, distributers, and the IESO are required to carry out regional planning activities for 21 electricity planning regions across Ontario, at least once every five years. The Ottawa Sub-Region covered by this IRRP is a sub-region of the "Greater Ottawa" Region, as shown in Figure 1-1 and

Figure **1-2**. The sub-region encompasses the City, including the Kanata, Nepean, and Orléans communities.

Figure 1-1: Sub-Regions of the Greater Ottawa Regional Planning Region

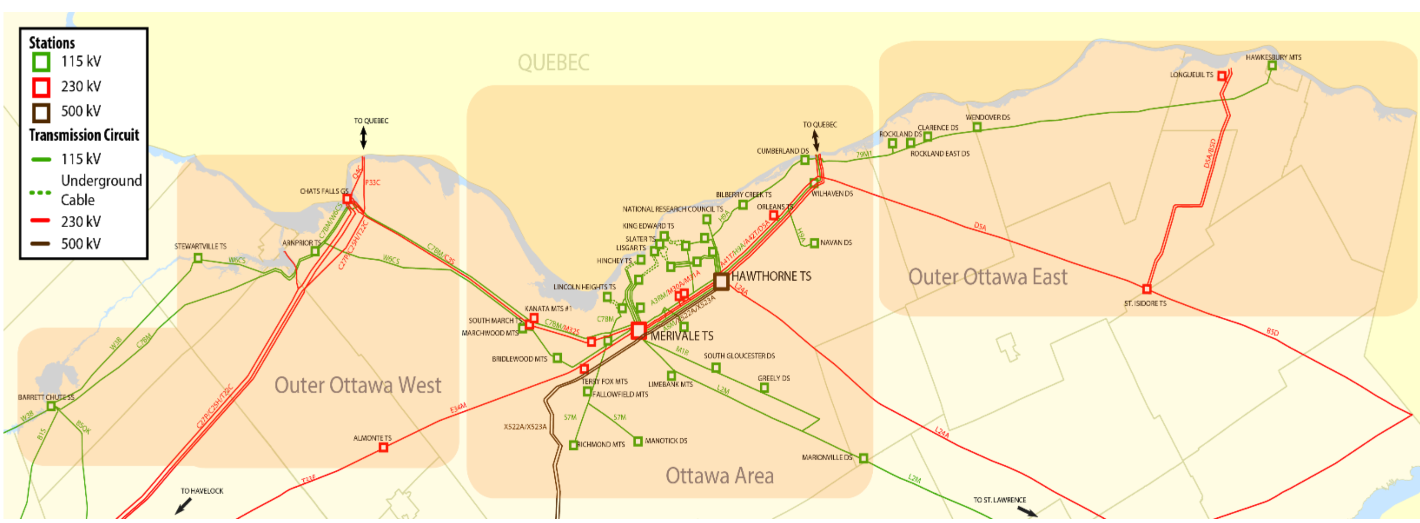
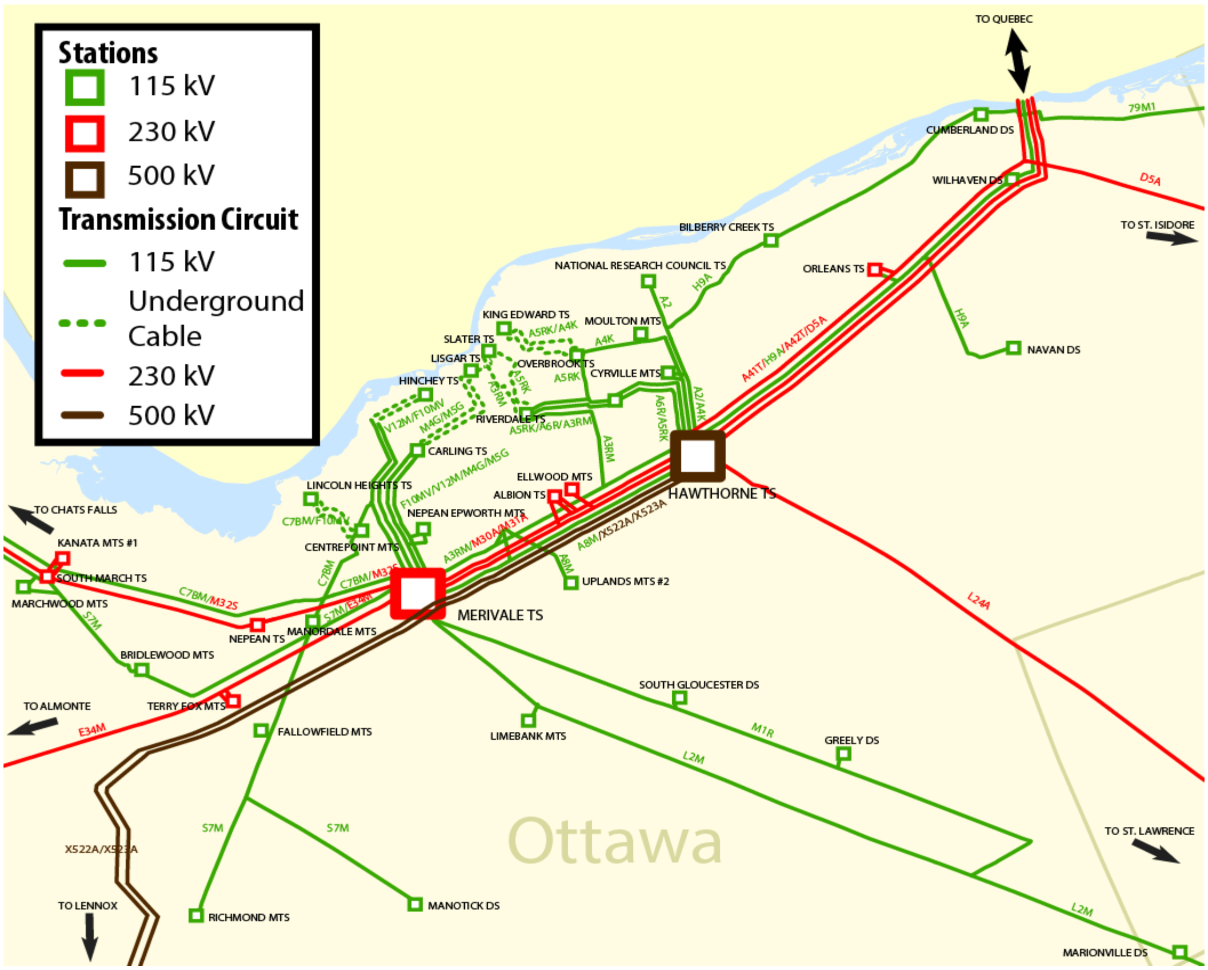


Figure 1-2: Ottawa Sub-Region Transmission System



The City of Ottawa has grown steadily over recent years, reaching a population of one million in 2019. This trend for growth is expected to continue; the City's Official Plan anticipates a 16% population increase between 2016 and 2031.[1] This expansion is resulting in residential and commercial development plans across the City, particularly in the suburban areas outside the Greenbelt. As a result, the electricity demand forecast for the City shows growth over the nearly 20-year forecast horizon.

This IRRP identifies upcoming power system capacity, reliability, and end-of-life asset replacement needs and recommends specific investments to address the most imminent needs.

[1] [1] https://ottawa.ca/en/city-hall/get-know-your-city/statistics-and-economic-profile/statistics/ottawas-population

This IRRP also recommends near-term activities to manage longer-term requirements. The next planning cycle is scheduled to be initiated in 2023, but may be triggered sooner depending on demand growth or other factors. Annual monitoring of potential needs will provide additional input on when the next regional planning cycle should be initiated.

This report is organized as follows:

- A summary of the recommended plan for the Ottawa Sub-Region is provided in Section 2;
- The process and methodology used to develop the plan are discussed in Section 3;
- The context for electricity planning in the sub-region and the study scope are discussed in Section 4;
- The demand outlook scenarios, as well as energy efficiency and distributed energy resource (DER) assumptions, are described in Section 5;
- Electricity needs in the Ottawa Sub-Region are presented in Section 6;
- Options and recommendations for addressing the needs are described in Section 7;
- A summary of engagement activities to date, and moving forward, is provided in Section 8; and
- A conclusion is provided in Section 9.

2 The Integrated Regional Resource Plan

This is the second IRRP for the Ottawa Sub-Region. The first IRRP was produced in 2015. Regional plans are based on 20-year station level demand forecasts generated by the local distribution companies that supply customers in the sub-region. The planning forecast for the Ottawa Sub-Region has changed since the 2015 IRRP. The planning forecast for this IRRP is about five percent higher in the long term; attributable mostly to changes in energy efficiency programs in the sub-region. Much of the load growth is forecast to occur in the communities of Kanata, Stittsville, Nepean and Barrhaven and Orleans, with smaller changes expected in the central part of Ottawa.

The Ottawa Sub-Region IRRP documents the sub-region's forecast electricity needs, based on the application of the IESO's Ontario Resource and Transmission Assessment Criteria (ORTAC).[2] The IRRP was developed based on a set of planning considerations, including reliability, cost, feasibility and flexibility; and, in the near term, it seeks to maximize the use of existing electricity system assets.

This IRRP identifies three planning horizons: from the base year when the forecast was originated (2017) through the near term (up to and including 2022), medium term (six to 10 years, from 2023 to 2027 inclusive), and longer term (11 to 20 years, or from 2028 to 2037 inclusive). This IRRP identifies and recommends investments to address the most imminent needs. The IRRP also spells out specific actions that will address remaining near term and medium-term needs. The Working Group will monitor long-term needs on an annual basis until the next regional planning cycle.

Ottawa's growth is increasing the burden on the transmission network that supplies the sub-region. Many stations across the sub-region are supplied by the older regional 115 kV transmission network. The demand at these stations is forecast to exceed the capability of that 115 kV system in coming years. The 115 kV transmission system is in turn supplied mainly by 230 kV bulk transmission lines that connect the sub-region to the rest of the province. Planning for the bulk transmission system is carried out separately from regional planning, since bulk facilities serve both local and provincial needs, however the two planning processes must be coordinated. The IESO is currently working on a plan for bulk transmission supply to the

[2] Refer to the ORTAC for details:
www.ieso.ca/~/.../IMO-REQ-0041 -TransmissionAssessmentCriteria.pdf

Ottawa area, which is expected to be completed later in 2020. Accordingly, this regional planning process has considered opportunities to coordinate regional planning decisions with the ongoing bulk planning process.

Ontario's formalized regional planning process is based on a minimum five-year review cycle. However, the process allows a regional planning cycle to be triggered before the five-year mark due to, for example, material resource or demand changes. The active part of this cycle is made up of needs assessment, scoping assessment, IRRP, and Regional Infrastructure Plan (RIP) stages, which take up approximately half of the typical five-year timeframe. In many regions, this period of active planning is followed by a period when plan implementation begins, and the technical working group monitors demand trends until the next cycle begins. In some large or fast growing regions like Ottawa, however, the complexity of issues requires the technical working group to continue to be engaged in integrated planning throughout the regional planning cycle, after the completion of the IRRP.

2.1 RECOMMENDED ACTIONS

The recommended actions are summarized in Table 2-1, below.

In the case of two near-term regional planning needs identified in this IRRP, it is beneficial to defer confirming a long-term plan until after the bulk transmission plan has been completed, to allow for integration between bulk planning and regional planning.

In the first case, there is a need for increased supply to the Kanata-Stittsville area, however the bulk transmission plan may provide additional options that should be considered before confirming a plan for long-term supply to the area. The IESO's Save on Energy Local Program Fund has recently approved two Hydro Ottawa programs to target system cost-effective energy efficiency measures to reduce station demand at three Hydro Ottawa stations in the Kanata-Stittsville area as a near-term measure to support reliable supply until a long-term solution for the area is implemented. In addition, Hydro Ottawa is planning distribution system transfers to reduce demand at heavily loaded stations.

In the second case, there is a need for increased supply to the regional 115 kV system, and the options for a long-term plan are closely related to the bulk transmission plan, which will focus on the 230 kV and 500 kV system. The technical Working Group will continue integrated planning for the 115 kV system after this IRRP is released, working in parallel with the IESO's ongoing bulk transmission planning study. A long-term plan for the 115 kV system is expected to be released later in 2020. The IESO will lead engagement with communities and stakeholders on the long-term plan for the 115 kV system, which will include assessment of non-wires alternatives. In the near term, Hydro One will replace transformer T22 at Merivale TS with one that is approximately equal to T21 as a first step to address the need for increased supply to the 115 kV system.

Four outcomes included in this plan address the future of assets that are approaching end of life at Bilberry Creek TS, Slater TS, Albion TS, and Lincoln Heights TS.

Finally, to address the need for additional supply station capacity in southeastern Ottawa, Hydro Ottawa will initiate development work and seek approval for a new 230 kV connected supply station.

Table 2-1: Recommended Actions Resulting from the Ottawa Sub-Region IRRP

Area	Action	Timeline
Kanata-Stittsville	Hydro Ottawa is to implement the North Kanata Retrofit Top-Up Program and the North Kanata Smart Thermostat Program, targeted commercial and residential energy efficiency programs. Hydro Ottawa is also planning distribution system transfers to reduce demand at heavily loaded stations.	Beginning in 2020
Regional 115 kV System	Hydro One is to replace Merivale TS Transformer T22 with one that is approximately equivalent to T21.	Planned Completion: mid-2020s
Orleans	Hydro One is to proceed with the like-for-like refurbishment of Bilberry Creek TS, which is approaching its end of life, and expand the station to accommodate two additional breaker positions to supply Hydro Ottawa customers.	Planned Completion: 2025
Central Ottawa	Hydro One is to replace Slater TS T2 and T3, which are approaching their end of life, with larger transformers, approximately 100 MVA, as was done for the recent replacement of T1.	Planned Completion: late 2023
Central Ottawa	Hydro One is to replace the two 75 MVA transformers at Albion TS, which are approaching their end of life, with similar size transformers.	Planned Completion: mid 2026
Central Ottawa	Hydro One is to replace the two 75 MVA transformers at Lincoln Heights, which are approaching their end of life, with similar size transformers.	Planned Completion: 2025
Southeast Ottawa	Hydro Ottawa is to plan and seek approval for a new 230 kV connected supply station in southeast Ottawa.	Estimated in-service date for the new station: 2025

3 Development of the Plan

3.1 THE REGIONAL PLANNING PROCESS

In Ontario, preparing to meet the electricity needs of customers at a regional level is achieved through regional planning. Regional planning assesses the interrelated needs of a region—defined by common electricity supply infrastructure—over the near, medium, and long term and results in a plan to ensure cost-effective, reliable electricity supply. A regional plan considers the existing electricity infrastructure in an area, forecast growth and customer reliability, evaluates options for addressing needs, and recommends actions.

The current regional planning process was formalized by the OEB in 2013 and is performed on a five-year planning cycle for each of the 21 planning regions in the province. The process is carried out by the IESO, in collaboration with the transmitter(s) and LDC(s) in each planning region.

The process consists of four main components:

1. A Needs Assessment, led by the transmitter, which completes an initial screening of a region's electricity needs;
2. A Scoping Assessment, led by the IESO, which identifies the appropriate planning approach for the identified needs and the scope of any recommended planning activities;
3. An IRRP, led by the IESO, which proposes recommendations to meet the identified needs requiring coordinated planning; and/or
4. A RIP which provides further details on recommended wires solutions.

Further details on the regional planning process and the IESO's approach to regional planning can be found in Appendix A.

The IESO is also currently conducting a Regional Planning Review Process to consider lessons learned and findings from the previous cycle of regional planning and other regional planning development initiatives, such as pilots and studies.[3]

[3] http://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Regional-Planning-Review-Process

3.2 OTTAWA SUB-REGION WORKING GROUP AND IRRP DEVELOPMENT

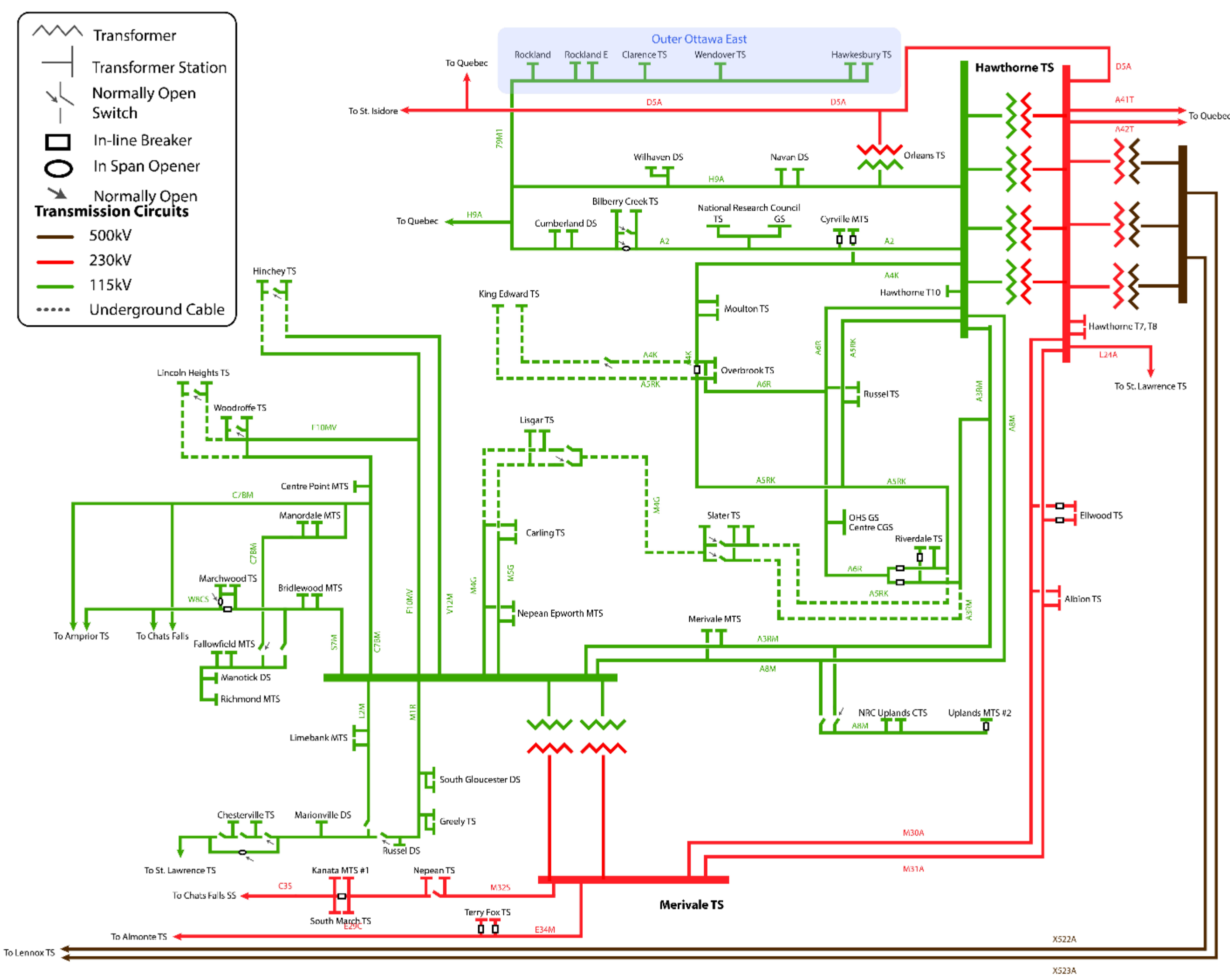
Development of the Ottawa Sub-Region IRRP was initiated in 2018 with the release of the Needs Assessment report for the Greater Ottawa Region. This product was prepared by Hydro One Transmission with participation from the IESO, Hydro Ottawa, and Hydro One Distribution. Screening for needs was carried out to identify needs that may require coordinated regional planning. The subsequent Scoping Assessment Outcome Report prepared by the IESO recommended that an IRRP should be developed to address previously identified and new needs in the Ottawa Sub-Region due to the potential for coordinated solutions.

