HAMILTON SUB-REGION INTEGRATED REGIONAL RESOURCE PLAN

Part of the Burlington to Nanticoke Planning Region | February 25, 2019

Connecting Today. Powering Tomorrow.

Integrated Regional Resource Plan

Hamilton

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

The IESO prepared the IRRP on behalf of the Hamilton sub-region Technical Working Group (the "Working Group"), which included the following members:

- Independent Electricity System Operator
- Alectra Utilities Corporation
- Hydro One Networks Inc. (Distribution)
- Hydro One Networks Inc. (Transmission)

The Working Group assessed the adequacy of electricity supply to customers in the Hamilton sub-region over a 20-year period; developed a flexible, comprehensive, integrated plan that considers opportunities for coordination in anticipation of potential demand growth scenarios and varying supply conditions; and developed an implementation plan for the recommended options, while maintaining flexibility to accommodate changes in key conditions over time.

The Working Group members agree with the IRRP's recommendations and support implementation of the plan through the recommended actions, subject to obtaining all necessary regulatory and other approvals.

Table of Contents

List of Figures

List of Tables

List of Appendices

List of Abbreviations

Abbreviations	Descriptions
CDM or Conservation	Conservation and Demand Management
CTS	Customer-owned Transformer Station
DG	Distributed Generation
DR	Demand Response
DESN	Dual Element Spot Network
FIT	Feed-in Tariff
Hydro One	Hydro One Networks Inc.
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
KWCG	Kitchener-Waterloo-Cambridge-Guelph
LDC	Local Distribution Company
LMC	Load Meeting Capability
LRT	Hamilton Light Rail Transit
LTR	Limited Time Rating
MVA	Mega Volt Amp
MW	Megawatt
OEB	Ontario Energy Board
OPA	Ontario Power Authority
ORTAC	Ontario Resource and Transmission Assessment Criteria
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
TS	Transformer Station
TWh	Terawatt-Hours
Working Group	Technical Working Group for Hamilton sub-region IRRP

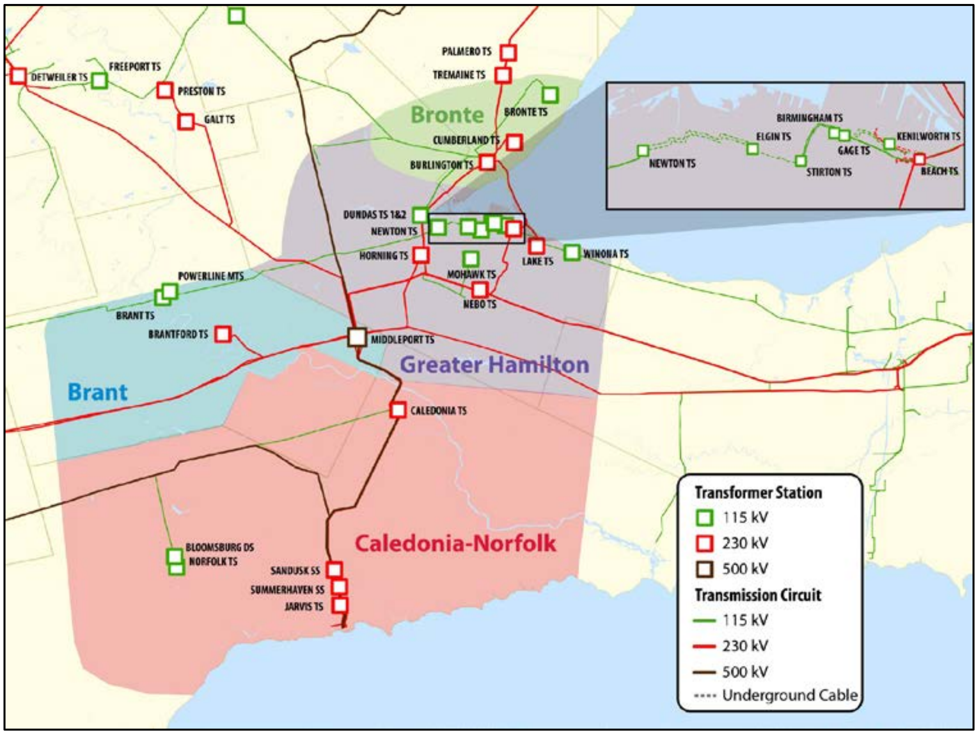
1. Introduction

This Integrated Regional Resource Plan ("IRRP") addresses electricity needs for the Hamilton sub-region over the next 20 years. This report was prepared by the Independent Electricity System Operator ("IESO") on behalf of the Working Group composed of the IESO, Alectra Utilities ("Alectra"), Hydro One Networks Inc. ("Hydro One") (Hydro One Distribution, and Hydro One Transmission).[1]

In Ontario, planning to meet the electrical supply and reliability needs of a large area or region is achieved through regional electricity planning, a process that was formalized by the OEB in 2013. In accordance with the OEB's regional planning process; transmitters, distributers and the IESO are required to conduct regional planning activities for the province's 21 electricity planning regions at least once every five years. The Hamilton sub-region is one of four sub-regions within the Burlington to Nanticoke planning region, one of the OEB's 21 identified regions (Figure 1-1). The other sub-regions within the Burlington to Nanticoke region are Bronte, Brant, and Caledonia-Norfolk.