In 2018 the Working Group was formed to develop Terms of Reference for this IRRP, gather data, identify near- to long-term needs in the sub-region, and recommend actions to address them.

4 Regional Overview

The Ottawa Sub-Region, as shown in 4-1, is supplied by both transmission connections to the Ontario grid and nearby electricity generation facilities, including hydroelectric generating stations on the Madawaska and Ottawa Rivers and renewable generation procured through the Feed-in Tariff (FIT) and microFIT programs.

Figure 4-1: Ottawa Sub-Region Electrical Single Line Diagram



Transmission supply to the sub-region is provided through a 500 kV double-circuit bulk system transmission line connecting to Hawthorne TS, a major TS on the eastern side of the city, and an expansive network of 230 kV and 115 kV transmission lines. Hawthorne TS and a second major TS on the west side of the city, Merivale TS, are the two main supply points for the sub-region. These stations have a total of six 230/115 kV transformers providing supply to the 115 kV system: four at Hawthorne and two at Merivale. Hawthorne and Merivale are connected by two 230 kV circuits in parallel with two 115 kV circuits. Together, these circuits make up the Hawthorne-Merivale transmission interface, the major transmission supply path across the City. Merivale TS is the primary supply point for the western half of the sub-region and receives the majority of its supply through the Hawthorne-Merivale interface.

The Greater Ottawa Region is home to 536 MW of contracted hydroelectric capacity. There are three transmission-connected hydroelectric generating stations on the Madawaska River (Stewartville, Barrett Chute and Arnprior) and one on the Ottawa River (Chats Falls) which, due to their connectivity in the western part of the Ottawa area system, have the potential to reduce the need for supply from the transmission system. However, it is important to note that these hydroelectric plants are run-of-river type generators, which do not have the ability to store water for controlled use at specific times. This type of generating facility typically produces peak output during the spring due to melting snow and ice and produce relatively low output at the time of peak system demand (which typically occurs during the summer). According to the ORTAC, a planning study shall assume a level of output for run-of-river hydroelectric generation that is available 98% of the time. This results in an output level for the of approximately 70 MW for these generators.

4.1 RECENT PLANNING ACTIVITIES IN THE REGION

This is the second cycle of regional planning for the Ottawa Sub-Region. When the OEB formalized the regional planning process in 2013, planning work was already underway in Ottawa. As such, the Needs Assessment and Scoping Assessment for the first cycle of the regional planning process were deemed to be complete and Ottawa was identified as a "transitional" region within the Group 1 planning regions, the first group to utilize the formalized regional planning process.

In April 2015 the Ottawa Area IRRP documented a number of recommendations to address near-term needs. In summary, these recommendations can be organized into four primary areas.

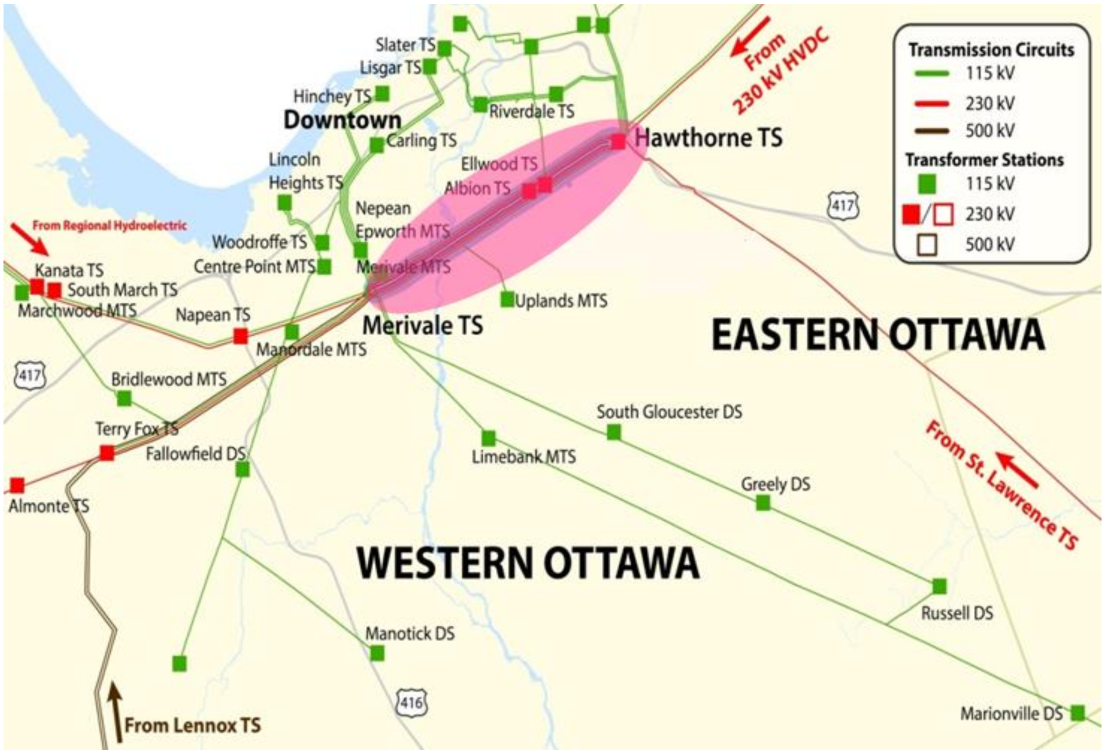
1. To reinforce electricity supply to southwest Ottawa: a 230 kV in-line breaker at Almonte TS was installed (2015), a section of the S7M circuit was upgraded (2017), and development work for a new South Nepean MTS and connection line ensued (expected in-service date of 2022).

2. To reinforce electricity supply to central Ottawa: Overbrook TS transformers were replaced and reconfigured (2018), a section of the A5RK circuit was rebuilt (2019), station capacity at King Edward TS will be increased (2023), and more generally, distribution system transfer capability between central Ottawa stations was increased.
3. To reinforce electricity supply to east Ottawa: transformers T7/T8 at Hawthorne TS were replaced with higher rated (125 MVA) transformers (2019).
4. More broadly, to reinforce the overall regional supply: end-of-life Hawthorne transformers T5/T6 are in the process of being replaced with higher rated transformers (T6 has been completed, T5 will be completed in 2021).

Two medium-term needs, the need for additional 230/115 kV transformer capacity at Merivale TS, and the need for an end-of-life plan for Bilberry Creek TS were also identified in that report, though no specific action was recommended. These two issues are now more imminent and are revisited in this report.

In addition to the enhancements identified in the 2015 IRRP, the IESO provided a hand-off letter to Hydro One in February 2019, requesting the transmitter to proceed with the upgrading of the 230 kV circuits M30A and M31A in the Hawthorne to Merivale transmission corridor (as shown in Figure 4-2). These circuits are critical for supplying customers in the western half of the City of Ottawa and providing a transmission path for a portion of the power transfers between Eastern Ontario and the Greater Toronto Area. The M30/31A reinforcements have a target in-service date of December 2022.

Figure 4-2: Hawthorne to Merivale Transmission Corridor



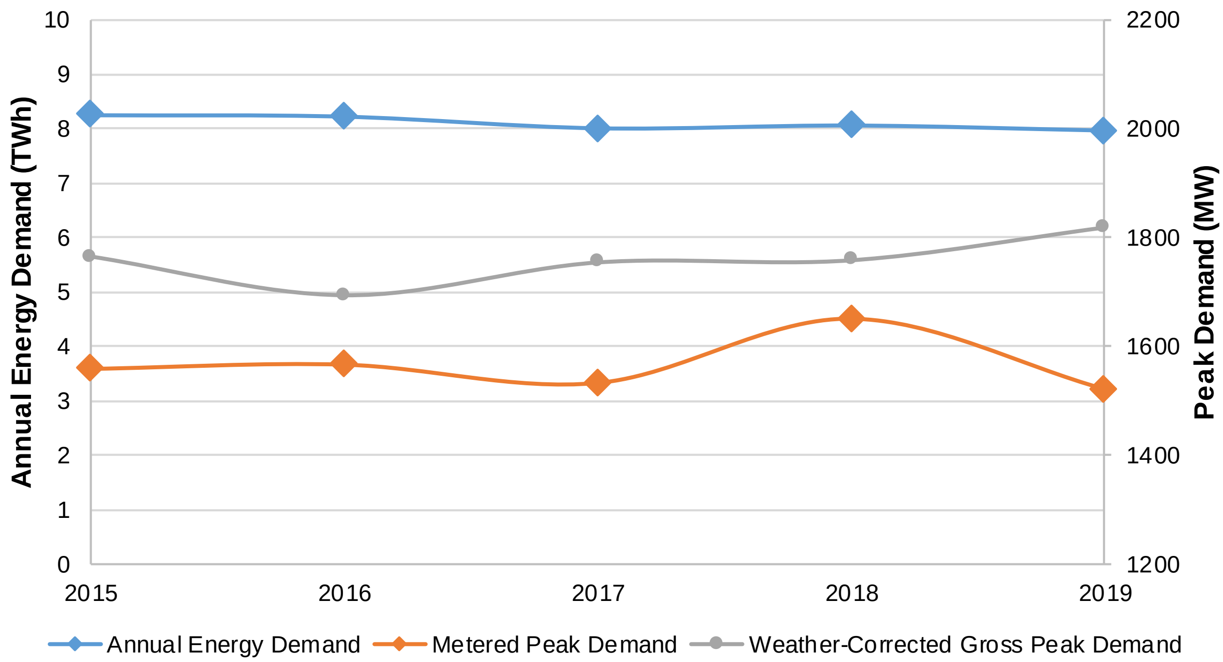
5 Demand Outlook

This section describes the development of the demand forecast for the Ottawa Sub-Region. Section 5.1 begins by describing the historic electricity demand in the sub-region from 2015-2019 inclusive. Section 5.2 describes the demand forecast used in this IRRP and the methodology used to develop it. Furthermore, Section 5.3 provides an overview of changes to the forecast since the 2015 Ottawa Area IRRP. Additional details on the demand forecast assumptions can be found in Appendix B.

5.1 HISTORICAL DEMAND

Over recent years, the electric system in the Ottawa Sub-Region has been summer-peaking, with the primary load centre being its central area within the Greenbelt. As seen in Figure 5-1, over the past five years, the annual energy requirements and coincident net peak demand in the sub-region have been around 8 TWh and 1600 MW, respectively. After correcting historical metered data for weather and the impact of both distributed generation and energy efficiency, the coincident peak demand in the Ottawa Sub-Region was determined to be closer to 1800 MW. This weather-normalized, gross peak-demand data more accurately represents customer electricity demand and its changes in the past five years; the process for calculating this is described in the next section of the IRRP.

Figure 5-1: Historical Net Summer Demand and Energy Consumption for the Ottawa Sub-Region



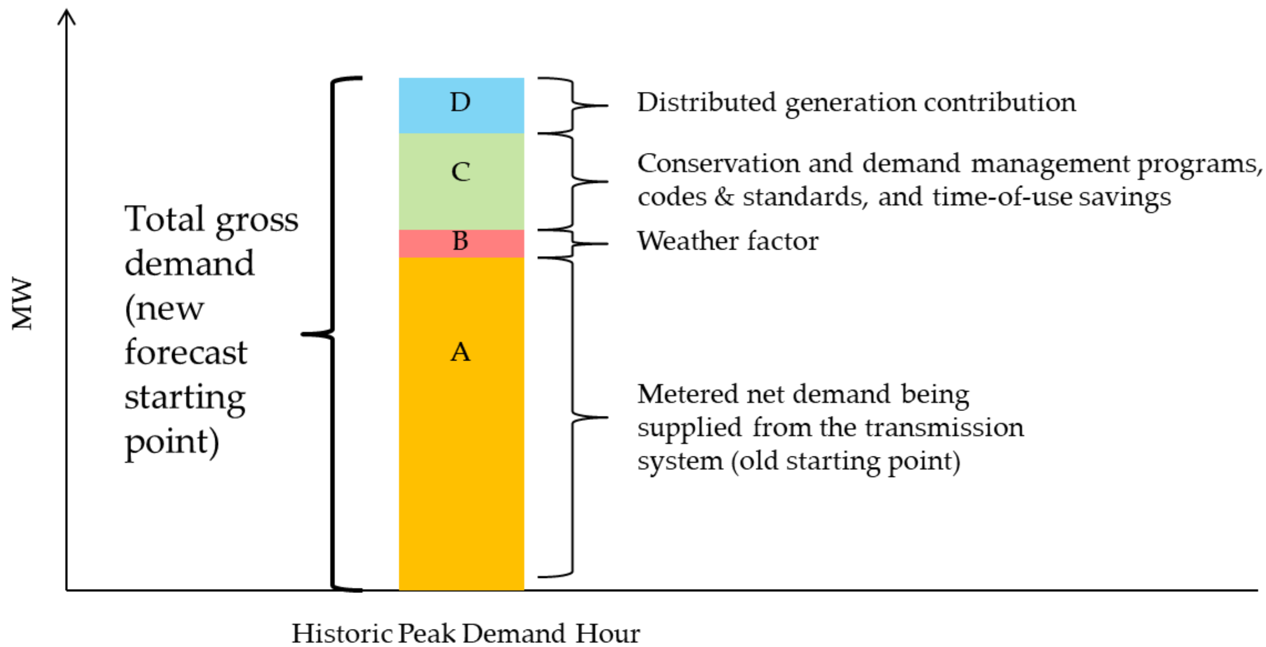
5.2 DEMAND FORECAST METHODOLOGY

5.2.1 Forecast Starting Point

Since electricity supply infrastructure is sized to meet peak-demand requirements, the Working Group developed a 20-year planning forecast to assess electricity supply and reliability needs in the sub-region. Due to their direct relationship with customers, LDCs have the best information on customer and regional growth expectations in the near- and medium term. These considerations include known connection applications and typical electrical demand for similar customer types. Gross demand was therefore forecast at the supply station level by the LDCs. The LDCs also used the IESO's forecast starting points developed through a load "unbundling" process and based on available data.

Historically (as was the case for the 2015 Ottawa Area IRRP), the starting point of the forecast was based on net demand (i.e., metered data). Recognizing that this was no longer an adequate representation of actual customer demand due to the impact of distributed generation, energy efficiency, and weather, the IESO established a new starting point to reflect actual gross demand under median weather conditions. Doing so allowed LDCs to forecast growth from a value that represents "true" customer demand, rather than simultaneously growing the existing savings from distribution generation and energy efficiency too. For illustrative purposes, this approach is summarized in Figure 5-2. Note that for the Ottawa Sub-Region, unbundling gross load was achieved to the extent for which the necessary data was available. More details regarding this methodology can be found in Appendix B.

Figure 5-2: Load Unbundling to Establish a Gross Demand Starting Point for Forecasting



The gross-demand forecasts provided by the LDCs after using these starting points are described in the following section. A net forecast is established for extreme weather conditions and used as the final planning forecast (later described in Section 5.2.5).

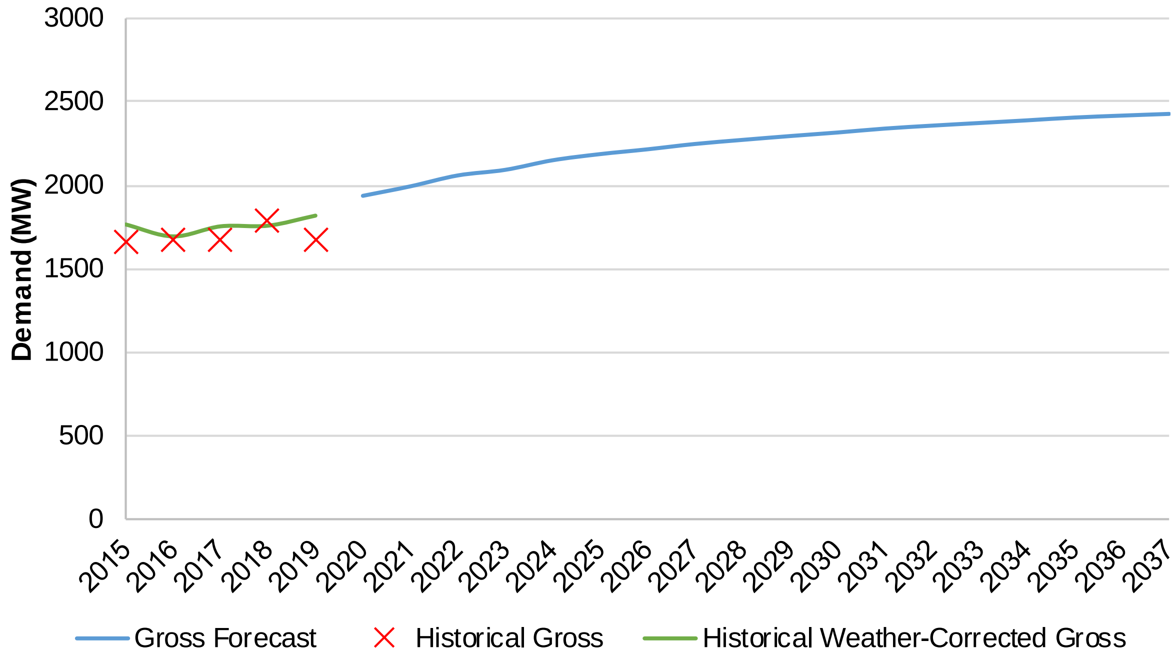
5.2.2 Gross-Demand Forecast

Gross supply station demand forecasts provided by the LDCs account for increases in demand from new or intensified development, but not for the full impact of future energy efficiency measures such as future codes and standards and energy efficiency programs. This is instead later accounted for when developing the net planning forecast.

The graph in

Figure **5-3** shows the forecast gross-demand outlook for the Ottawa Sub-Region under median weather conditions, combined with historical data points for comparison. Details regarding the station-level gross-demand forecast are provided by Hydro Ottawa and Hydro One Distribution in Appendix B.

Figure 5-3: Ottawa Sub-Region Demand Outlook (Median Weather Summer Gross Forecast)



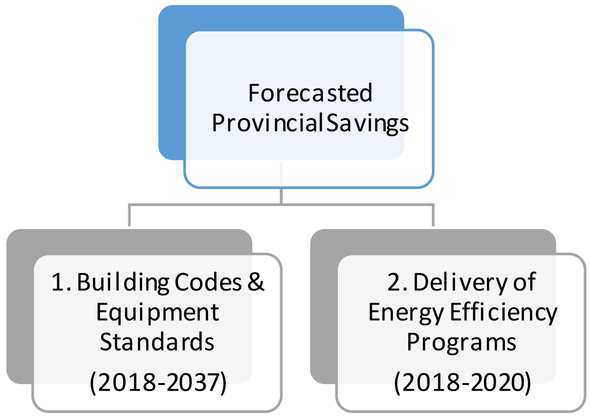
5.2.3 Energy Efficiency Assumed in the Forecast

Energy savings can be achieved through a mix of program-related energy efficiency activities, as well as mandated efficiencies from building codes and equipment standards. It plays a key role in maximizing the use of existing assets and maintaining reliable supply by offsetting a portion of a region's growth, and helping to ensure demand does not exceed equipment capability. The expected energy efficiency savings expected building codes and equipment standards and committed programs that are forecast for the Ottawa Sub-Region have been applied to the gross peak-demand forecast for median weather, along with the peak contribution of distributed generation resources (described in Section 5.2.4), to determine the net peak demand for the sub-region.