[1] For the purpose of this report, "Hydro One Transmission" and "Hydro One Distribution" are used to differentiate the transmission and distribution accountabilities of Hydro One Networks Inc., respectively.

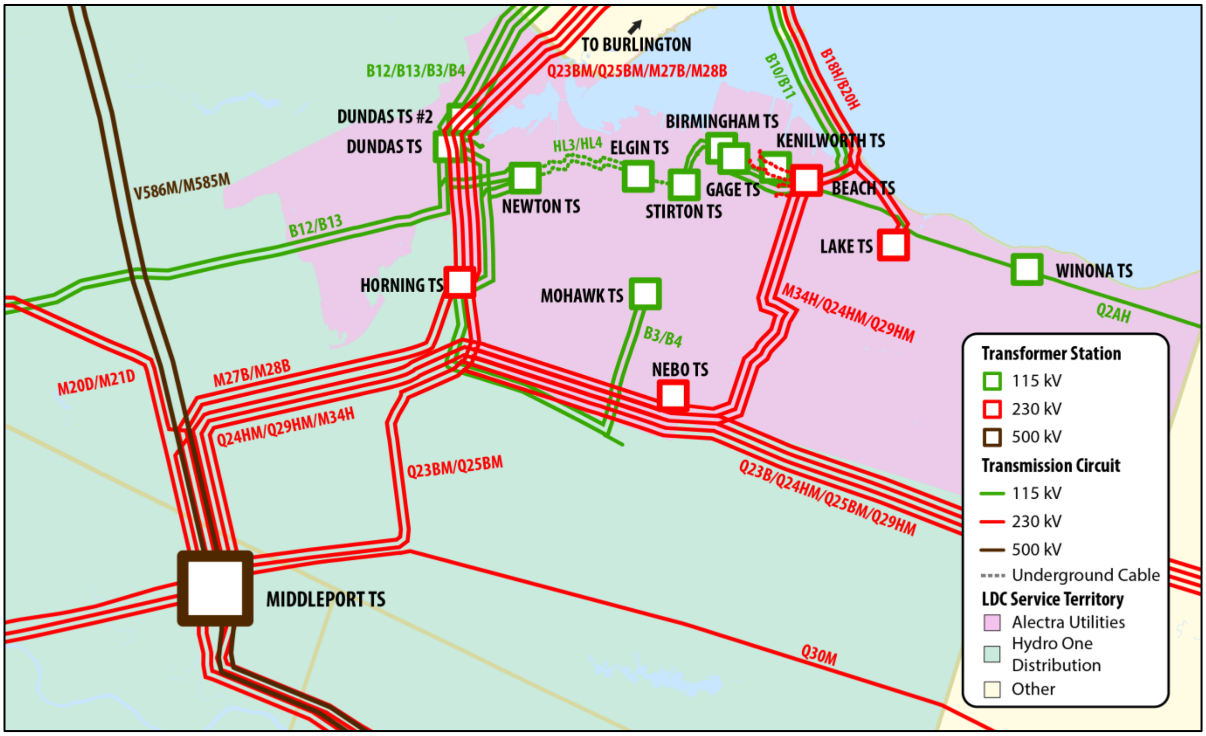
Figure 1-1: Map of the Burlington to Nanticoke Region



The Hamilton sub-region is a summer-peaking region that is the City of Hamilton and is supplied from the Beach, Birmingham, Dundas, Dundas #2, Elgin, Gage, Kenilworth, Mohawk, Newton, Lake, Nebo, Horning, Stirton, and Winona transformer stations ("TS"). The Hamilton sub-region also includes three customer-owned transformer stations ("CTS"). The approximate geographical boundaries of the sub-region are shown in Figure 1-2.

The study area is shown in Figure 1-2, along with the service area of each local distribution company ("LDC") in the sub-region.

Figure 1-2: Map of Hamilton Sub-region



This IRRP identifies power system capacity and reliability requirements, and options to meet customer needs in the area over the next 20 years. Specifically, this IRRP identifies recommendations to meet a number of end-of-life asset replacement needs that will arise over the study period. These recommendations account for current and forecast system conditions when determining the optimal replacement option for these aging transmission assets.

Given forecast uncertainty, the longer development lead time and the potential for technological change, the plan does not recommend specific investments or projects to meet long-term needs. Instead, the plan identifies near-term actions to consider alternatives, engage with the community, and gather information to lay the groundwork for determining options for future analysis. These actions are intended to be completed before the next IRRP cycle, scheduled for 2023 or sooner, depending on demand growth. Completion of the recommended actions will inform decisions for the next planning cycle, particularly with respect to end-of-life asset replacement needs, should any be required at that time.

This report is organized as follows:

- A summary of the recommended plan for the Hamilton 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 Hamilton sub-region and the study scope are discussed in Section 4;
- Demand forecast scenarios, and Conservation and Demand Management ("CDM" or "conservation") and distributed generation ("DG") assumptions, are described in Section 5;
- Electricity needs in the Hamilton sub-region are presented in Section 6;
- Alternatives and recommendations for meeting needs are addressed in Section 7;
- A summary of engagement to date and moving forward is provided in Section 8; and
- A conclusion is provided in Section 9.

2. The Integrated Regional Resource Plan

The Hamilton sub-region IRRP provides recommendations to address the electricity needs forecast for the area over the next 20 years, based on the application of the IESO's Ontario Resource and Transmission Assessment Criteria ("ORTAC"). This IRRP identifies three main categories of needs over the near term (up to five years, or 2017[2] through 2021), medium term (six to 10 years, or 2022 through 2026) and longer term (11 to 20 years, or 2026 through 2036). These planning horizons reflect the different levels of forecast certainty, lead time for development, and planning commitment associated with the length of each term.

The IRRP was developed based on consideration of planning criteria, including reliability, cost, feasibility, and flexibility. In examining a number of end-of-life asset replacement needs over the near-, medium- and long-term planning horizons, this IRRP seeks to maximize the use of existing electricity system assets in the context of the forecast conditions for the overall planning area.

However, as a number of these significant asset replacement needs are forecast to arise in the future, it is not necessary, nor would it be prudent given forecast uncertainty and the potential for technological change, to recommend specific projects at this time. Instead, the IRRP identifies near-term actions to gather information and lay the groundwork for future options. These actions are intended to be completed before the next IRRP cycle so that their results can inform further discussion at that time.

The recommendations in the IRRP are focused on replacement of assets at their end of life, relieving modest capacity needs in pockets of the area, and ensuring that reliability is met by examining the capability to restore load throughout the area following specific transmission outages. The recommendations are summarized below.

2.1 Plan for Asset Replacement

The plan to meet a number of medium- and long-term end-of-life asset replacement needs was developed to maximize the use of the existing electricity system in consideration of planning criteria, such as reliability, cost, and feasibility, as outlined earlier in section 2. The plan

[2] When the IRRP study was initiated in 2017, the most recently available historical data (2016) was used as the basis for the load forecast, with 2017 being the first forward looking year of the study period. The Working Group monitored activity in the region throughout the duration of the planning process and accounted for any significant changes in the base year assumptions.

accounts for the forecast long-term development of the sub-region's electricity system and reflects uncertainty inherent in long-term planning, particularly for needs that are not forecast to emerge until the latter half of the study period.

Due to the age and condition of the transmission infrastructure in the Hamilton sub-region, a number of past planning products have focused primarily on the area's end-of-life asset replacement needs. At the end of the first cycle of regional planning for the broader Burlington-Nanticoke area, the 2017 Regional Infrastructure Plan ("RIP") published by Hydro One identified and recommended several sustainment projects (i.e., end-of-life replacement projects) for load supply transformer stations in the Hamilton sub-region. The stations and lines where replacement work was identified and the high-level scope of work outlined in the RIP are summarized in Table 2-1.

Table 2-1: Summary of Ongoing End-of-Life Asset Replacement Work in the Hamilton Sub-region

Station/Line Section	Proposed Configuration	Proposed In-service Date
Horning TS	• Replace end-of-life transformers T1/T2 and rebuild the two sets of end-of-life low-voltage switchgear they currently supply	2018[3]
Beach TS	• Replace end-of-life transformers T3/T4 and uprate from a 115 kV (kilovolt) supply to a 230 kV supply	2018[4]
Mohawk TS	• Replace existing end-of-life transformers T1/T2	2018[5]
Elgin TS	• Replace the four existing end-of-life single winding transformers (T1/T2/T3/T4) with two new dual winding transformers, and the three existing low-voltage switchgear with two new switchgear	2020[6]
B3/B4 115 kV Line	• Refurbish from Horning Mountain Jct. to Glenford Jct.	2020[7]

[3] Work has been completed.
[4] Work has been completed.
[5] Updated in-service date since RIP was completed.
[6] Updated in-service date since RIP was completed.
[7] Updated in-service date since RIP was completed.

Station/Line Section	Proposed Configuration	Proposed In-service Date
Gage TS	• Replace the four existing end-of-life single winding transformers (T3/T4/T5/T6) with two dual winding transformers and replace the end- of-life low-voltage switchgear	2021[8]
Kenilworth TS	• Downsize number of station transformers by decommissioning T1/T4, replacing T3 and using T2/T3 to supply a new bus to replace the end-of- life bus previously supplied by T1/T4	2021

The projects include end-of-life replacement of station and line assets, as well as reconfigurations of these stations based on their historical or forecast utilization. By the time of this IRRP, significant work had already been completed at these stations, with facility in-service dates ranging from 2018 to 2021. Further details on the scope and driver of a number of these projects are provided in Appendix D, which includes a report by Hydro One summarizing the ongoing planned sustainment work for a number of stations in the Hamilton Bayfront Industrial Area servicing predominantly industrial customers.

The impact of these sustainment projects in terms of station layout and capacity were considered when assessing the capability of the transmission system in the Hamilton sub-region, as well as the area's mid- to long-term electricity needs. Hydro One is also planning on refurbishing the line tap section (Horning Mountain Jct. to Glenford Jct.) of 115 kV circuits B3/B4, which supplies Mohawk TS, in 2020. The potential incremental change in line rating provided by this work has been considered in the IRRP studies.