Future energy efficiency savings for the Ottawa Sub-Region have been applied to the gross peak-demand forecast to take into account both policy-driven and funded energy efficiency through the Interim Framework (estimated peak-demand impacts due to program delivery to the end of 2020), as well as expected peak-demand impacts due to building codes and equipment standards for the duration of the forecast. As policy related to future provincial energy efficiency activities changes, the forecast assumptions will be updated accordingly.

To estimate the peak-demand impact of energy-efficiency savings in the sub-region, the forecast provincial savings were divided into two main categories:

Figure 5-4: Categories of Energy Efficiency Savings



1. *Savings due to building codes & equipment standards*
2. *Savings due to the delivery of energy efficiency programs*

For the Ottawa Sub-Region, the IESO worked with the LDCs to establish a methodology to assess the estimated savings for each category, which were further subdivided by customer sector: residential, commercial and industrial. This provides a better resolution for the forecast energy efficiency, as energy efficiency potential estimates vary by sector due to differing energy consumption characteristics and applicable measures.

For the Ottawa Sub-Region, LDCs provided both their gross-demand forecast and a breakdown of electrical demand by sector for each TS. Once sectoral gross demand at each TS was estimated, peak-demand savings were assessed for each energy efficiency category – codes and standards, and energy efficiency programs. Due to the unique characteristics and available data associated with each group, estimated savings were determined separately. The final estimated energy efficiency peak-demand reduction, 173 MW by 2037, was applied to the gross demand to create the planning forecast. Table 5-1 provides the peak-demand savings for a selection of the forecast years.

Table 5-1: Peak-Demand Savings from Energy Efficiency (Select Years), in MW

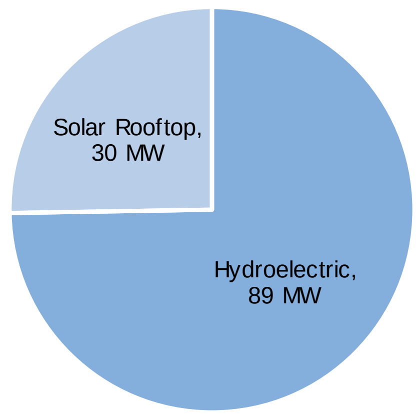
Year	2020	2025	2030	2037
Savings (MW)	108	122	150	173

Additional energy efficiency forecast details are provided in Appendix B.

5.2.4 Distributed Generation Assumed in the Forecast

There are several contracted distributed generation resources in the Ottawa Sub-Region. A full breakdown of distributed generation resources is shown in Figure 5-5.

Figure 5-5: Installed Distributed Generation in the Ottawa Sub-Region in 2020 by Resource Type (Type, Contract Capacity in MW)



The contracted distribution-connected generators in the forecast comprise a mix of rooftop solar and hydroelectric projects. Most of these generators in the sub-region are hydroelectric (75% of total contracted DG capacity in 2020), with solar accounting for 25% of the contracted capacity. Capacity contribution factors of 62% and 30% (hydroelectric and solar respectively) to the regional peak have been assumed to account for the expected output of the mix of local generation resources during summer peak conditions. Based on the IESO contract list as of February 2019, distributed generation projects are expected to offset 64 MW of peak demand within the Ottawa Sub-Region by 2020.

In the process of adjusting the gross forecast (described in Section 5.2.2) to produce a net forecast, projected load is decremented by the expected effect of the distributed generation at each station. This considers the typical peak effective contribution of the relevant generation technology. Once a generation contract expires, the effect of that generation is removed from the forecast.

For the Ottawa Sub-Region, this approach meant that the gross forecast was decremented by 30% of the total installed solar at each station. However, because hourly output data from existing distribution-connected hydroelectric facilities was not available for the creation of the gross forecast, their contribution to peak-demand savings was assumed to be embedded in the gross forecasts provided by the LDCs. For instance, this was the case for the 29 MW Chaudière Hydro facility at Carling TS, which came into service in 2017. Consequently, the gross forecast was not decremented by 62% of all installed hydroelectric at each station – rather, only the new hydroelectric capacity. This corresponds to approximately 40 MW of new installed hydroelectric generation between Hinchey TS and Lisgar TS starting in 2020, corresponding to the Gatineau No. 1 and Hull No. 2 units.

Additional information on the regional demand impacts from distributed generation are provided in Appendix B.

5.2.5 Planning Forecasts

After taking into consideration the combined impacts of energy efficiency and distributed generation, as well as extreme weather, a 20-year planning (net extreme) forecast was produced for the Ottawa Sub-Region. Generally, the forecast indicates an average growth rate of 1.7% each year and a total increase in load of 340 MW over the next 10 years. This is nearly a 20% increase from the weather-corrected peak gross demand observed for the Ottawa Sub-Region in 2019.

Figure 5-6: Ottawa Sub-Region Demand Outlook (Summer Planning Forecast)

The following three figures show this planning forecast divided into three smaller forecast areas based on electricity system connectivity, in order to indicate the distribution of demand and forecast growth across the City. The West Ottawa planning forecast generally consists of stations outside the Greenbelt supplied by Merivale TS. Here, an average growth rate of 2.2% is observed for each year and a total of 169 MW of load is projected by 2030. The Central Ottawa planning forecast generally consists of stations within the Greenbelt. In this area, the average growth rate is 0.9 % per year, with 76 MW of additional load estimated within the next decade. The East Ottawa planning forecast consists of stations outside the Greenbelt supplied by Hawthorne TS. The average growth rate is 2.4% year-over-year, and a total increase of 96 MW is projected by 2030.

The detailed breakdown of stations within each sub-forecast area can be found in Appendix B.

Figure 5-7: West Ottawa Summer Planning Forecast

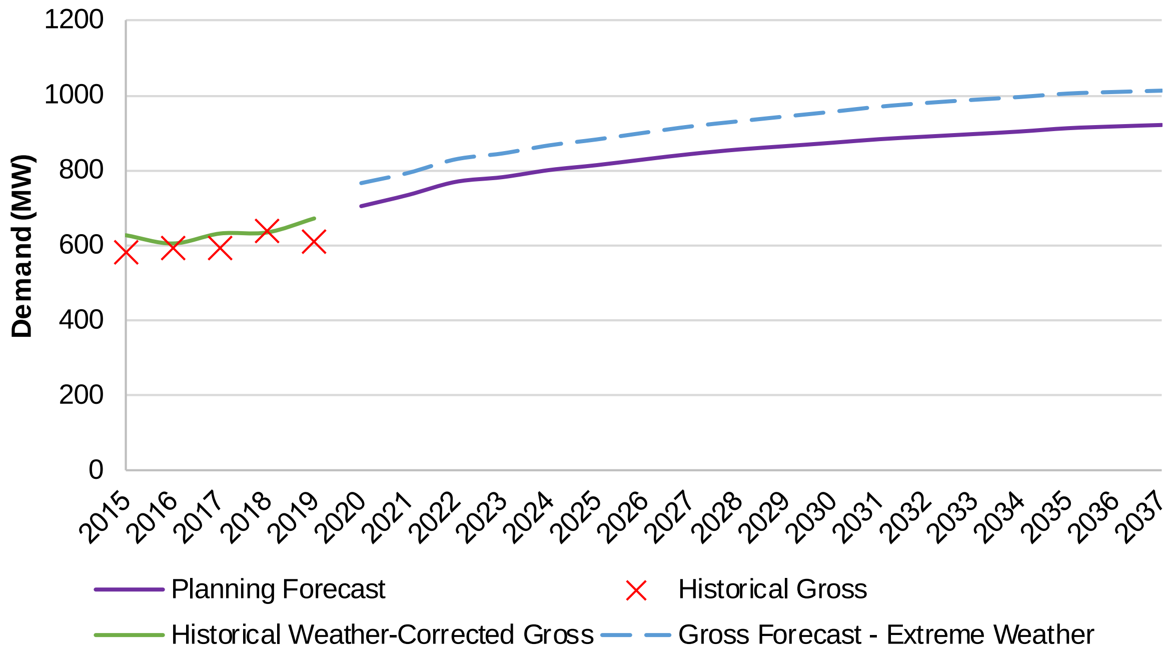


Figure 5-8: Central Ottawa Summer Planning Forecast

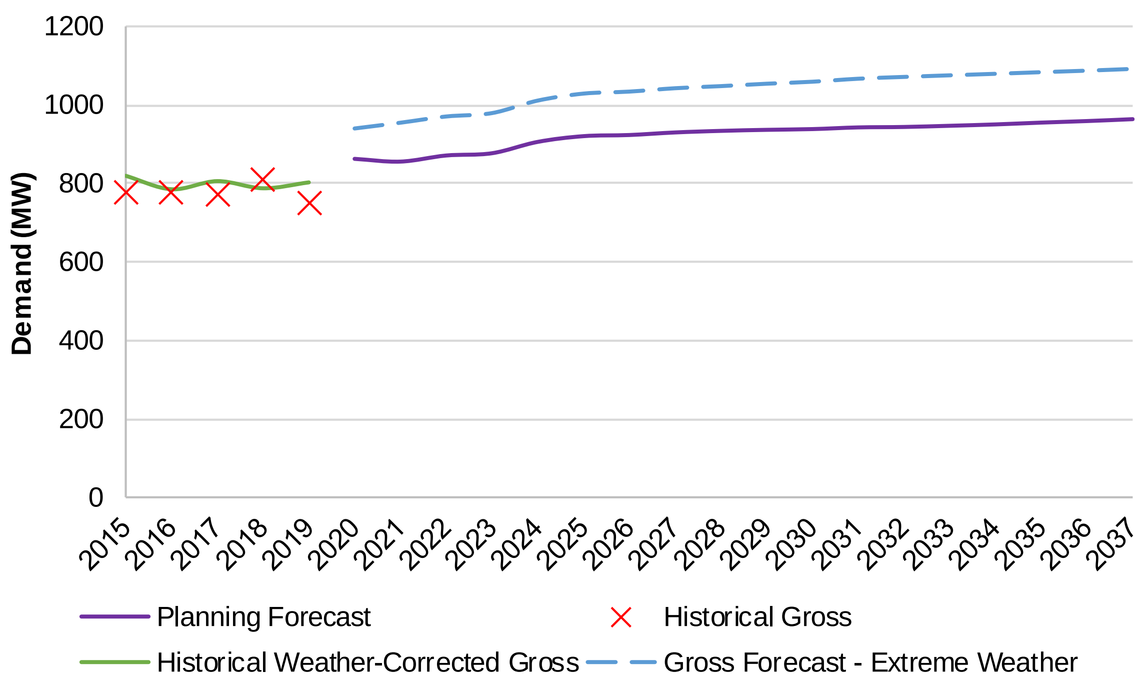
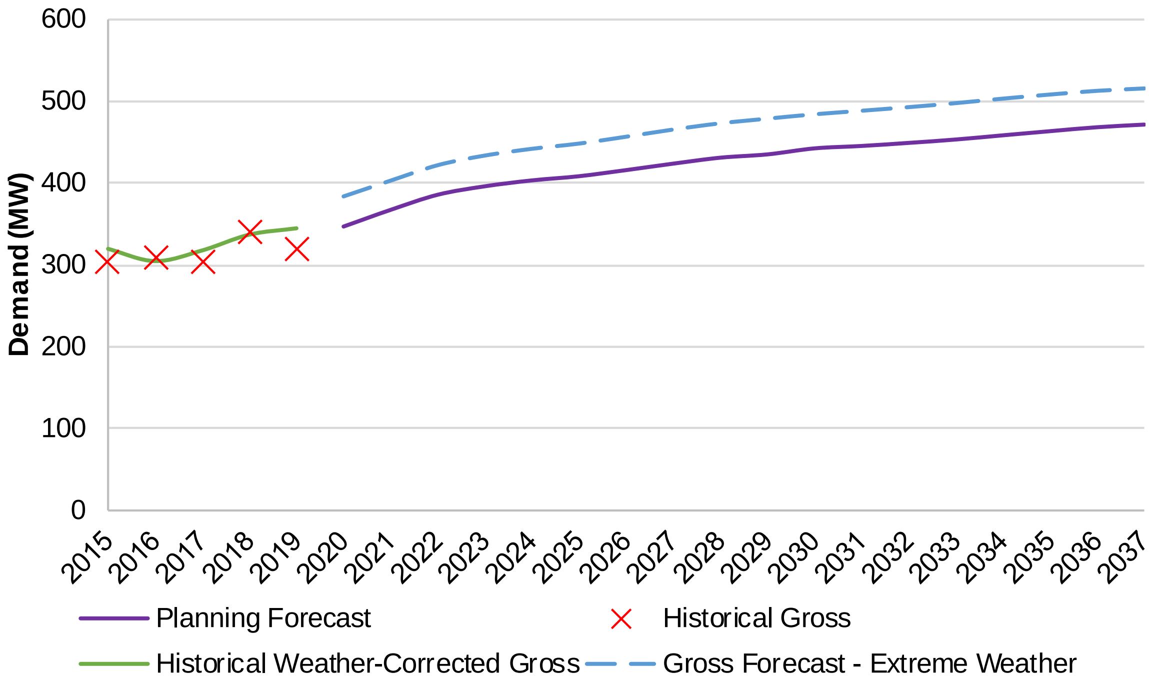


Figure 5-9: East Ottawa Summer Planning Forecast



5.2.6 Hourly Forecasts

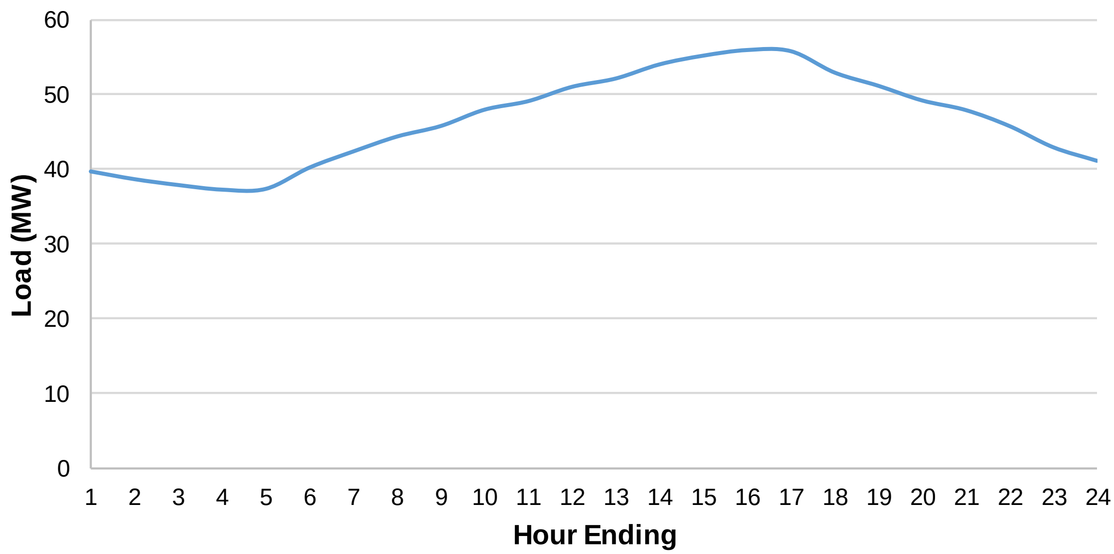
While needs later described in Section 5.3 are primarily based upon annual peak-demand forecasts, additional work was done to develop hourly forecasts. These projected hourly load profiles were integral to better understanding the needs in the Ottawa Sub-Region on a more granular level and ultimately, for evaluating the feasibility of non-wires options (explained further in Section 7.1.1).

Hourly load forecasts were created for the following stations:

- Kanata-Stittsville: Terry Fox MTS, Marchwood MTS, Kanata MTS
- Southeast Ottawa: Leitrim MS

Figure 5-10 shows a sample hourly forecast profile in 2037.

Figure 5-10: Sample Hourly Profile for a Summer Peak Day in 2037 at Leitrim MS

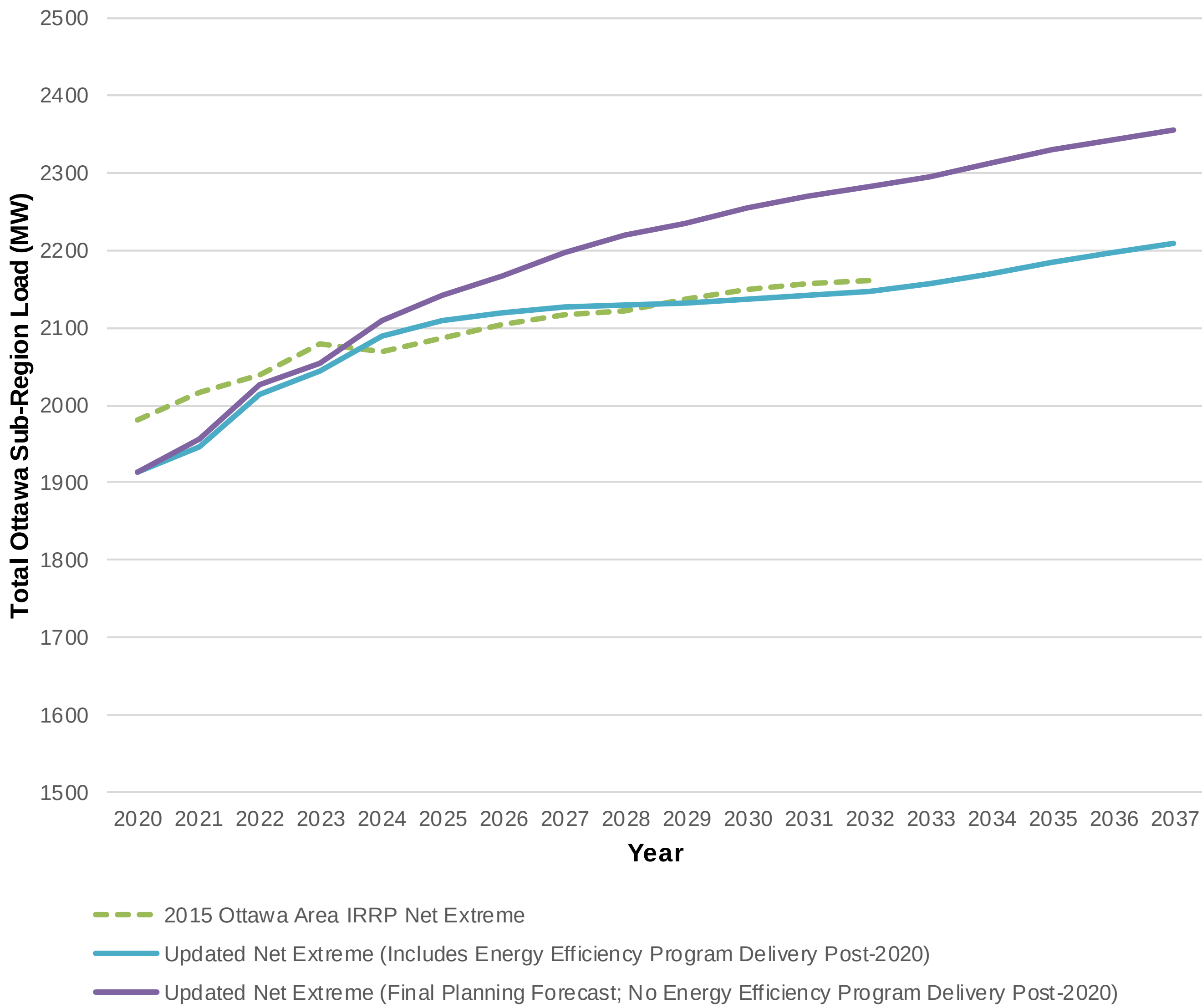


Additional details regarding the hourly forecasting methodology can be found in Appendix D.

5.3 COMPARISON OF PEAK FORECASTS

To better understand the nature of the load growth in the Ottawa Sub-Region – and therefore, the electricity needs later identified in Section 6 – this IRRP compares the most up-to-date planning forecast against what was previously estimated in the 2015 Ottawa Area IRRP. This comparison is summarized in Figure 5-11.

Figure 5-11: Comparison of Total Sub-Region Planning Forecasts (Current and 2015 Ottawa Area IRRP)



Ten years from now, in 2030, the overall planning forecast (net extreme) for the Ottawa Sub-Region is moderately different from its counterpart in the 2015 Ottawa Area IRRP. However, the forecasts differ even more depending on station and area within the sub-region. For instance, when comparing planning forecasts at year 2030, many stations in the current IRRP have projected loads that are at least 15 MW greater than previously predicted:

- Marchwood MTS
- Uplands MTS
- Greely DS
- Kanata MTS
- Terry Fox MTS

- King Edward TS
- Orleans TS
- Hawthorne TS

These changes can lead to imminent needs later identified in Section 6. Table 5-2 further summarizes the planning forecast differences at year 2030 according to the area within the Ottawa Sub-Region.[4]

Table 5-2: Current Net Extreme Forecast vs. 2015 Ottawa Area IRRP Net Extreme Forecast, by Area, in 2030

Forecast Scenario		Current Forecast – Old Forecast (in Year 2030)
Net Extreme	West Ottawa	+134 MW
	East Ottawa	-52 MW
	Central Ottawa	+23 MW
	Entire Region	+105 MW

The old and new forecasts diverge in the long term. Two key factors account for this divergence:

1) Long-term energy efficiency savings targets no longer being assumed in the planning forecast, and
2) The predicted extreme weather impact on load.

Weather correction is integral to the development of a forecast because peak demand is sensitive to different weather conditions. Since the 2015 Ottawa Area IRRP, for which a standard 6% extreme weather factor was applied to the entire region, the Technical Working Group more closely explored the local weather-load behaviour. Continuous improvement efforts led to a new approach that uses an extreme weather correction factor based on historical weather-load behaviour for each area. For the Ottawa Sub-Region, this required a more a more granular analysis. Rather than correcting the region as a whole, loads were weather-normalized separately for three areas (West Ottawa, Central Ottawa, and East Ottawa), assuming that stations located closely together experience similar weather conditions. Linear regression was performed for each area using 31 years of historical temperature and load data. Median weather and extreme weather conditions were also defined using this data set. As a result, a factor

[4] These areas are defined in Appendix B and were used for weather normalization.

between 7-9% was applied to the median forecast depending on the area within the Ottawa Sub-Region. Additional details on the weather normalization methodology can be found in Appendix B.

In addition to the predicted extreme weather impact, changes to the planning forecast's energy efficiency assumptions result in more load (approximately 120 MW) than previously indicated in the 2015 IRRP. Ultimately, these factors advance some needs in the Ottawa Sub-Region, as identified through this current IRRP.

6 Needs

The Working Group identified needs for this IRRP at several different stages of the regional planning process. The preliminary regional planning Needs Assessment was completed by Hydro One in June 2018. The Scoping Assessment was completed by the IESO in September 2018. Finally, in 2019 the IESO completed the needs assessment for the IRRP based on the final IRRP planning forecast provided by Hydro One Distribution and Hydro Ottawa. This needs assessment is described in Appendix C. This section summarizes the needs that were identified for this IRRP.

6.1 NEEDS ASSESSMENT METHODOLOGY

The ORTAC are used for assessing the reliability of the transmission system. These criteria were applied to the existing system to assess supply capacity and reliability needs. The Working Group also considered end-of-life asset replacement needs identified by the asset owners.

6.1.1 Station and Transmission Capacity

Station and transmission capacity describes the electricity system's ability to deliver power to the distribution network through regional step-down transformer stations. In most cases, the MW load meeting capability (LMC) of a transformer station is determined based on the number of transformers at the station and their specifications. For stations with more than one transformer, the LMC is equivalent to the 10-day limited time rating (LTR) of a station's smallest transformer(s), assuming that the largest transformer is out of service. The LMC of one or more transformer stations can also be limited when another system element, such as the transmission line that supplies the station(s) or a circuit breaker, limits the total supply capacity of the line.

The distribution systems in urban areas are often networked, in which case the LDC has options for transferring feeders (which supply distribution customers) from being supplied by their primary supply station to being supplied by an alternate station. This is different than the situation in areas with sparse electricity supply infrastructure, where there may only be one supply station in the vicinity. In both cases, the station's LMC is used to indicate the need to plan for adequate supply capacity based on the station's annual peak-demand forecast.

6.1.2 Voltage Regulation

The ORTAC includes voltage related criteria such as the limits of the acceptable voltage range, and the magnitude of acceptable voltage change for all buses that make up the IESO controlled grid (ICG). The voltage criteria prescribed by the ORTAC are described in Appendix C.

6.1.3 Load Security and Restoration

Load security and restoration refers to the electricity system's ability to minimize the impact of potential supply interruptions to customers in the event of a major transmission outage, such as the loss of a double-circuit tower line resulting in the loss of both circuits. Load security describes the total amount of electricity supply that would be interrupted in the event of a major transmission outage. Restoration describes the electricity system's ability to restore power to those affected by a major transmission outage within reasonable timeframes. The specific load security and restoration requirements prescribed by the ORTAC are described in Appendix C. A summary of these requirements are found in

Table 6-1 and

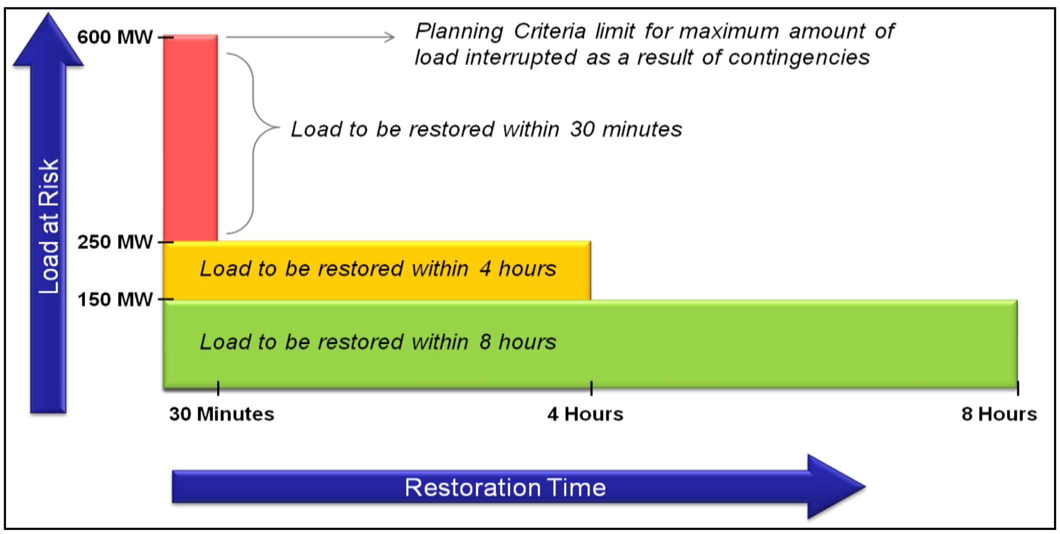
Figure 6-1 below.

Table 6-1: Load Security Criteria

Number of transmission elements out of service	Local generation outage?	Amount of load allowed to be interrupted by configuration	Amount of load allowed to be interrupted by load rejection or curtailment	Total amount of load allowed to be interrupted by load curtailment, rejection, and curtailment
One	No	≤ 150 MW	None	≤ 150 MW
	Yes	≤ 150 MW	≤ 150 MW	≤ 150 MW
Two	No	≤ 600 MW	≤ 150 MW	≤ 600 MW

	Yes	≤ 600 MW	≤ 600 MW	≤ 600 MW

Figure 6-1: Load Restoration Criteria



6.1.4 End-of-Life Equipment

As described in the 2018 Greater Ottawa Needs Assessment, equipment end of life presents an opportunity to:

1) Maintain the status quo,
2) Replace the equipment with similar equipment with lower ratings and built to current standards,
3) Replace equipment with equipment with lower ratings and built to current standards by transferring some load to other existing facilities,
4) Eliminate the equipment by transferring all of the load to other existing facilities,

5) Replace equipment with similar equipment and built to current standards (i.e., "like-for-like" replacement), or

6) Replace equipment with equipment with higher ratings and built to current standards.[5]

End-of-life planning should begin when an aging asset is approaching the end of its expected service life, which is an estimate of the lifespan. However, the condition of the asset, which can only be confirmed by physical testing, along with the risk associated with the failure of the asset may shorten or extend the timeline for implementation of the plan, and could affect which options are available. Replacement needs identified in the near-term typically reflect the condition of the assets, while replacement needs identified in the longer-term are often based on the expected service life of the equipment. As such, any recommendations for longer-term needs should reflect the potential for the need date to change as condition information is routinely updated.

6.2 POWER SYSTEM NEEDS

Electricity demand growth is forecast across the Ottawa area. Ottawa's population is growing faster than that of Ontario or Canada.[6] In June 2019 the City celebrated reaching a population of one million. In particular portions of the City outside the Greenbelt are the focus of increasing intensification and development. The existing transmission and distribution systems in these areas were designed to supply agricultural or low density suburban communities. Changing development patterns are adding new residential, commercial and institutional customers in these areas. As a result, many existing stations are operating at or near their LMC.

This needs section is divided into the following local areas, which describe the status and specific needs for each portion of the electricity system in the sub-region:

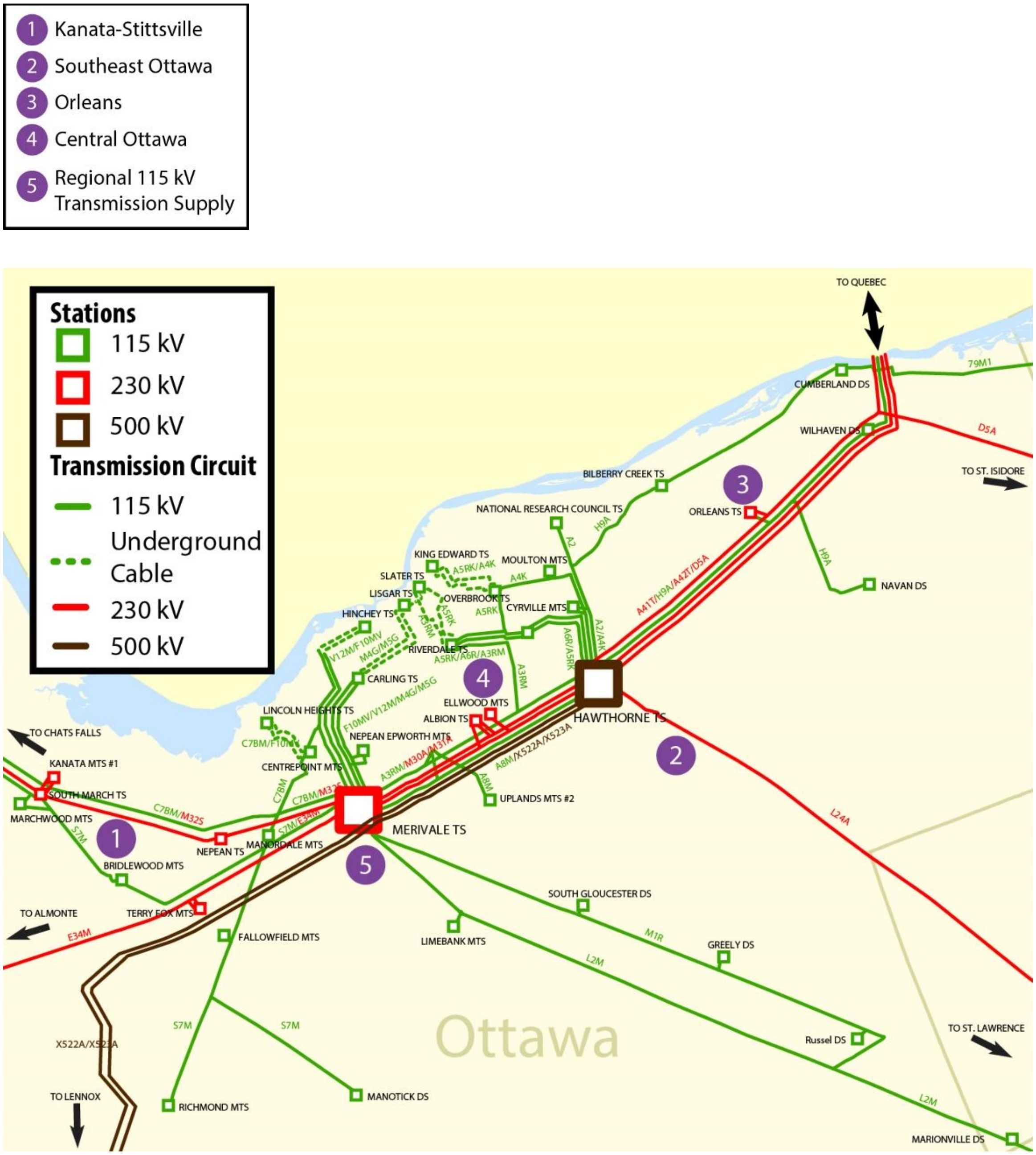
- the Kanata-Stittsville area,
- the Southeast Ottawa area,
- Orleans,
- Central Ottawa, and
- the regional 115 kV system.

These locations are identified on a transmission map in Figure 6-2. Each section concludes with a table summarizing the needs in each portion of the system.

[5] Greater Ottawa Needs Assessment 2018, p. 15.

[6] https://ottawa.ca/en/city-hall/get-know-your-city/statistics-and-economic-profile/statistics/ottawas-population

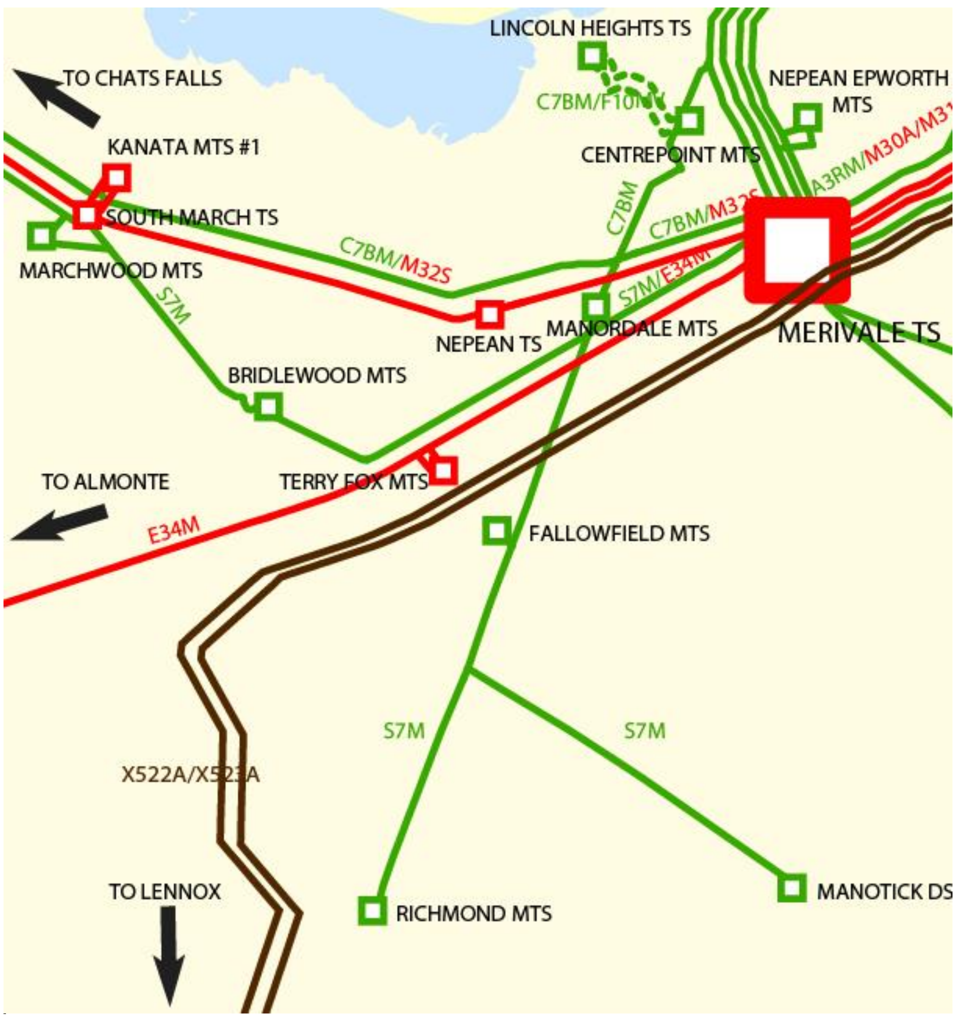
Figure 6-2: Needs Assessment Locations for the Ottawa Sub-Region



6.2.1 The Kanata-Stittsville Area

Kanata-Stittsville is a suburban portion of the City of Ottawa located west of the Greenbelt, about 25 km from downtown Ottawa. This area has been a centre for high tech employers for several decades. This area is supplied by several transformer stations, including South March TS, Kanata MTS, Marchwood MTS, Bridlewood MTS and Terry Fox MTS. The demand forecast for these stations reflects growing interest in intensification and development in the area. This forecast has increased since the 2015 IRRP; however, there is uncertainty associated with the timing of new developments included in the forecast, such as the Kanata North Community Development Plan and the Fernbank Community. The Kanata-Stittsville area is shown in Figure 6-3, below.

Figure 6-3: Transmission System in the Kanata-Stittsville Area



27.6 kV Supply Station Capacity

Three stations in the area, Marchwood MTS (115 kV supplied), Kanata MTS (230 kV supplied), and Terry Fox MTS (230 kV supplied) supply load at the 27.6 kV voltage level, which makes it feasible to transfer demand between the stations, depending on the individual feeder capabilities. All three of these stations are owned by Hydro Ottawa. Marchwood MTS and Kanata MTS are already loaded near their LMC. Terry Fox MTS came into service in 2013 and is the newest of the three stations. Loading at Terry Fox is forecast to reach its LMC by 2030. The combined demand of the three Kanata-Stittsville 27.6 kV stations is forecast to exceed the combined LMC for the three stations by 41 MW in 2020, and 65 MW in 2028. While this appears to represent an imminent capacity shortfall, because distribution transfer options are available it is acceptable to load these stations above the LMC for an interim period until a plan for long-term reliable supply can be implemented. In such a case, customers may experience a supply interruption if a transformer experiences an unplanned outage (contingency) when a station is loaded above the LMC. Relying on distribution transfer capability for post-contingency restoration makes the distribution system more complex for an LDC to operate. As an interim measure, this approach represents a limited risk to customers because annual peak loading only lasts for a short period of time and there are many periods of the year when a station that is heavily loaded at peak will be supplying much lower demand. Nevertheless, the forecast exceeding the LMC for these stations indicates the need to plan for an enduring solution for reliable supply to the Kanata-Stittsville area.