Both Hydro One's needs assessment and the IESO's scoping assessment identified additional near-term end-of-life needs for consideration in this planning cycle, through either local planning or in the IRRP. The IRRP recommends a set of actions to address end-of-life asset replacement needs identified at Newton TS, Lake TS, Beach TS, and for the underground 115 kV transmission cables in the Hamilton sub-region.

[8] Updated in-service date since RIP was completed.

Recommended Actions

1. Rebuild End-of-Life Equipment at Lake TS

The low-voltage switchgear supplied by one set of station transformers at Lake TS requires replacement in the 2025 timeframe. To ensure that load in the Lake TS area can be adequately supplied and to maintain desired distribution supply voltages, the Working Group recommends that existing equipment be replaced with the closest available standard without resulting in downsizing of the facilities.

2. Rebuild End-of-Life Equipment at Newton TS

To mitigate challenges posed by the station transformers and a number of the 115 kV breakers at Newton TS reaching end of life, the Working Group recommends that existing equipment be replaced with the closest available standard without resulting in any downsizing of facilities. The targeted in-service date for the project is currently 2025 based on the latest assessments of asset condition, as well as the need to coordinate work with the Hamilton Light Rail Transit ("LRT") project.

3. Explore Feasibility of Future Consolidation at Beach TS as Equipment Continues to Reach End of Life

In the mid to long term, the Beach TS T5/T6 DESN (dual element spot network[9]) transformers and the associated low-voltage switchgear will reach their end of life. Based on the current load forecast for the Beach TS service area, this could present an opportunity to reduce the number of transformers and/or the amount of low-voltage switchgear at the station. The need to replace existing T5/T6 transformers and low-voltage switchgear is expected to arise in 2027. Given this timing, the current and forecast load, and associated lead time of the solution, the recommendation is for the Working Group to monitor station load growth and asset condition before making a final determination on whether to proceed with reconfiguring the station in the next planning cycle.

[9] Dual element spot network (DESN) refers to a standard station layout used throughout the province, where two supply transformers are paralleled to supply one or two low-voltage switchgear, which the distributor uses to supply load customers. The paralleled dual supply ensures a standard level of reliability where one supply transformer can be lost due to an outage or planned maintenance without compromising customer supply.

4. Undertake a Comprehensive Study of the Hamilton Sub-region 115 kV Cables

The long-term need to replace the 115 kV underground cables in the Hamilton sub-region once they reach end of life would benefit from a detailed study investigating the impact of sustained cable outages if a failure were to occur. Since Hydro One has recently advanced the current forecast need date for end-of-life cable replacement to 2026 from 2017-2032, is the Working Group recommends that a detailed study of the associated contingencies be initiated in Q2 2019 and completed before the next planning cycle as an addendum to the IRRP. A study plan for the proposed work is provided in Appendix C.

5. Undertake a Bulk Transmission Planning Study of the Broader Area

To investigate replacement options for the Beach TS autotransformers once they reach end of life, the Working Group recommends the autotransformers be studied as part of the broader Middleport area bulk transmission planning study. This work will occur later than anticipated in the terms of reference of the IESO's scoping assessment due to the ongoing development of the IESO's formalized bulk planning process and the timing of the next cycle of regional planning for the Kitchener-Waterloo-Cambridge-Guelph ("KWCG") region, which also falls within the Middleport area. Since the Beach TS autotransformers are expected to require replacement in 2027, outcomes of the bulk study will inform recommendations for the scope of replacement.

2.2 Plan for Managing Long-term Growth and Capacity Needs

Based on the IRRP planning forecast presented in section 5.6, and assuming provincial conservation targets remain in place, the Hamilton sub-region's electricity demand is expected to stay relatively flat in the medium to long term.

This IRRP sets out the near-term actions required to ensure options are available to address future capacity needs in the most efficient and cost-effective way, if and when they arise. The recommended actions also focus on ensuring that if capacity needs emerge, conservation and other opportunities to manage growth are adequately explored.

Recommended Actions

1. Ensure End-of-Life Replacement Work Proceeds as Planned for Mohawk TS

In the 2017 RIP, Hydro One recommended a plan both to replace the supply transformers at Mohawk TS with the closest available standard, and to refurbish the section of 115 kV line supplying that Mohawk TS. As the IRRP forecast identifies a minor capacity need at Mohawk TS, addressed through the incremental capacity offered by this planned refurbishment, that need, the Working Group recommends that this work proceed toward its associated in-service dates and be fully completed by 2020.

2. Implement Conservation and Distributed Generation

The implementation of provincial conservation is a key action of the Hamilton sub-region near-term plan, which will continue to offer benefits into the medium and long term. In developing the demand forecast, peak-demand impacts associated with meeting provincial targets were assumed before identifying the residual needs, consistent with the approach taken in all IRRPs.

Meeting provincial conservation targets amounts to approximately 96 MW (Megawatt), or 165% of the forecast demand growth in the Hamilton sub-region during the first 10 years, and a total of 181 MW, or 184% of the total forecast demand growth by the end of the study period. Existing conservation targets, combined with the relatively flat growth rate of gross load forecast for the area result in an overall negative growth rate over the study period.

In particular, implementation of the existing target helps to address the existing capacity need at Nebo TS and maintain load levels below the available station capacity into the medium and long term based on the forecast. Up to 34 MW of demand growth at Nebo TS is addressed by existing CDM targets over the study period. Achievement of provincial conservation targets is key to ensuring that capacity needs do not arise in the Hamilton sub-region over the mid to long term, particularly in the Nebo TS and Mohawk TS service territories.

Absent of provincial targets, or if the forecast load were to increase for these areas, additional studies into the local achievable potential of CDM for impacted areas should be undertaken by the Working Group as part of its efforts to monitor the study area between regional planning cycles.

On an annual basis, the IESO, with the Working Group, will review CDM achievement, the uptake of provincial DG projects, and actual demand growth in the Hamilton sub-region. This information will be used to determine when decisions on the long-term plan are required, and to inform the next cycle of regional planning for the area. Information on conservation and DG is also a useful input into the ongoing development of non-wires options as potential long-term solutions.

2.3 Plan for Maintaining Reliability through Timely Load Restoration

While relatively low load growth is forecast for the Hamilton sub-region over the study period, some reliability needs are linked to the existing load levels at a number of stations. The issues identified arise from the amount of load interrupted for certain transmission outages. In these instances, recommendations may need to be made depending on the level of load lost and how quickly it can be restored.

Recommended Action

1. Use Identified Load Transfer Capability on the Distribution System to Restore Load

Existing load restoration needs were identified for the loss of the B3/B4 115 kV supply circuits, as well as the Q24HM/Q29HM 230 kV supply circuits. In both instances, Alectra was able to identify existing distribution load transfer capability that can be utilized in conjunction with existing transmission reconfiguration options to restore the lost load in excess of 150 MW within four hours, satisfying the ORTAC planning criteria.

3. Development of the IRRP

3.1 The Regional Planning Process

In Ontario, meeting the electricity needs of customers at a regional level is achieved through regional planning, which assesses the interrelated needs of a region—defined by common electricity supply infrastructure—over the near, medium, and long term and develops 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 a five-year planning cycle conducted for the province's 21 planning regions. The process is carried out by the IESO, in conjunction 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 identifies recommendations to meet the identified needs requiring coordinated planning and/or 4) a RIP, led by the transmitter, 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.

3.2 Hamilton Sub-region Working Group and IRRP Development

The process to develop the Hamilton sub-region IRRP was initiated in 2017 with the release of the needs assessment report for the Burlington to Nanticoke region prepared by Hydro One Transmission with participation from the IESO, Alectra, and Hydro One Distribution. This process was carried out to identify needs that may require coordinated regional planning in the Burlington to Nanticoke region. The subsequent scoping assessment report produced by the IESO recommended that a number of needs identified for the Hamilton sub-region be further pursued through an IRRP. This was due to the potential for coordinated solutions and due to the significant number of assets reaching end of life.

In 2017 the Working Group was formed to develop terms of reference for this IRRP, gather data, identify near- to long-term needs in the area, and recommend near-, medium-, and long-term actions.

4. Background and Study Scope

This is the second cycle of regional planning for the Burlington to Nanticoke region. When the OEB formalized the regional planning process in 2013, planning work was already ongoing in the Brant area, a sub-region of the Burlington to Nanticoke region. As such, Burlington to Nanticoke became one of the Group 1 planning regions, the first to undergo the formalized regional planning process.

On May 23, 2014, Hydro One Transmission published the first needs assessment report for the region. Subsequently on September 25, 2014, the former Ontario Power Authority ("OPA") (which has since merged with the IESO) published a scoping assessment report for the Burlington to Nanticoke region. The report, which specified the terms of reference for the Bronte IRRP (and the already published terms of reference for the Brant IRRP), indicated no IRRP was required for the Hamilton or Caledonia-Norfolk sub-regions and that the needs identified for those sub-regions would be addressed through local planning between the LDCs and the transmitter.

IRRPs were completed for the Brant and Bronte sub-regions in April 2015 and June 2016, respectively, and Hydro One completed a local planning report for the broader region in October 2015. On the basis of these planning reports, Hydro One completed the Burlington to Nanticoke RIP on February 7, 2017.

The RIP identified a number of regional sustainment investments above and beyond what was indicated in earlier planning products. At the time that the RIP was published, many of these projects were already underway, due to the transmitter's end-of-life considerations. Many of the sustainment investments identified in the RIP had also appeared in Hydro One's 2017/2018 rate filing with the OEB.

Due to the timelines associated with the near-term investments in the RIP, the IESO reviewed the ongoing work with Hydro One in the context of existing plans for the region and the latest load forecast information, particularly for the Hamilton Bayfront Industrial Area (Gage TS, Beach TS, Kenilworth TS, and Birmingham TS). Further details on these projects are provided in Table 2-1 in section 2.1 and an updated copy of the report Hydro One prepared as part of this review can be found in Appendix D. Additionally, the RIP recommended that, in light of the new sustainment information available for the mid to long term, the next cycle of regional planning for the Burlington to Nanticoke region should begin and Hydro One should conduct a needs assessment, which triggered the next cycle of regional planning, the IESO's scoping assessment, and the Hamilton sub-region IRRP.