Summary of Needs in Kanata-Stittsville

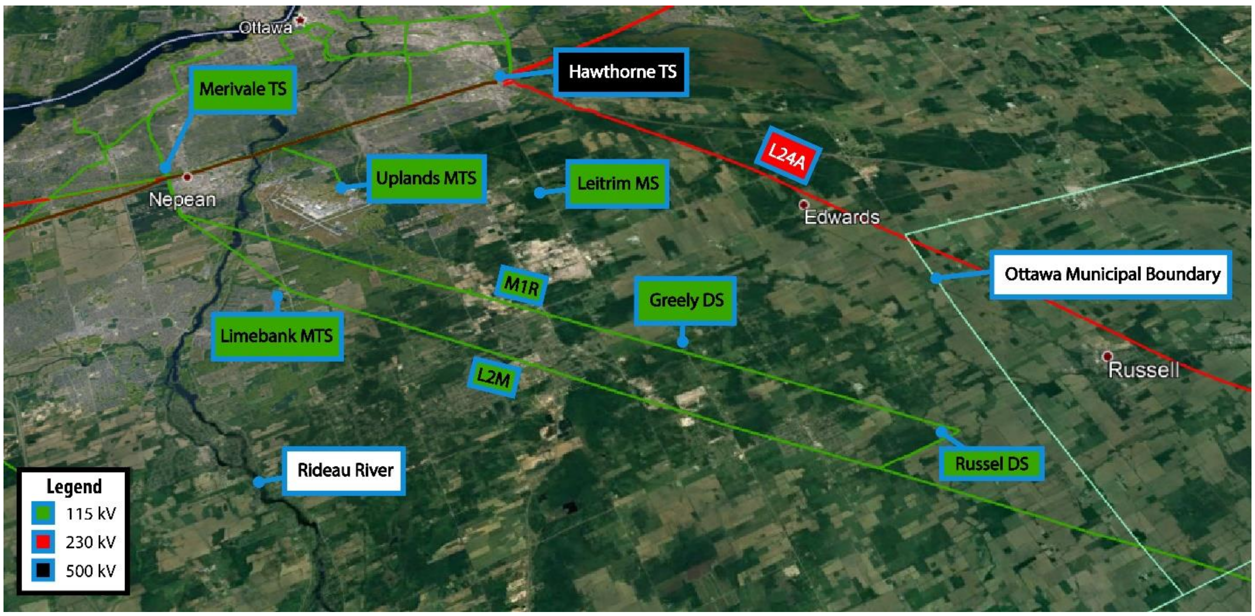
Description	Need	Forecast Timing
27.6 kV Supply Station Capacity (Terry Fox MTS, Marchwood MTS and Kanata MTS)	Station Capacity	In the near term Hydro Ottawa is able to manage high demand at these stations operationally. A plan for an enduring solution to be implemented in the medium term is required.

6.2.2 The Southeast Ottawa Area

For the purpose of this plan, the southeast area of the City of Ottawa describes the portion of the City bounded by the Rideau River (west), the Greenbelt (northwest), Highway 417 (northeast) and the municipal boundary between Ottawa and the Municipality of Prescott-

Russell (east and south). Highway 417 is the Trans-Canada Highway that connects Ottawa and Montreal. The Macdonald-Cartier International Airport, located south of the Greenbelt, on the east side of the Rideau River is also located in this area. This area is primarily agricultural, however there are several recent and planned residential, mixed and industrial developments that are increasing electricity demand in this area. The Hydro Ottawa service territory boundary passes through this area, with Hydro One Distribution serving customers in the outer portions of the City. The Southeast Ottawa area is shown in Figure 6-4, below.

Figure 6-4: Transmission System in the Southeast Ottawa Area



The southeast Ottawa area is presently supplied by four 27.6 kV supply stations: Uplands MTS #2 (115 kV/27.6 kV), Limebank MTS (115 kV/27.6 kV), Greely DS (115 kV/27.6 kV), and Leitrim MS (44kV/27.6kV), which is supplied by Hawthorne TS. Uplands MTS, Limebank MTS and Leitrim MS are owned by Hydro Ottawa. Greely DS and Hawthorne TS are owned by Hydro One. Uplands MTS is located slightly north of Macdonald-Cartier International Airport. Limebank MTS is located about 3 km south of the Airport. Leitrim MS is located about 6 km east of the Airport, and 8 km west of the Highway 417/Boundary Rd. intersection. Greely DS is located about 20 km southeast of the airport, and about 13 km south of the Highway 417/Boundary Rd. intersection. Leitrim MS is supplied by a 44 kV feeder from Hawthorne TS, which is about 7 km to the north. One 230 kV circuit (L24A) extends southeast from Hawthorne TS, a few km south of Highway 417.

Station Capacity at Uplands MTS and Limebank MTS

As a result of anticipated demand increases, Hydro Ottawa is currently implementing plans to expand the LMC at Uplands MTS and Limebank MTS, both of which are loaded to near their LMC. At Uplands MTS, this work will consist of replacing the existing 33 MVA 115/27.6 kV transformer with two 50 MVA transformers. This will increase the station's LMC from 33 MVA to 50 MVA (45 MW). This expansion is expected to be completed in 2021. The planning forecast anticipates demand at Uplands MTS will exceed the station's expanded LMC by 2024.

Hydro Ottawa plans to install the 33 MVA transformer that is removed from Uplands MTS at Limebank MTS, adding to the three existing 33 MVA transformers at that station. This will increase the station capacity from 66 MVA to 99 MVA (89.1 MW) however it is expected that the capability of the existing transmission circuit L2M will limit the LMC of the station to about 75 MW. It is possible that upgrading the transmission circuit could increase the LMC to 89 MW, however Hydro Ottawa has not yet committed to upgrading L2M. Hydro Ottawa expects to complete this station upgrade project by 2021. The IRRP planning forecast anticipates demand at Limebank MTS will reach 75 MW by 2021.

The existing transformers at Limebank MTS are approaching their end of life around the early 2030s.[7] The opportunity to consider future plans for Limebank MTS will be reviewed in the next IRRP cycle.

Station Capacity at Leitrim MS and Hawthorne TS

As described above, Leitrim MS is a 44/27.6 kV supply station connected to a 44 kV feeder that is supplied by Hawthorne TS. The 44 kV feeder limits the LMC of Leitrim MS to 25 MVA (22.5 MW). Leitrim MS supplies Hydro Ottawa customers as far away as Hydro Ottawa's service territory boundary, approximately 15 km to the east, as Hydro Ottawa does not have any other supply stations in the vicinity. The planning forecast for Leitrim MS is shown in Table 6-2, below. This is a forecast of the remaining demand at Leitrim MS after Hydro Ottawa has maximized the potential to transfer loads in the southeast area to Uplands MTS and to Limebank MTS, both of which are west of Leitrim. The planning forecast anticipates demand at Leitrim MS will exceed the station's LMC by 2022. Leitrim MS is forecast to be overloaded by 33.5 MW by 2037.

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[7] This is updated end-of-life information. The 2018 Needs Assessment indicated that the Limebank MTS transformers would reach their end of life in the early 2020s.

Table 6-2: Electricity Planning Forecast for Leitrim MS

		Summer Planning Peak-Demand Forecast (MW)								
Station	**LTR**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Leitrim MS	**22.5**	18.9	20.8	26.7	29.8	30.3	32	33.7	36.2	38.8
		2029	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**
		41.8	43.3	44.8	46.2	48.3	50.4	52.6	54.7	56

Hawthorne TS is a 230/44 kV transformer station on the east side of central Ottawa. Both Hydro Ottawa and Hydro One supply customers from this station. As noted in Section 4.1 a station expansion project that was recommended as part of the 2015 IRRP was completed in 2019. This project has increased the LMC of Hawthorne TS to 158 MVA (142 MW). The IRRP forecast anticipates demand at Hawthorne TS will reach the expanded LMC by 2028, however the overloading at Leitrim MS is a large factor in this. If the overloading at Leitrim MS were removed from Hawthorne TS the station forecast would be within the LMC for the entire forecast period.

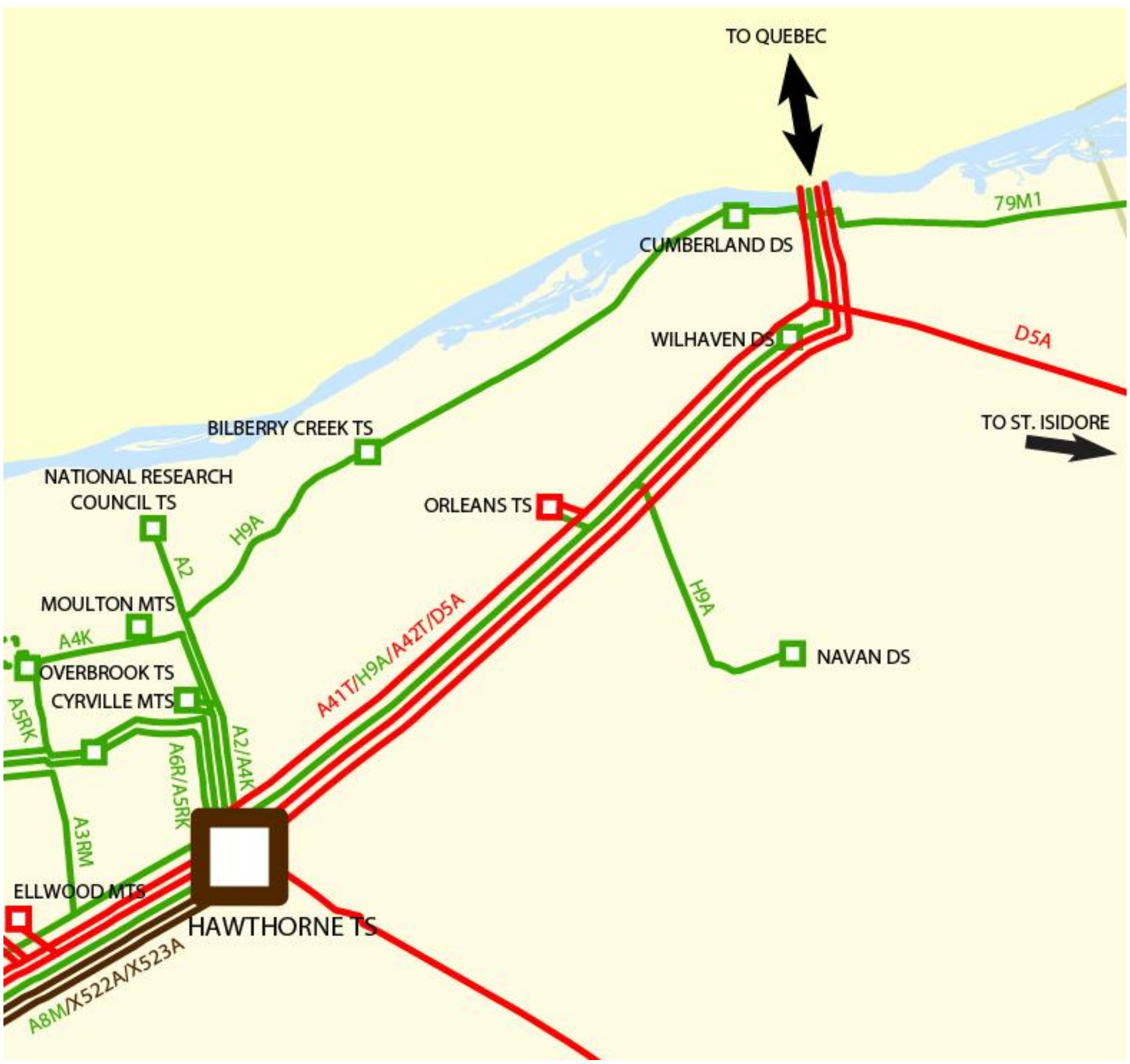
Summary of Needs in Southeast Ottawa

Description	Need	Forecast Timing
Uplands MTS	Station Capacity	Medium Term (after planned Hydro Ottawa station expansions)
Limebank MTS	Station Capacity	Near Term (after planned Hydro Ottawa station expansions)
Limebank MTS	End-of-Life Transformers	Medium Term
Leitrim MS (44/27.6 kV station supplied by Hawthorne TS)	Station Capacity	Near Term
Hawthorne TS	Station Capacity	Medium Term

6.2.3 Orleans

Orleans is a suburb in the eastern part of the City of Ottawa located along the Ottawa River. Like other areas outside the Greenbelt, development is underway in this area, including development of the East Urban Community and the Orleans Industrial Park. East Ottawa is supplied by one 230 kV circuit (D5A) and a network of 115 kV circuits (including H9A, A2, and A4K) that emanate from Hawthorne TS toward the northeast. The Orleans community is supplied by five stations. Four of these stations, Bilberry Creek TS, Cumberland DS, Navan DS and Wilhaven DS are supplied by the 115 kV system. Orleans TS is the newest station, completed in 2015. It is supplied at both the 230 kV and 115 kV voltage levels. Figure 6-5 below shows the location of the Orleans planning area in relation to Hawthorne TS.

Figure 6-5: Transmission System in Orleans



Station Capacity at Orleans TS

Orleans TS is a dual element spot network (DESN) type station, a design that consists of two transformers typically supplied by two circuits, one transformer connected to each. The existing configuration of Orleans, however, is such that one transformer is connected to 115 kV circuit H9A and the other transformer is connected to 230 kV circuit D5A. Because the transformers are supplied at two different voltages the station must be operated with the low voltage bus-tie breaker open. If there is an outage on one of the supply circuits supply will be restored to affected customers by closing the bus-tie breaker, after a momentary outage. The 2015 IRRP noted that although this supply configuration is acceptable, regional planning should consider potential opportunities to convert this station to a typical DESN configuration in conjunction with addressing other reliability needs in the vicinity. At the time Orleans TS was constructed, 115 kV circuit H9A was built ready for conversion to 230 kV operation; however, presently it operates at 115 kV.

The IRRP planning forecast for Orleans TS anticipates it will be loaded to the planning capacity level of 117 MW by 2025.

Upcoming End-of-Life of Bilberry Creek TS

Bilberry Creek TS is a 115 kV connected supply station built in 1964 to supply the Orleans area. Bilberry Creek TS is owned by Hydro One and supplies both Hydro One and Hydro Ottawa.

Hydro One has indicated that Bilberry Creek TS will reach its end of life around 2023 and will require substantial refurbishment to continue operation. This issue was identified prior to the 2015 IRRP. At that time, the Working Group determined that there was sufficient time available to defer the decision about the future of Bilberry Creek TS until this IRRP. A plan for the long-term reliability supply to customers supplied by Bilberry Creek TS must be confirmed in this IRRP. This plan should be coordinated with the plan for Orleans TS which is located 5 km south of Bilberry Creek.

Summary of Needs in Orleans

Description	Need	Forecast Timing
Orleans TS	Station Capacity	Near Term
Bilberry Creek TS	End of Life	Near Term

6.2.4 Central Ottawa

Central Ottawa is the portion of the City inside the Greenbelt. Section 6.2.5, below, describes the supply to central Ottawa in more detail, in the context of the 115 kV transmission system that supplies most of the area. This section focuses on the end-of-life replacement of transformers and other equipment at three central Ottawa stations: Slater TS and Lincoln Heights TS, which are supplied by the 115 kV system, and Albion TS, which is supplied by the 230 kV system.

Upcoming End-of-Life of Slater TS Components

Slater TS is a supply station in downtown Ottawa which was originally consisted of three 65 MVA transformers. Transformer T1 failed in 2018 and was replaced with a 100 MVA unit in 2018. Transformers T2 and T3 are reaching their end of life around 2022. A decision on the size of the replacement transformers is required.

Upcoming End-of-Life of Albion TS Components

Albion TS is a supply station in south central Ottawa. The two 75 MVA transformers at Albion TS and station switchgear are reaching their end of life around 2028. A decision on the size of the replacement transformers is required.

Upcoming End-of-Life of Lincoln Heights TS Components

Lincoln Heights TS is a supply station in central Ottawa that consists of two 75 MVA transformers that are reaching their end of life around 2027. A decision on the size of the replacement transformers is required.

Summary of Central Ottawa Needs

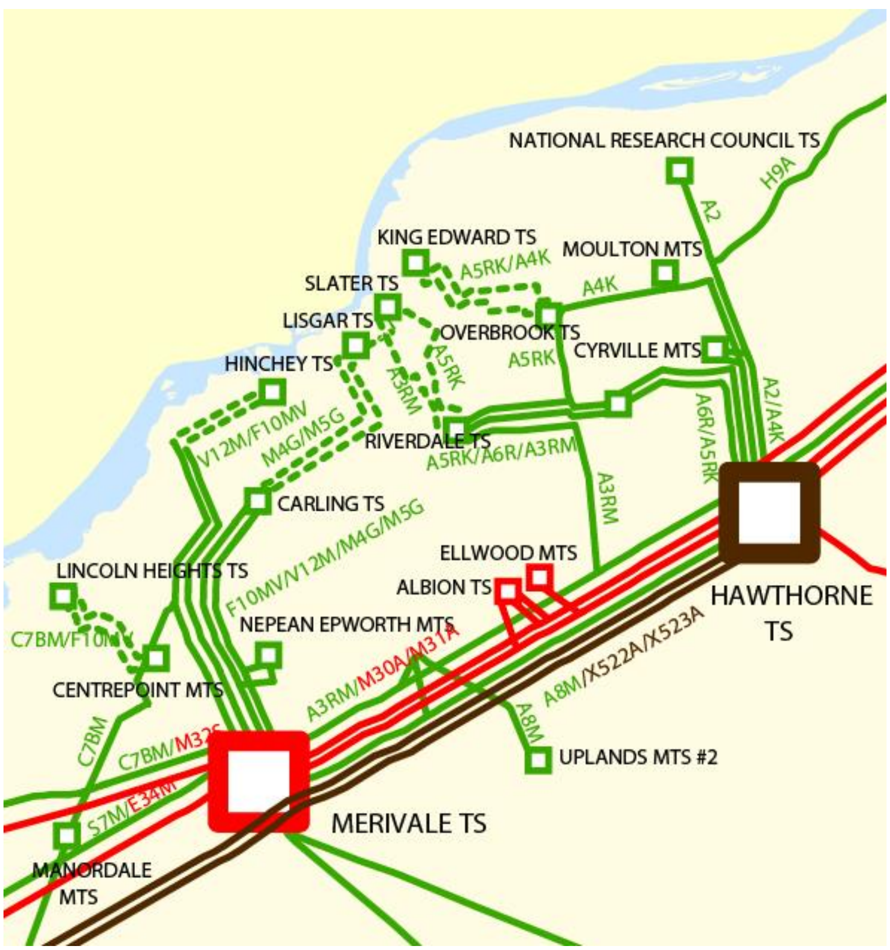
Description	Need	Forecast Timing
Slater TS	End of Life	Near Term
Albion TS	End of Life	Medium Term
Lincoln Heights TS	End of Life	Medium Term

6.2.5 The Regional 115 kV System

As described in Section 4, the 115 kV system is supplied by a total of six 230/115 kV transformers: four at Hawthorne TS, on the east side of the City, and two at Merivale TS, on the west side. A large number of stations in the sub-region, including nearly all of the stations located within the Greenbelt, are supplied by the 115 kV transmission system, which includes overhead transmission lines as well as underground cables that supply several stations in downtown Ottawa.

Figure 6-6 below shows the 115 kV system in central Ottawa, however this figure does not show the full extent of the 115 kV transmission circuits that connect Ottawa with three 115 kV connected hydroelectric generating stations west of the City. As described in Section 4, while these facilities supply variable amounts of energy throughout the year, the 115 kV transmission system in the Ottawa area is mainly supplied from the 230 kV system during peak periods.

Figure 6-6: The 115 kV Transmission System in Ottawa



Demand growth on the 115 kV system is increasing the power flow through the 230/115 kV transformers to the point where they are generally reaching their LMC. This issue was identified prior to the 2015 IRRP. At that time, the Working Group determined that sufficient time and mitigating options were available to defer the decision on a plan for the 115 kV system. A plan for long-term reliable supply to the 115 kV system must be confirmed in the near future.

The combined capacity of the existing 115 kV supply stations is generally matched to the LMC of the 230/115 kV transformers. Accordingly, the planning forecast indicates that a number of these stations are currently being operated at or near their planning capacity. Notwithstanding other station limitations, the potential to expand these stations will be limited by the LMC of the 115 kV system as a whole. An integrated plan for the 115 kV system will consider the options for increasing the LMC of the 115 kV system in conjunction with the limitations of the 115 kV transmission lines and the LDCs plans for the 115 kV supply stations. This plan will determine a strategy for the future of the 115 kV system.

230/115 kV Transformation Capacity – Merivale TS T22 Limitation

As described above, the LMC of the 115 kV system is limited by the thermal capability of the 230/115 kV transformers. The most limiting transformer is T22 at Merivale TS. Transformers T21 and T22 at Merivale TS have different overload capabilities, with T22 having a lower thermal rating. Merivale TS transformer T22 would today be exceeding its limited time thermal rating after the loss of the companion transformer, T21, at time of peak demand. The existing transformer T22 came into service in 1978. Addressing this limitation in this IRRP will increase the LMC of the 115 kV system in the near term. It is important to note, however, that the increase will only be adequate for a few years because once this limitation is removed the LMC will be limited by other factors, including the continuous rating of 230/115 kV transformer T21 at Merivale TS, and the continuous rating of 230/115 kV transformers at Hawthorne TS.

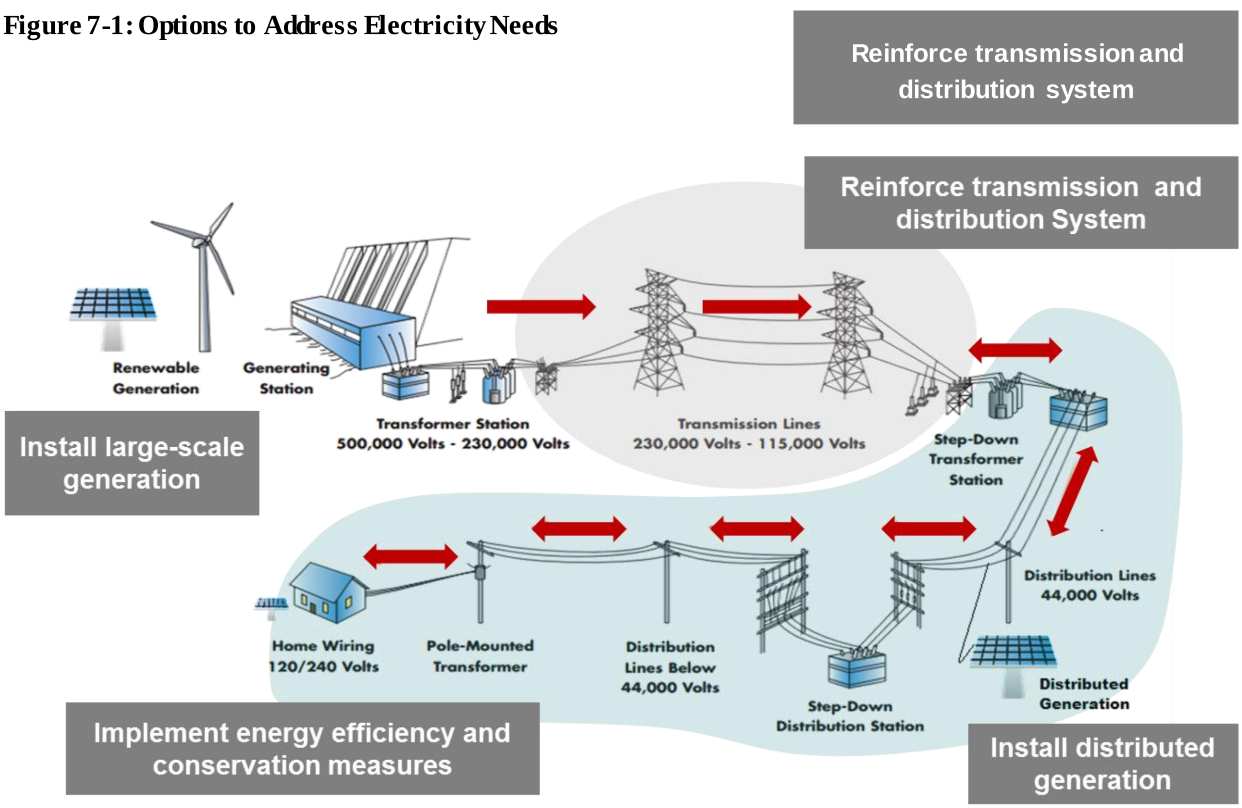
Summary of Regional 115 kV System Needs

Description	Need	Forecast Timing
Merivale TS T22 – LTR exceeded post-contingency (loss of T21)	230/115 kV Transformer Capacity	Near Term

7 Options and Recommendations

As shown in Figure 7-1, Ontario communities have traditionally been supplied with electricity generated from large, centralized generation sources delivered through transmission and distribution infrastructure. To address regional and local electricity needs, one approach is therefore to reinforce the transmission and distribution infrastructure supplying the local area. In recent years, communities and customers have also been exploring opportunities to reduce their reliance on the provincial electricity system by meeting their electricity needs with local, distributed energy resources and community-based solutions. This approach includes a combination of emerging technologies and programs, such as targeted demand response and energy efficiency programs, distributed generation and advanced storage technologies, micro-grid and smart-grid technologies, and more efficient and integrated process systems combining heat and power.

Figure 7-1: Options to Address Electricity Needs



7.1 GENERAL OVERVIEW OF OPTIONS EVALUATION

When evaluating alternatives, the Working Group considered a number of factors, including technical feasibility to meet capacity needs, timing, cost, solution flexibility, alignment with broader planning policies and priorities, and consistency with long-term needs and options. Solutions that maximized the use of existing infrastructure were given priority.

Investing in new electricity infrastructure such as a new transmission line or a generation facility requires substantial capital investment and may have environmental or land-use impacts. This, in conjunction with the long-service life of such facilities, requires the Working Group to give careful consideration to the longer-term cost implications, value, and potential risks (e.g., stranded or underutilized assets) before recommending an investment. Furthermore, considering the lengthy process of obtaining necessary approvals, construction, and other activities during the development phase, decisions on new facilities must take into account the required lead time to ensure they are available when needed.

When assessing the need for infrastructure investments, it is also important to strike a balance between overbuilding infrastructure (e.g., committing to infrastructure when there is insufficient demand to justify the investment) and under-investing (e.g., avoiding or deferring investment despite insufficient infrastructure to support growth in the region). Investment cost, as well as cost responsibility, for recommendations made through regional planning depend on the type and classification of assets. Costs may potentially be shared by all provincial ratepayers or recovered only by the specific customers they serve (e.g., LDCs, industrial customers). In some cases, a combination of cost-sharing may occur when there are both provincial and local benefits.

In developing the IRRP, the Working Group examined a wide range of integrated solutions to address local and regional needs, as well as identified additional studies that will help inform mid- and long-term plans and actions. These options are discussed in detail in Sections 7.2-7.7, organized by areas of need in the Ottawa Sub-Region. Preceding this, in Section 7.1.1, is commentary specifically on how non-wires options were considered for this IRRP.

7.1.1 Consideration of Non-Wires Options

Complementary to the IRRP's objective to consider the most effective integrated solutions to address regional electricity system needs, technologies continue to advance and mature, increasing customer and community choice. While there is an abundance of options that may be evaluated, many resource options may not suitable for all different types of needs (whether they be capacity, load security and restoration, end of life, etc.). Moreover, resource options may address some types of needs, but perhaps only for a few years. Key considerations when evaluating non-wires option feasibility are further explained in this section.

Technical Ability to Address the Local Capacity Need

As previously described, regional planning identifies needs based upon provincial planning criteria, peak-demand forecasts, and the existing system load supply capability. While the cause of needs can vary, IRRPs focus on the shortfall between the LMC of the local area's existing transmission infrastructure and its projected load requirements during periods of peak demand.

Before other matters, the recommendations in this IRRP prioritize options that can, either alone or as a package of solutions, provide the peak capacity (MW) needed and allow the local transmission system to fulfill planning criteria. Options are therefore developed and sized according to capacity requirements rather than multi-hour energy needs. However, in recognition that non-wires options offer diverse services, hourly load forecasts (as first mentioned in Section 5.2.6) were developed for the Ottawa Sub-Region to better understand needs beyond the single peak hour. From these hourly load forecasts, needs were further characterized by three primary traits:

1. The magnitude (MW) over the supply limit,
2. The duration (consecutive hours) that demand exceeds the supply limit, and
3. The frequency at which the need occurs per year or season.

To help visualize these characteristics and show the probabilistic nature of needs – which vary daily and seasonally – the hourly load forecasts were used to produce "heat maps". An example is shown in Figure 7-2 where the estimated needs in the Kanata-Stittsville area during 2037 are depicted.

Figure 7-2: Heat Map for Kanata-Stittsville Area (Terry Fox MTS, Marchwood MTS, Kanata MTS) Needs in 2037)

24	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%
18	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%
12	2%	2%	2%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	2%	2%	2%	2%
6	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
0	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
MW / Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Each cell in the heat map shows the probability that, of the total numbers of hours where demand exceeds supply capability, a need will occur in the hour shown on the x-axis and with a magnitude shown on the y-axis or greater. For instance, of all the hours of need in the Kanata-Stittsville area in 2037, ~4% is expected to occur at 5 PM. Moreover, ~1% of need events is estimated to occur at 5 PM *and* exceed 18 MW in magnitude. Figure 7-2 also suggests that for the Kanata-Stittsville area in 2037, a need event likely occurs throughout all hours of the day – albeit its magnitude will likely vary hour to hour.

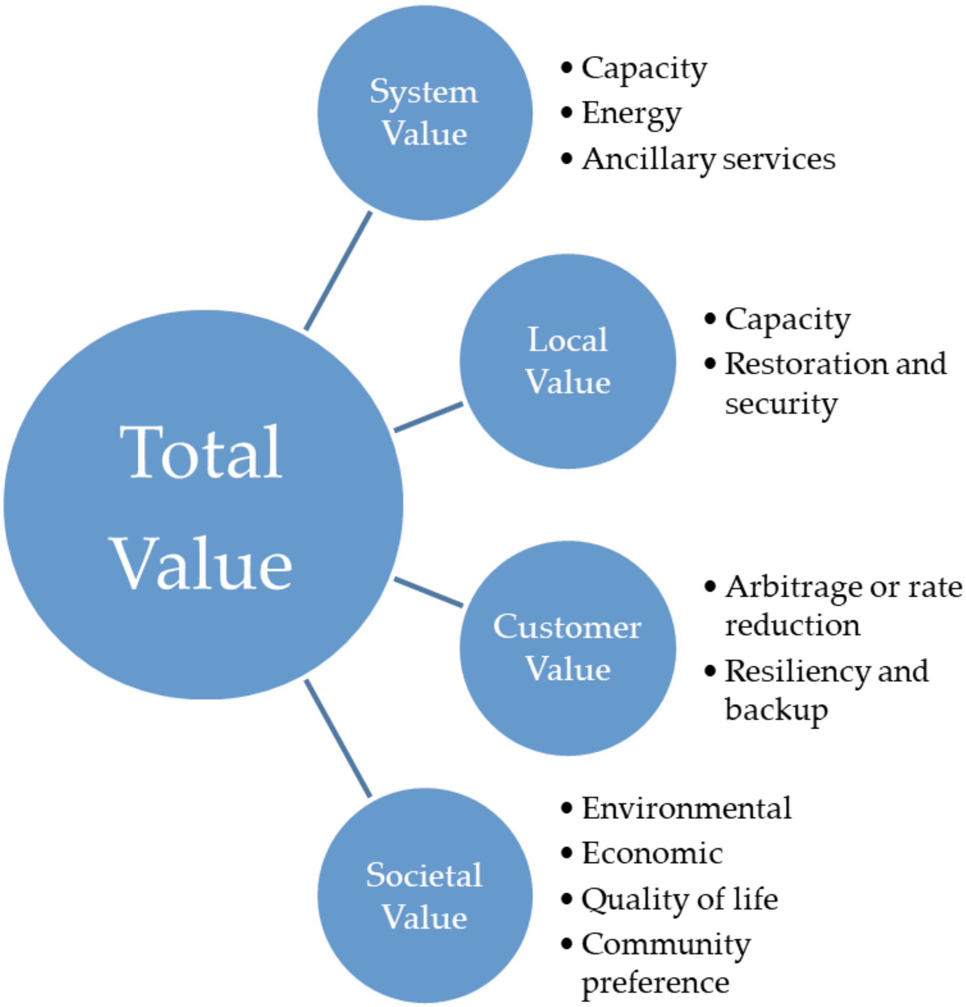
It is worthwhile to note that forecasts have less certainty as they project farther into the long-term time horizon – and this is even more significant when forecasting on a level as granular as each hour. As such, the heat maps and hourly forecasts developed for this IRRP are intended only to help better understand the nature of the needs and guide the development of non-wires options. Ultimately, when evaluating a non-wires option's technical ability to solve a need, the Working Group assessed its capacity contribution or expected performance during predicted need hours. This technical potential (a resource's capability without considering cost-effectiveness or market adoption) was then united with economic considerations to screen in or out a non-wires option.

Further details on the hourly forecasting methodology and more heat maps can be found in Appendix D.1 and D.2, respectively.

Costs and Benefits

While many non-wires options may have some technical potential to address local capacity needs identified in an IRRP, costliness can detract from their candidacy. To gauge the full costs and benefits of non-wires options, various value or funding streams must be considered. A non-wires option may have to provide multiple services concurrently to be economically viable, recovering costs through mechanisms such as regulated rates, market revenues, or program funding through uplift. Some potential value streams are highlighted in the figure below.

Figure 7-3: Potential Value Streams Provided by a Non-Wires Option



Since IRRPs focus on regional needs and their possible solutions, an option's *local value* is naturally best identified through regional planning and is traditionally recovered through regulated rates. Conversely, *system value* refers to the resource's ability to provide services to the bulk system, and is typically identified and accessed through wholesale markets.[8] *Customer value*, which may be defined as the option's ability to provide services and financial benefits directly to the customer, can be established between the option proponent and electricity customers. *Societal value* is determined by the community and includes benefits that are beyond

[8] The IESO's 2020 Annual Planning Outlook includes an avoided cost analysis that considers both avoided energy and capacity costs due to reduced demand. This avoided cost data can be found in the data tables at http://www.ieso.ca/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook.

what is typically recovered by the ratepayer (such as greenhouse gas emission reduction, economic stimuli, improved air quality, etc.).

In IRRPs, the local value of each option is prioritized. As the electricity industry evolves (including any market reform), standardized tools and methodologies may be developed to confidently compute and sum different value streams for more resource types. Overall relative costs and rates of return between all options – wires or otherwise – may be calculated, allowing for a more comprehensive comparison. Table 7-1 below characterizes the non-wires options that were considered during the development of this IRRP. Specific details regarding the local capacity deferral value available are described later, as they are dependent on the unique Ottawa area need. Additional details on the methodology for quantifying resource potential and economic comparison can be found in Appendix D.3 and D.4.

Table 7-1: All Non-Wires Options Considered for the Ottawa Sub-Region

Resource Type	Description
Energy Efficiency	Technologies and operational measures that increase the efficiency of electricity usage at the end-use level. Examples include programs for high-efficiency HVAC equipment or LED lighting.
Lithium Battery Energy Storage	Energy is stored and then dispatched during times of need.
Demand Response	Curtailment of electricity consumption targeting specific hours when a need occurs; considered to be a dispatchable resource that responds to price signals or is implemented through contractual obligations.
Natural Gas Generation	Simple Cycle Gas Turbine (SCGT): natural gas power plant whose waste heat is not used; best for peak power needs on the electric grid. Combined Heat and Power (CHP): gas generation providing both electricity and heat (for end-use).
Solar Generation	Solar panels (typically rooftop or ground-mounted) installed to provide electricity.

Other Barriers to Implementation

Even beyond a non-wires option's technical and economic feasibility, a multitude of barriers to implementation may still persist and had to be considered during the development of the Ottawa Sub-Region IRRP.[9] Some of these barriers were easily quantifiable – such as the option's

[9] Launched in 2018, the Regional Planning Process Review is exploring a number of enhancements to regional

lead time in comparison to the timing of the need, or even the duration of the need versus the longevity or persistence of the resource. Generally, demand management and energy efficiency programs can be implemented within six months (or up to two years for larger projects), whereas transmission and distribution facilities can take five to seven years to come into service. The lead time for generation development is typically two to three years, but could be longer depending on the size, technology type, or environmental impact assessment. All of these factors were considered in unison with the firmness of the needs that were identified.

Successful implementation of a non-wires option also requires community input and local intelligence. Community preferences, such as those for non-emitting resources, were inherently considered in this IRRP through its engagement process. These preferences not only influenced which options were initially evaluated by the Working Group, but also indicated the likelihood of feasibility. Zoning or siting of resources (such as large gas generation) and firmness of acquisition potential are examples of factors that impact feasibility of an option and are unique to the Ottawa Sub-Region's customers (or whoever else is ultimately responsible for hosting or implementing the solution). It is not only the maturity of a technology that was considered; local unfamiliarity and lack of experience with measures such as demand response or specific energy efficiency programs can lead to both cost and implementation uncertainty. Moreover, operational requirements (to fulfill both local and bulk system needs) and regulatory structures for cost recuperation may not yet be well defined enough to actualize all value streams. All of this, in conjunction with unknown future market behaviour and other competitive procurement processes, can contribute to even greater cost and implementation variability. These are all considerations taken into account during the development of this IRRP's recommendations.

7.1.2 Energy Efficiency Opportunities

Since March 2019, the IESO has been given a mandate to centrally deliver energy efficiency programs on a province-wide basis with a focus on business and industrial programs. Through the 2019-2020 Interim Framework, the IESO offers energy efficiency incentives and rebates to electricity customers through a suite of Save on Energy programs, which provide a valuable and cost-effective system resource that helps customers better manage their energy costs.

The IESO is currently working with government and stakeholders to consider opportunities for energy efficiency in Ontario beyond 2020 and recently completed an integrated electricity and

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Planning and includes the Barriers to Non-Wires sub-initiative. More information can be found here: http://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Regional-Planning-Review-Process natural gas conservation achievable potential study (2019 APS) in partnership with the OEB. This 2019 APS identified significant and sustained potential for energy and efficiency across all customer sectors throughout the study period.

Energy efficiency investment decisions are typically determined by assessing the cost effectiveness of the initiative (i.e., whether the incremental cost of the energy efficiency measure is outweighed by the benefits to the electricity system, with some value also being attributed to non-energy benefits such as customer comfort or improved business productivity). The 2019 APS identified energy efficiency opportunities that are cost-effective from the system perspective in all areas of the province. The cost-effective energy efficiency opportunities throughout Ottawa are shown in Appendix D, alongside more information about the methodology used to calculate energy efficiency potential. Across the Ottawa Sub-Region, by 2037, system cost-effective energy efficiency could reduce the summer peak demand by approximately 28 MW.

While the rapid growth in a region may limit the ability for energy efficiency to fully meet forecast near-term needs, any medium- to longer-term needs can present an opportunity for system cost-effective energy efficiency. Energy efficiency could also be used as an interim measure to support reliability until long-term solutions in an area are implemented. Consequently, the impact on load growth of any near-term energy efficiency initiatives in the area should be evaluated and monitored between regional planning cycles.

7.2 OPTIONS FOR ADDRESSING KANATA-STITTSVILLE AREA NEEDS

27.6 kV Supply Station Capacity

As described in Section 6.2.2, there is a need for additional station capacity to supply the 27.6 kV distribution system in the Kanata-Stittsville area because the combined demand at the three existing 27.6 kV stations is forecast to exceed the combined LMC of the three stations by 41 MW in 2020, increasing to 65 MW by 2028.[10] Demand is expected to continue increasing, at a consistent, slower rate, over the second half of the forecast period. While using this measure suggests the need for additional supply capacity is imminent, the networked 27.6 kV distribution system supplied by these three stations provides the capacity for Hydro Ottawa to

[10] These numbers are the difference between the combined demand forecast for the three Kanata-Stittsville 27.6 kV stations and the combined planning rating (LTR) of 160 MW for the three stations.

supply peak loading above the LMC for the near term. Nevertheless, a plan to address the need for supply capacity in the area should be readied for implementation in the medium term.