Building on these past regional studies and taking into account updates to activities in the region and LDCs' load forecasts, this report presents an IRRP for the Hamilton sub-region for the 20-year period from 2017 to 2036, with a focus on identifying recommendations for the identified end-of-life asset replacement needs. To set the context for this IRRP, the scope of the planning study and the area's existing electricity system are described in section 4.1.

4.1 Study Scope

This IRRP develops and recommends options to meet the supply needs of the Hamilton sub-region in the near, medium, and long term. The plan was prepared by the IESO on behalf of the Working Group. The plan includes consideration of forecast electricity demand growth, CDM, transmission and distribution system capability, relevant community plans, developments on the bulk transmission system, condition of transmission assets, and generation uptake.

The needs addressed in this IRRP include adequacy, security, and relevant end-of-life asset considerations.

The following transmission facilities were included in the scope of this study:

- 230 kV connected stations – Beach TS (T3/T4), Beach TS (T5/T6), Horning TS, Lake TS, Nebo TS;
- 115 kV connected stations – Newton TS, Dundas TS, Dundas #2 TS, Mohawk TS, Elgin TS, Stirton TS, Birmingham TS, Gage TS, Kenilworth TS, Winona TS;
- Three customer-owned transformer stations (CTS);
- 230 kV transmission lines – B18H/B20H, H35D/H36D, Q24HM/Q29HM, M27B/M28B;
- 115 kV transmission lines – B12/B13, Q2AH, B10/B11, B3/B4, HL3/HL4115 kV;
- Transmission cables – H5K/H6K, K1G/K2G, HL3/HL4; and
- 230/115 kV autotransformers at Beach TS and Burlington TS.

Supply to the Hamilton sub-region is provided from three main points: Burlington TS, Beach TS and Middleport TS. The 115 kV supply southwest from Burlington TS and the 230 kV supply from Beach TS service the 115 kV network in the Hamilton sub-region, while 230 kV circuits between Burlington TS and Beach TS, Beach TS and Middleport TS, and Middleport TS and Burlington TS supply the Hamilton sub-region's 230 kV connected load supply stations. The supply to the 115 kV system in the Hamilton sub-region is dependent on the 230 kV/115 kV autotransformers at Beach TS and Burlington TS. These transformers form part of the bulk transmission system, as they are impacted by changes in load and generation in the broader Middleport area (including Niagara, KWCG, Brant, Caledonia, and Bronte), rather than the local system. Accordingly, any needs related to the autotransformers are assessed by the IESO through a separate bulk planning study.

The Hamilton sub-region and its supply infrastructure are shown in Figure 4-1 and Figure 4-2.