Several options were evaluated while considering the magnitude and timing of the cumulative capacity need: the expansion of existing stations, the construction of a new station, and the use of non-wires alternatives.

Option 1: Expansion of Existing 27.6 kV Stations

Options for reinforcing one or more existing stations in the Kanata-Stittsville area were considered – specifically, expanding Kanata MTS and Marchwood MTS. The Working Group determined that these were inadequate options due to the number of egress feeders from these stations, which are in close proximity. With no space for additional feeders on existing overhead lines, any expansion would require underground extensions. This would increase the complexity and cost of these options.

Option 2: A New Supply Station in Kanata-Stittsville

The demand forecast indicates that there is a need for 65 MW of additional station capacity in the Kanata-Stittsville area by 2028. This growth is expected to come from new residential, commercial and institutional customer connections in the area. These customers will each require an incremental amount of electricity supply, despite technological improvements in end-use efficiency. This is enough demand to utilize about 80% of the capacity of a station similar to Terry Fox MTS, which has a LMC of about 80 MW. A new supply station is therefore an important option to consider for this area of Ottawa. According to Hydro Ottawa, a new station, if built, should be located in the northern part of Kanata, to the north of Kanata MTS, and Marchwood MTS.

Developing a long-term plan for a new supply station requires evaluation of the potential transmission connection points for the new station. The IESO is currently leading the development of a long-term bulk transmission supply plan for the Ottawa area. This bulk transmission plan may recommend changes to the transmission configuration in the Kanata-Stittsville area, which may change the consideration of transmission connection options for a new station. The following paragraphs provide a high-level assessment of existing transmission connection options.

There are three existing transmission circuits that pass through the northern part of Kanata: 230 kV circuit C3S is part of a 230 kV transmission path between Ottawa and the Greater Toronto Area, and 115 kV circuits C7BM and W6CS are part of the 115 kV network between Merivale TS and the Ottawa River and Madawaska River hydroelectric generation sites. Due to the limited LMC of the 115 kV system, as described in Section 6.2.4, the Working Group determined that a 230 kV connection would be preferable.

As mentioned above, the IESO has a bulk transmission planning study underway to consider the potential end-of-life options for several circuits that were placed into service as early as the 1930s. The IESO expects to complete this study in 2020. The outcome of this study will include a plan for long-term reliable supply to Ottawa. This plan may result in changes to transmission flow on existing circuits in the area, including C3S. The study may also recommend transmission reinforcement in the western Ottawa area which could provide an additional option(s) for connecting a new supply station for northern Kanata.

Option 3: Non-Wires Alternatives

The Working Group examined the feasibility of implementing non-wires resources to offset load growth in the Kanata-Stittsville area. These potential resources, considered both on an individual basis and as a package of solutions, were outlined previously in Table 7-1.

Non-wires options may be preferred over a wires investment due to their ability to address needs more incrementally. However, due to the size of the capacity and energy needs in the Kanata-Stittsville area, most non-wires options were found to be insufficient for the deferral of a new station if used alone. For instance, peak reduction of battery energy storage was not a cost-effective option due to the long duration (spanning multiple hours) and large MW size of the need. This was illustrated in heat maps (Figure 7-2). With solar resources, because the expected capacity contribution for peak-demand reduction ranges between 13% - 30%, the costs increase significantly to install the capacity actually required. Consequently, for full station deferral in the Kanata-Stittsville area, the lowest cost resource alternative was identified to be a new natural gas-fired SCGT.

The table below shows the costs for the most cost-effective package of non-wires alternatives and compares them to the local value (i.e., what would be spent on the wires alternative). A planning estimate of approximately $33 million was used for the cost of a new 90 MVA 230 kV connection station. Note that any additional 230 kV connection costs would increase this preliminary estimate.

Table 7-2: Non-Wires Options Considered for the Kanata-Stittsville Area

<table>
<tr><th>Most Cost-Effective Non-Wires Alternative</th><th>Cost (2019 $CAD, millions)</th><th>Local Value (2019 $CAD, millions)</th><th>Remaining Costs to be Recovered (2019 $CAD, millions)</th></tr>
<tr><td>70 MW of SCGT</td><td>244</td><td rowspan="2">39</td><td>205</td></tr>
<tr><td>Package of solutions:
- 55 MW of SCGT
- 4.5 MW of DR
- 10 MW of system cost-effective EE[11]</td><td>230</td><td>191</td></tr>
</table>

This NPV assessment indicates that the majority of their costs would need to be recovered through funding streams beyond local value. This includes the possibility of the resource contributing to system needs (capacity, energy, or otherwise) and having the potential for high customer or societal value. However, considering the magnitude of remaining costs to be funded, in addition to the other barriers to implementation described in Section 7.1.1, the probability of full cost recovery for the non-wires options appears to be low. While it is prudent at this time for the Working Group to continue considering a new transformer station as the cost cost-effective long-term solution, non-wires options proponents may wish to investigate other funding streams and services provided by the non-wires options.

Details on the NPV calculation and assumptions can be found in Appendix D.4.

Recommended Actions

Addressing the need for additional 27.6 kV supply capacity in the Kanata-Stittsville area involves several components. Analysis in this IRRP suggests that the long-term plan will likely consist of a new station; however, development of this option should be coordinated with ongoing bulk transmission planning. Operational measures, as well as targeted energy efficiency, will support reliability in this area until the long-term plan is implemented.

The long-term plan for Kanata-Stittsville will be confirmed after the bulk transmission plan for the area is complete, later in 2020. In addition to considering new station connection options that arise from the bulk transmission supply plan, the long-term plan for Kanata-Stittsville will

[11] For the purpose of this non-wires options assessment, costs of system cost-effective EE were assumed to be zero. This assumes that their costs would be incurred through provincial program delivery.

consider the most up-to-date information on the potential and cost for non-wires alternatives that is available at that time.

Interim Measures

The networked distribution system in the Kanata-Stittsville area allows Hydro Ottawa to restore peak demand post-contingency at the heavily loaded Marchwood MTS and Kanata MTS. Hydro Ottawa's distribution system plan includes investments to increase load transfer capability and post-contingency capacity. While this operational capability is not equivalent to new supply capacity, this approach will support reliability at these stations for the near term.

In 2019, in consultation with IESO staff, Hydro Ottawa submitted two proposals to Save on Energy's LDC Local Program Fund (the "Fund), a program application stream which allows LDCs to continue to design and deliver energy efficiency programs that serve the needs of their specific customers. Programs approved through the Fund must demonstrate cost-effectiveness based on the resulting net benefit when comparing the program investment (cost) against the provincial average avoided costs of providing electricity (benefit). So while these investments will benefit ratepayers province-wide, these offerings are also expected to help reduce the reliability risk due to heavily loaded stations in Kanata-Stittsville.

The IESO recently approved both of Hydro Ottawa's proposed programs for delivery in 2020, which include the Kanata North Retrofit+ Program and the Kanata North Smart Thermostat Program. As highlighted below, both of these programs leverage the existing delivery infrastructure of current electricity and natural gas province-wide programs, which reduces administrative costs, streamlines customer experiences, and avoids market duplication and confusion. These local programs are an example of using system cost-effective energy efficiency to help address local system needs, and can inform similar approaches in the future. It is forecasted that these two initiatives could combine to offset more than 3 MW of peak demand in the Kanata North area in 2022. In doing so, these programs could help address the capacity need in the Kanata-Stittsville area and support reliable supply until a long-term solution for the area is implemented.

<u>Kanata North Retrofit+ Program</u>

The Kanata North Retrofit+ Program mimics the existing province-wide Save on Energy Retrofit program in that it provides participant incentives to the business sector to upgrade their facilities with measures that reduce electricity consumption. However, in the case of the local program, businesses in Kanata North are offered up to triple the provincial Retrofit incentives for measures that reduce peak demand. This is intended to make the business cases for energy efficiency projects much more attractive in order to drive higher uptake in the constrained area. In addition to the increased incentives, this program will be supported by a targeted outreach strategy that embeds three full-time resources – one energy consultant and one program consultant, along with a sales support agent – to work with customers to identify opportunities, develop business plans, submit incentive applications and support the implementation of energy efficiency measures. The energy consultant will target and engage primarily with the subsectors which represent the largest technical potential for peak-demand reduction (primarily large commercial buildings, manufacturing facilities, and data centers). The program consultant will target and engage primarily with schools, hotels, food stores, box stores, and other small businesses in the area.

Kanata North Smart Thermostat Program

The Kanata North Smart Thermostat Program intends to leverage the existing Smart Thermostat Program offered by Enbridge Gas Inc., where customers who reside in single-family households are eligible to receive an instant $75 rebate towards a qualifying smart thermostat purchased online or at Home Depot stores province-wide. However, in addition to the $75 rebate that the participant receives from Enbridge, the local program will, in many cases, subsidize the remaining cost of the smart thermostat for those qualifying households located in the area of Kanata North. Once more, this offering is meant to increase uptake in the grid-constrained area by creating a very attractive value proposition for customers to invest in energy efficiency.

By offering energy efficiency programs to a specific local area, Hydro Ottawa and Save on Energy are helping customers better manage energy use in communities where local infrastructure is in need of reinforcement. The electricity system relies on various resources and approaches to help balance electricity needs, and with offerings such as the Kanata North Retrofit+ and Smart Thermostat programs, energy efficiency is being positioned as one of the tools. Encouraging customers now to invest in energy efficiency provides short and long-term savings could reduce the need to build new infrastructure while supporting businesses as they continue to grow. The benefits of these energy efficiency programs persist over the lifetime of the equipment installed, which in most cases means they'll continue to provide relief until the long-term local supply plan can be implemented.

7.3 OPTIONS FOR ADDRESSING THE SOUTHEAST OTTAWA AREA NEEDS

27.6 kV Supply Station Capacity

As described in Section 6.2.3, there is a foreseeable need for additional station capacity to supply the 27.6 kV distribution system in the southeast Ottawa area. The planning forecast for Leitrim MS, the most southeasterly of the stations, exceeds the station's LMC by 4 MW in 2022, 20 MW in 2030 and 33 MW in 2037. This forecast is the demand remaining at Leitrim MS after the capability to transfer growth away from Leitrim MS to Uplands MTS and Limebank MTS has been maximized. Demand growth is located east of Leitrim MS at the outer edge of the station's distribution feeder range. As a result, new station capacity is required in the southeast as early as 2022, based on the limited LMC of Leitrim MS. Hydro Ottawa estimates the cost of a new 90 MVA 230 kV connection station to be approximately $28 million, plus about $5 million in 230 kV connection costs.[12]

The Working Group evaluated several options while considering the magnitude and timing of the capacity need, including non-wires resources, expansion of existing stations, and construction of a new station.

Options for New or Expanded 27.6 Supply in Southeast Ottawa

As described in Section 6.2.2, Hydro Ottawa is already pursuing expansions to Uplands MTS and Limebank MTS, to supply demand growth in the southeast Ottawa area.

Section 6.2.2 also describes how the demand at the recently expanded Hawthorne TS, which supplies Leitrim MS, is forecast to be exceed the station LMC by 2027. As noted in Section 6.2.2, a large portion of the demand growth is forecast at Leitrim MS, and moving this growth away from both Leitrim MS and Hawthorne TS removes the need for additional supply capacity at Hawthorne TS. Accordingly, expanding Leitrim MS or supplying a new 44kV/27.6 kV station from Hawthorne TS is not a feasible means of increasing 27.6 kV supply capacity in southeast Ottawa.

Transmission circuit L24A is a 230 kV circuit that connects Hawthorne TS to St. Lawrence TS (in the Cornwall area) and is part of the bulk transmission system that supplies the Ottawa area from the south. This circuit passes through southeast Ottawa, slightly west of Highway 417.

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[12] Connection cost estimate is based on preliminary assumptions about the connection configuration and the proximity of the station to the transmission line.

Due to the sparse transmission network on the east side of Ottawa, L24A is the only option for connecting a new station to supply the southeast area.

Non-Wires Alternatives

The Working Group examined the feasibility of implementing non-wires resources to reduce the forecast demand in the area and defer the need for a new station or existing station expansion. These potential resources, considered both on an individual basis and as a package of solutions, were defined previously in Table 7-1. Similar to the economic assessment performed for Kanata-Stittsville area needs, costs for the most cost-effective package of non-wires alternatives in Southeast Ottawa were compared to the theoretical local value (i.e., what would be spent on the new 90 MVA 230 kV connection station).

Table 7-3: Non-Wires Options Considered for the Southeast Ottawa Area

<table>
<tr><th>Option</th><th>Cost (2019 $CAD, millions)</th><th>Local Value (2019 $CAD, millions)</th><th>Remaining Costs to be Recovered (2019 $CAD, millions)</th></tr>
<tr><td>35 MW of SCGT</td><td>151</td><td rowspan="2">39</td><td>112</td></tr>
<tr><td>Package of solutions:
- 25 MW of SCGT
- 4.5 MW of DR
- 7 MW of system cost-effective EE[13]</td><td>93</td><td>54</td></tr>
</table>

Similar to what was described for the Kanata-Stittsville area options, the NPV assessment for the Southeast Ottawa area indicates that the majority of the non-wires alternatives costs would need to be recovered through other funding streams beyond local value. Therefore, the probability of full cost recovery for the non-wires options appears to be low, and it is prudent for the Working Group to continue considering a new transformer station as the most cost-effective long-term solution.

Details on the NPV calculation and assumptions can be found in Appendix D.4.

[13] For the purpose of this non-wires options assessment, costs of system cost-effective EE were assumed to be zero. This assumes that their costs would be incurred through provincial program delivery.

Recommended Actions

A new 27.6 kV station supplied by 230 kV circuit L24A is the preferred wires option to supply the southeast Ottawa area. This station will provide a new supply point in a growing part of the City that is more than 10 km from the existing supply stations, therefore reducing distribution distances for customers.

Hydro Ottawa, the station proponent, has not yet identified a site for a new station in proximity to circuit L24A. Once a site is identified, Hydro Ottawa will initiate the environmental approval process, which will include engaging with stakeholders and communities. The size and design of the new station will be similar to that of two other Hydro Ottawa stations: Terry Fox MTS, completed in 2014, and South Nepean MTS which is currently under construction and scheduled to be in service before the end of 2022. Based on the costs of these two stations, the estimated cost of the new supply station is $28 million, plus approximately $5 million in 230 kV connection costs, assuming the new station is in close proximity to 230 kV circuit L24A. Hydro Ottawa indicates this station could be in service as early as 2025. The Working Group recommends that Hydro Ottawa initiate development work and seek approval for this new station.

Interim Measures

Hydro Ottawa has indicated that they will continue to redistribute loads in the southeast area between their existing supply stations over the coming years, for example as expanded capacity becomes available at Uplands MTS and Limebank MTS. Hydro Ottawa may also utilize some of the small amount of supply capacity available at Hydro One's Greely TS (less than 10 MW) to meet near-term demands near the service boundary as an interim measure until the new station is available.

7.4 OPTIONS FOR ADDRESSING ORLEANS AREA NEEDS

Bilberry Creek TS End-of-Life

As described in Section 2.3, the Working Group has been aware since the previous regional planning cycle that Bilberry Creek TS is approaching its end of life. The Working Group considered the two main options of retiring Bilberry Creek TS or refurbishing Bilberry Creek TS with like-for-like transformers. These options are described in the following subsections.

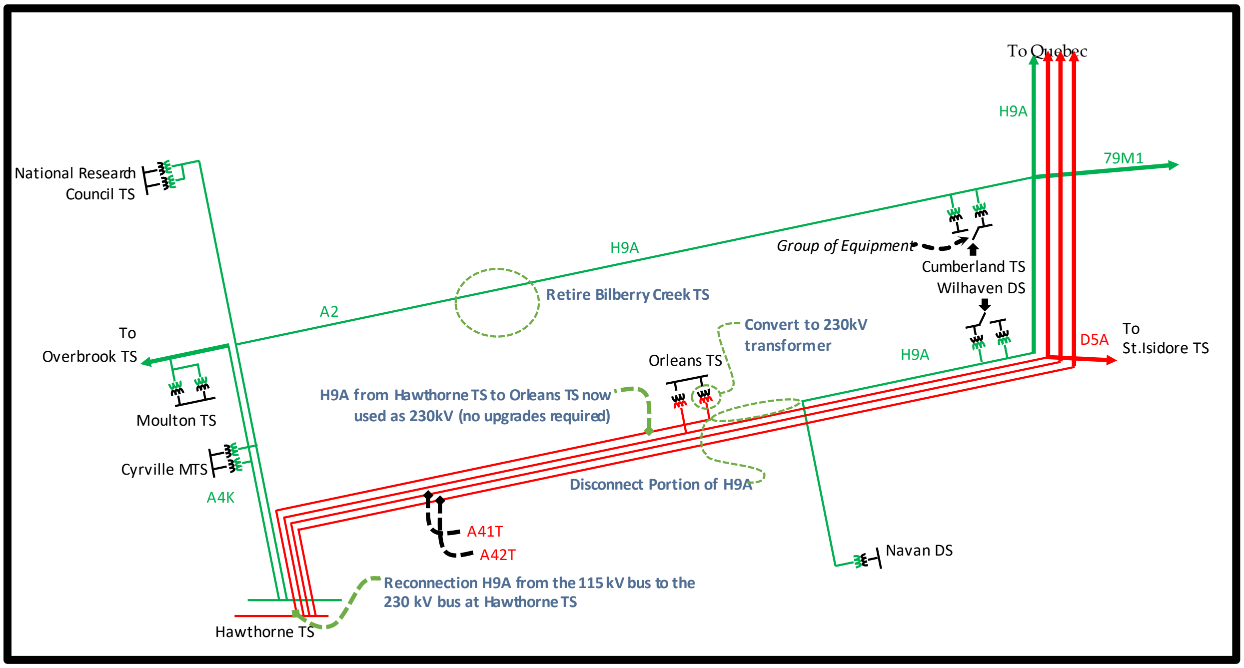
Option 1: Retire Bilberry Creek TS

In local areas where electricity demand is declining or shifting geographically retiring an existing transmission station at the end of its life and consolidating demand at a newer station may be part of a cost-effective plan. Like many parts of Ottawa, Orleans is a growing community with an increasing electricity demand forecast. While Bilberry Creek TS itself is not fully loaded, the nearby Orleans TS is forecast to be loaded to its planning capacity by 2025. The combined demand forecast for the two stations is 167 MW in 2023, rising slowly to 179 MW in 2028. The planning capacity of Orleans TS is 117 MW, so in terms of these two stations combined, if Bilberry Creek TS were retired in 2023 there would be an immediate shortfall of station capacity in the area. Additional station capacity (i.e., a new station or an expansion of Orleans TS), preferably supplied by the local 230 kV network due to the supply limitations on the regional 115 kV transmission system, would be needed to replace the loss of Bilberry Creek TS as soon as it were retired.

The retirement of Bilberry Creek TS option was therefore considered in conjunction with transferring Bilberry Creek TS customers to an expanded Orleans TS. This option would take advantage of the opportunity to convert 115 kV circuit H9A to 230 kV operation and convert the existing Orleans TS DESN to dual 230 kV supply, eliminating the brief outages that occur before switching to 230 kV operation when 115 kV circuit H9A is not available, as described in Section 6.2.3. A single line diagram of this configuration is shown in Figure 7-4. Hydro One indicated that in conjunction with the conversion to dual 230 kV supply the existing Orleans TS DESN could be expanded to 170 MVA (153 MW). This option would cost approximately $21 million, but would not result in sufficient capacity to supply the combined Bilberry Creek TS and Orleans TS demand forecast for 2023.

The option of retiring Bilberry Creek TS, would therefore need to be implemented in conjunction with a larger incremental capacity option than the expansion of the existing Orleans TS DESN could provide. This would likely take the form of a new second DESN station at the Orleans TS location, an option that would cost about $30 million.

Figure 7-4: Single Line Diagram of the East Ottawa Transmission System if Bilberry Creek TS Were Retired

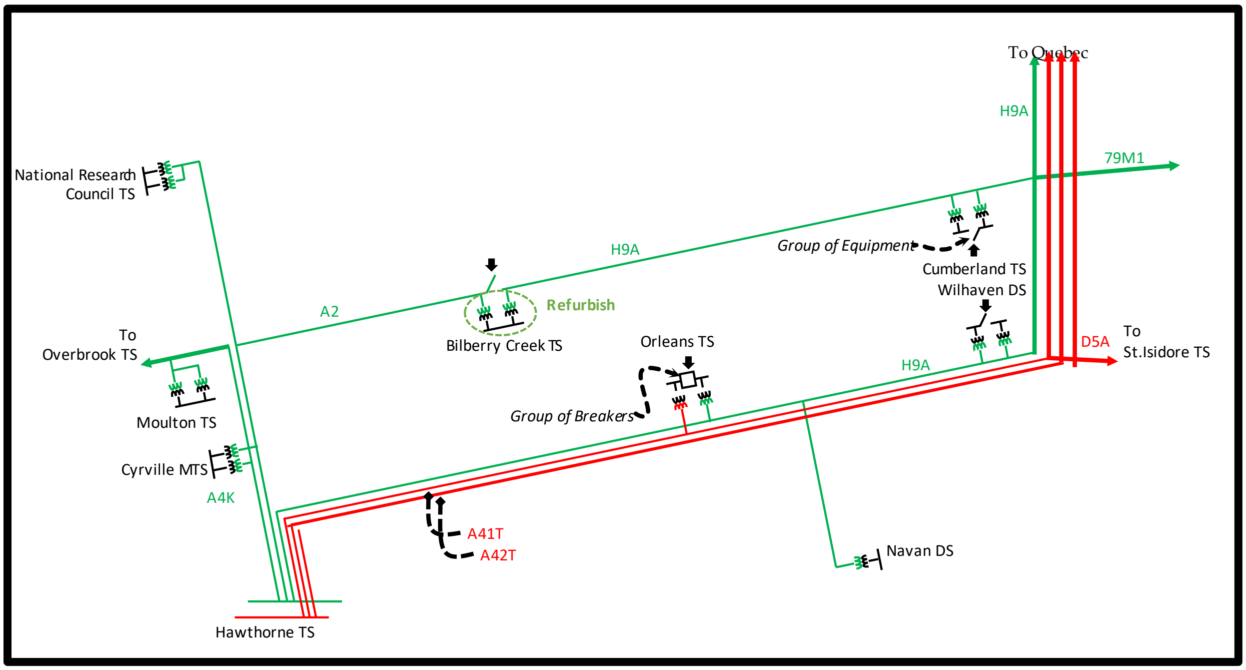


Option 2: Refurbish Bilberry Creek TS

The second main option is to refurbish Bilberry Creek TS. This includes the like-for-like replacement of two step-down transformers, the replacement of the majority of the low voltage breakers, and the installation of a new protection and control building. A single line diagram of this configuration is shown in

Figure 7-5. This option maintains the existing total of 225 MVA (202.5 MW) of supply capacity at the two stations; however, two new feeder positions would need to be added to Bilberry Creek TS to enable Hydro Ottawa to transfer some of the demand growth forecast for Orleans TS. This option would cost approximately $22 million and would provide adequate supply station capacity for the forecast period.

Figure 7-5: Single Line Diagram of the Existing Transmission Configuration in Orleans (Consistent with Option 2)



Recommended Actions

A comparison of the retire Bilberry Creek and refurbish Bilberry Creek options is shown in Table 7-4, on the following page. The demand forecast for Bilberry Creek TS and Orleans TS is also provided in Table 7-5 for reference.

Table 7-4: Comparison of Two End-of-Life Options for Bilberry Creek TS

Option	Estimated Cost	Resulting Supply Capacity in 2023	Adequacy of Supply Capacity for Combined Bilberry Creek TS and Orleans TS Forecast	Additional Benefits
Retire Bilberry Creek TS, Expand Orleans TS and Convert Orleans TS to dual 230 kV supply	$21 million	153 MW	Insufficient supply capacity for the forecast period. Additional supply capacity (i.e., a second DESN station at Orleans TS) would be required in 2023.	• Orleans TS is converted to a dual 230 kV supply • Decreases demand on the 115 kV system in the area
Refurbish Bilberry Creek TS and Provide Two Additional Feeder Positions for Hydro Ottawa	$22 million	202.5 MW	Adequate supply capacity for the forecast period	• Retains a second supply point in the northern part of the community

Table 7-5: IRRP Forecast for Bilberry Creek TS and Orleans TS

Station Forecast (MW)								
Station	**2023**	**2025**	**2027**	**2029**	**2031**	**2033**	**2035**	**2037**
Bilberry Creek TS	51.8	51.5	51.2	51	50.7	50.9	50.9	51
Orleans TS	115	119.4	126.1	129.1	130.8	132.1	134	134.9
Total	**166.8**	**170.9**	**177.3**	**180.1**	**181.5**	**183**	**184.9**	**185.9**

The Working Group recommends that Hydro One proceed with the like-for-like refurbishment of Bilberry Creek TS, with expansion to accommodate two additional breaker positions to supply Hydro Ottawa customers. The two options that were considered have similar estimated costs, however only the refurbishment option results in sufficient capacity to supply the combined demand forecast at Bilberry Creek TS and Orleans TS.

The decision to refurbish Bilberry Creek TS and expand the station in order to transfer some of the demand growth from Orleans TS will increase the loading on 115 kV circuit H9A by the mid-2020s. The 2018 Needs Assessment identified a potential voltage regulation need on 79M1, a 65 km 115 kV transmission circuit that branches off of 115 kV circuit H9A and supplies five stations on the outskirts of Ottawa. The Needs Assessment noted that the voltage on circuit 79M1 is dependent on the loading on H9A. As stated in the 2018 Greater Ottawa Needs Assessment, Hydro One will review the impact of forecast changes on the 79M1 voltage as part of the Regional Infrastructure Plan.

7.5 OPTIONS FOR ADDRESSING CENTRAL OTTAWA NEEDS

Recommended Action for Slater TS

Hydro Ottawa and Hydro One are investigating the feasibility and cost-effectiveness of replacing T2 and T3 at Slater TS with larger 100 MVA transformers, as was the case for the recent replacement of T1. This will increase the station's LMC by approximately 50%. This additional LMC would provide Hydro Ottawa with flexibility to transfer load from other stations in the downtown Ottawa area, where there are limited options for siting new supply stations. Hydro One anticipates completing the transformer replacement at Slater TS by the end of 2023.

Recommended Action for Albion TS

The working group has confirmed the need to retain the station at its existing transformation capacity. Hydro One will therefore proceed with its sustainment plan, with expected in service of 2026.

Recommended Action for Lincoln Heights TS

Hydro One intends to replace transformers T1 and T2 at Lincoln Heights with equivalent transformers when they reach end of life. Hydro One, the asset owner, anticipates completing the transformer replacement at Lincoln Heights TS later than 2025.

7.6 OPTIONS FOR ADDRESSING THE REGIONAL 115 KV SYSTEM NEEDS

As described in Section 6.2.4, T22 at Merivale TS is presently limiting the LMC of the 115 kV system. The Working Group recommends that Hydro One replace T22 with a larger capacity transformer so that it more closely matches the T21, the companion transformer Merivale TS. Hydro One estimates that this project will cost $10 million. Transformer T22 was put in service in 1978. Replacing it in the near-term advances the end-of-life replacement.

After transformer T22 is replaced, the LMC of the 115 kV system will be limited pre and post contingency by several of the 230/115 kV transformers. The complexity of the multiple subsequent constraints means that further increasing 115 kV supply will require consideration of expanding Merivale TS to include a third 230/115 kV transformer, an option that costs in the range of $100 million. This potential costly option to increase the LMC of the 115 kV system must be considered in conjunction with planning for the loading of 115 kV transmission circuits, and the 115 kV system stations, in order to ensure that all costs related to 115 kV system expansion option are included. A plan for the 115 kV system will consider the potential for non-wires alternatives to manage demand growth at heavily loaded individual stations supplied by the 115 kV system, while maintaining demand on the overall 115 kV system within the LMC of the existing 230/115 kV transformers. Another approach that will be considered is the potential for converting some 115 kV transmission lines and supply stations to 230 kV supply.

This IRRP has identified the scope and complexity of integrated planning needs for the 115 kV system in the Ottawa area, however additional work is required beyond the timeframe of this IRRP. Following the completion of this IRRP, the Working Group will focus on developing a long-term integrated plan for the 115 kV transmission system. This work will be coordinated with the IESO's ongoing bulk transmission planning study for the Ottawa area, which may consider bulk transmission options that provide additional considerations for future supply to existing 115 kV stations.

7.7 SUMMARY OF RECOMMENDED ACTIONS AND NEXT STEPS

Table 7-6, below, summarizes the specific recommendations that should be implemented immediately to address the most imminent electricity supply needs in the Ottawa area.

Table 7-6: Summary of 2020 Ottawa Sub-Region IRRP Recommendations

Area	Need	Recommended Solutions	Lead Responsibility	Estimated Cost	Timeline
Kanata-Stittsville	27.6 kV Supply Capacity	Implement the North Kanata Retrofit Top-Up Program and the North Kanata Smart Thermostat Program, targeted commercial and residential energy efficiency programs.	Hydro Ottawa	Cost for these system cost-effective resources will be recovered through a provincial program.	Beginning in 2020
Southeast Ottawa	27.6 kV Supply Capacity	Plan and seek approval for a new 230 kV connected supply station in southeast Ottawa.	Hydro Ottawa	MTS: $28 million; 230 kV connection: $5 million	Estimated in-service date for the new station: 2025
Orleans	Bilberry Creek TS End-of-Life	Proceed with the like-for-like refurbishment of Bilberry Creek TS, with expansion to accommodate two additional breaker positions to supply Hydro Ottawa customers.	Hydro One	$22 million	Planned completion: 2025
Central Ottawa	Slater TS End-of-Life Transformers	Replace end-of-life Slater TS transformers T2 and T3 with larger 100 MVA transformers, as was done for the recent end-of-life replacement of T1.	Hydro One	To be confirmed	Planned completion: late 2023
Central Ottawa	Albion-TS End-of-Life Transformers and Switchgear	Proceed with the like-for-like replacement of the transformers which are approaching their end of life.	Hydro One	To be confirmed	Planned completion: mid 2026

Central Ottawa	Lincoln Heights TS End-of-Life Transformers	Proceed with the sustainment plan for replacement of the transformers which are approaching their end of life.	Hydro One	To be confirmed	Planned completion: 2025
Regional 115 kV System	115 kV Supply Capacity	Replace Merivale TS Transformer T22 with one that is approximately equivalent to T21.	Hydro One	$10 million	Planned completion: mid-2020s

The Working Group has also identified the following additional planning activities to address ongoing regional planning needs.

Targeted Need or Area	**Action**	**Timeframe**
Across the Sub-Region	Monitor the City of Ottawa's Energy Evolution mandate and explore the potential for alignment between integrated regional planning and the Energy Evolution mandate.	Throughout the next regional planning cycle
Regional 115 kV System	Develop a long-term plan for the 115 kV transmission system. This study will include an assessment of the potential for non-wires alternatives to manage demand growth at heavily loaded stations supplied by the 115 kV system while maintaining demand on the overall 115 kV transmission system within the capability of the existing 230/115 kV transformers.	2020
Across the Sub-Region	Monitor demand growth and the status of major development proposals on an annual basis. The next regional planning cycle is scheduled to begin in 2023, however it could be triggered sooner if the Working Group identifies a material need.	Annually

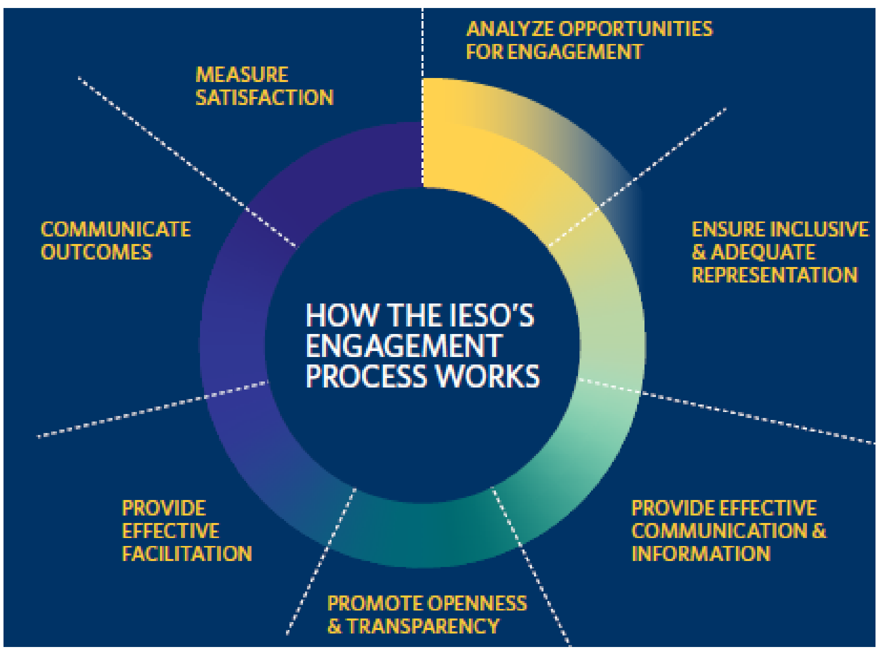
8 Community and Stakeholder Engagement

Engaging with communities and interested parties is an integral component of the regional planning process. Providing opportunities for input in regional planning enables the views and preferences of the community to be considered in the development of an IRRP and helps lay the foundation for successful implementation. This section outlines the engagement principles and activities undertaken for the Ottawa Sub-Region IRRP.

8.1 ENGAGEMENT PRINCIPLES

The IESO's Engagement Principles[14] guided the process to help ensure that all interested parties were aware of and could contribute to the development of this IRRP. The IESO uses these principles to ensure inclusiveness, sincerity, respect and fairness in its engagements, and to support its efforts to build trusted relationships.

Figure 8-1: IESO Engagement Principles



[14] http://www.ieso.ca/Sector-Participants/Engagement-Initiatives/Overview/Engagement-Principles

8.2 CREATING AN ENGAGEMENT APPROACH

The outreach and engagement approach was designed to ensure the IRRP reflected input from key community and stakeholder representatives. A dedicated engagement web page[15] was also created to provide openness and transparency throughout the engagement process. This web page hosted all engagement activities, including background information, presentations and public meetings/webinars on the development of this IRRP, as well as previous plans for the area.

The IESO's email subscription service for the Greater Ottawa planning region was used to send information to interested communities and stakeholders who subscribed to receive updates. Targeted outreach to municipalities, Indigenous communities and other business sectors in the region was also conducted at the outset of this engagement and continued throughout the planning process.

In addition, regular communications were sent via the IESO's weekly Bulletin, which includes subscribers from across Ontario's electricity sector.

8.3 ENGAGE EARLY AND OFTEN

Leveraging relationships built during the previous planning cycle, the IESO held preliminary discussions to help inform the engagement approach during this second planning cycle – starting with the Scoping Assessment Outcome Report.

Early communication and engagement activities began with invitations to all subscribers and targeted communities to learn about and provide comments on the draft Greater Ottawa Scoping Assessment Outcome Report before it was finalized. This scoping assessment identified the need for an IRRP specifically for the Ottawa Sub-Region, and included Terms of Reference to guide development of the plan. Following a window for comments to be submitted by interested parties, the final Scoping Assessment Outcome Report was published in September 2018. No comments were received during this feedback period.

Outreach then began with targeted communities to inform early discussions for the development of the IRRP including the IESO's approach to engagement. In response to the input received through these initial discussions, the IESO undertook direct outreach and

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[15] http://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Integrated-Regional-Resource-Plan-Ottawa-Area-Sub-Region

engagement with municipal councilors in targeted areas of need in the City of Ottawa. The launch of a broader engagement initiative followed with an invitation to subscribers to ensure that all interested parties were made aware of this opportunity for input.

Two public webinars were held at major junctures during IRRP development to give interested parties an opportunity to hear about its progress and provide comments on key components. Both webinars received strong participation with cross-representation of stakeholders and community representatives attending the webinar, and submitting written feedback during a 14-day comment period.

The first webinar sought input on the electricity demand forecast and needs in the Ottawa area and potential solutions to be examined. Several comments were received during the feedback window that touched on the following major themes:

- Non-wires solutions
- Land use
- GHG reduction
- Cost effectiveness
- Feasibility of generation

As a final step in the engagement initiative, a second public webinar was held to seek input on the analysis of options and draft IRRP recommendations. Feedback received during the written comment period were related to the major themes below:

- Options analysis: delivery models
- Options analysis: non-wires alternatives
- Alignment with local initiatives
- Engagement

Based on the discussion in the webinar and written feedback received, it is clear that there is a strong interest and need for ongoing monitoring of capacity and local demand growth and continued discussion and engagement with communities and stakeholders. While there is strong community interest in non-wires alternatives, the near-term nature of the needs will require other solutions to be in place in order to ensure a continued reliable electricity supply to support rapid local growth. Furthermore, other factors and initiatives that may have an impact on local electricity needs will continue to evolve post IRRP, such as projects arising from the City of Ottawa's Energy Evolution. To that end, ongoing discussions will continue through the

IESO's Eastern Ontario Regional Electricity Network to keep interested parties engaged on local developments, priorities and planning initiatives.

All background information, including engagement presentations, recorded webinars, detailed feedback submissions, and responses to comments received, are available on the IESO's Integrated Regional Resource Plan engagement web page.

8.4 OUTREACH WITH MUNICIPALITIES

As the City of Ottawa was a key stakeholder in the development of this IRRP, the IESO held a number of meetings with City representatives, to exchange information on municipal planning and electricity planning processes, as well as the City's community energy transition strategy, called Energy Evolution. Meetings began in August 2018 at the outset of this planning project and continued in April, August and October 2019. These meetings were held with municipal representatives in the climate change resiliency and planning areas, as well as with some City Councilors to build awareness and provide opportunities to raise concerns that might arise from their constituents. No concerns were raised. The potential for future alignment between Energy Evolution and regional planning was also a topic of discussion with municipal representatives. In addition to helping to inform the City's electricity needs, these meetings also provided opportunities to strengthen relationships to enable ongoing dialogue beyond this IRRP process.

9 Conclusion

This report documents an IRRP that has been carried out for the Ottawa Sub-Region of the OEB's Greater Ottawa planning region. The IRRP identifies electricity needs in the sub-region over the 20-year period from 2018-2037 and recommends preferred solutions to address near-term needs. The Working Group recommends Hydro One initiate a RIP. The Working Group will continue to provide support throughout the RIP process, and assist with any regulatory matters that may arise during plan implementation.

The IRRP also identifies actions to monitor, defer, and address remaining needs and to inform the next regional planning cycle. The Ottawa Sub-Region Working Group will continue to meet at regular intervals to monitor developments in the sub-region and track progress toward the plan deliverables. In the event that underlying assumptions change a new regional planning cycle may be initiated sooner than the OEB mandated five-year schedule.