Figure 4-1: Regional Transmission Facilities

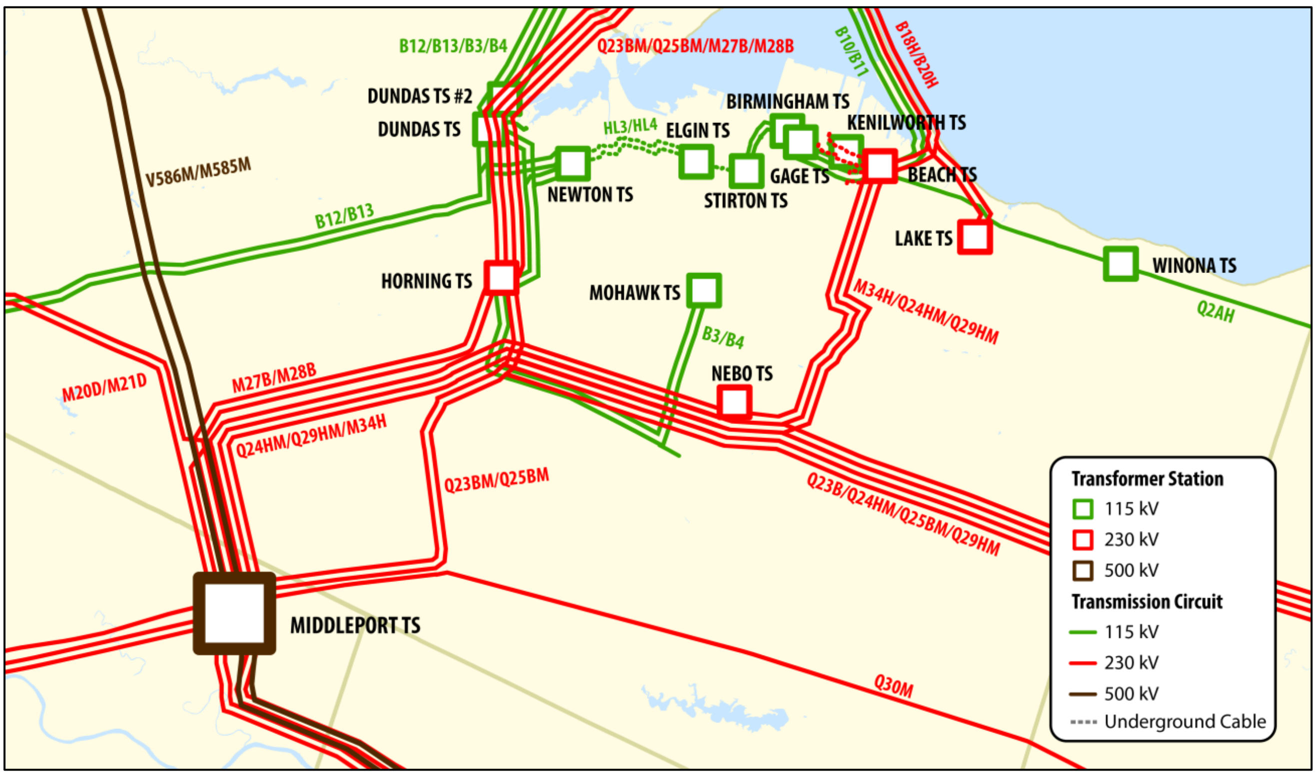
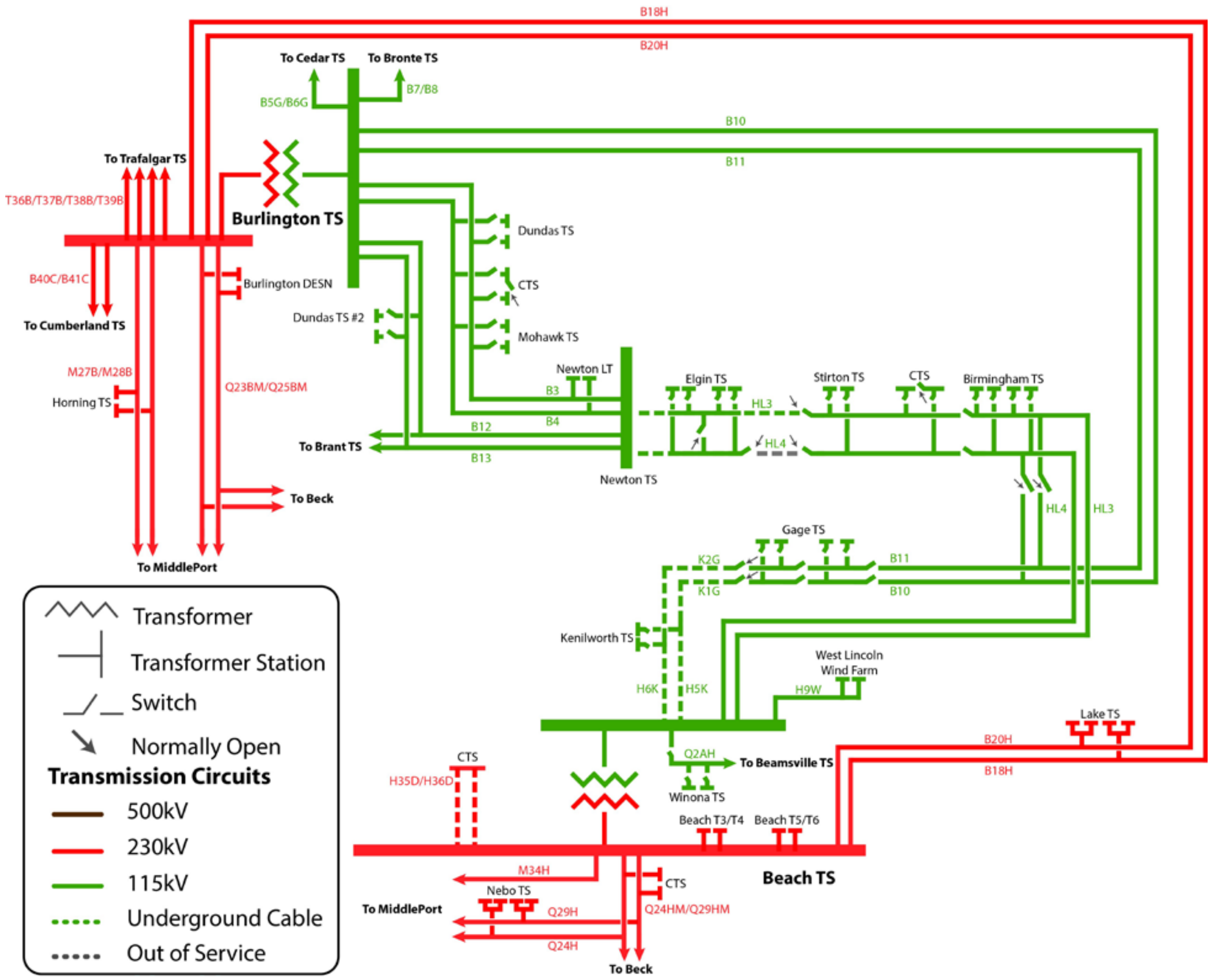


Figure 4-2: Hamilton Sub-region Electrical Sub-system and Single Line Diagram[10]



The Hamilton sub-region IRRP was developed by completing the following steps:

- Preparing a 20-year electricity demand forecast and establishing needs over this timeframe.
- Examining the load meeting capability ("LMC") and reliability of the transmission system supplying the Hamilton sub-region, taking into account facility ratings and performance of transmission elements, transformers, local generation, and other facilities, such as reactive power devices. Needs were established by applying the ORTAC.

[10] The single line diagram reflects the end-of-life replacement projects that are already underway for the Hamilton area with in-service dates in the near-term, as identified in Table 2-1.

- Confirming identified end-of-life asset replacement needs with the transmitter.
- Establishing feasible integrated alternatives to address needs, including a mix of CDM, generation, transmission and distribution facilities, and other electricity system initiatives.
- Evaluating options using decision-making criteria that include technical feasibility, cost, reliability performance, flexibility, environmental and social factors.
- Developing and communicating findings, conclusions and recommendations.

5. Demand Forecast

5.1 Demand Forecast Methodology

For the purpose of the IRRP, a 20-year planning forecast was developed to assess electricity supply and reliability needs at the regional level.

Regional electricity needs are driven by the limits of the transmission infrastructure supplying an area, which is sized to meet peak-demand requirements. Regional planning, therefore, typically focuses on the growth in regional-coincident peak demand. Since the load today in the Hamilton sub-region is relatively low compared to the existing system's capability and is forecast to remain relatively flat, station-level forecast information is also a focus. Station-level forecasts allow capability in pockets where there is load growth, or where existing equipment has been historically close to its load supply capability, to be more closely assessed.

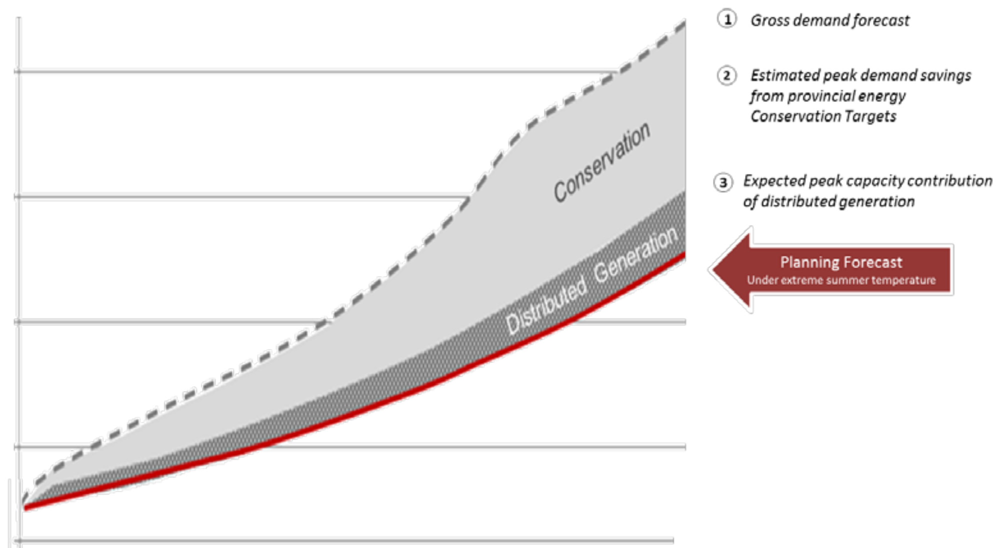
The 20-year planning forecast is divided notionally into three timeframes: near, medium, and long term. The near term (0-5 years) has the highest degree of certainty; any near-term needs are typically met using regional transmission or distribution solutions as other methods (i.e., DG or CDM) are still being tested to determine if their lead times will be suitable. The medium term (5-10 years), however, typically provides more lead time to develop and incorporate DG and CDM options.

The long-term forecast, which covers the 10- to 20-year period and has the lowest degree of certainty, is used to identify potential longer-term needs, and for the consideration and development of integrated solutions, including CDM, DG, and major transmission upgrades. Early identification of potential long-term needs and solutions makes it possible to begin engagement with the local community and all levels of government long before the need is triggered. This provides the greatest opportunity to gain input on decision-making, and to ensure local planning can account for new infrastructure.

To address the long-term uncertainty in the load forecast for the Hamilton sub-region IRRP, the existing system was assessed to determine its ability to supply new large customer loads, particularly on the 115 kV system. This approach was informed by Alectra's knowledge of anticipated load growth in the area and the fact that potential large customer loads with a preference for capacity above other location considerations are currently a main source of mid- to long-term forecast uncertainty.

The regional peak demand forecast was developed as shown in Figure 5-1. Gross-demand forecasts, assuming normal-year weather conditions, were provided by the LDCs and informed by conversations with transmission-connected customers in each LDC's service territory. The LDC forecasts are based on growth projections included in regional and municipal plans. Additional details on the assumptions in the LDC forecast can be found in Appendix B. These forecasts were then adjusted to produce a planning forecast (i.e., to reflect the peak-demand impacts of provincial energy-efficiency activities, DG contracted through provincial programs such as FIT and microFIT, and extreme weather conditions). The planning forecast was then used to assess any growth-related electricity needs in the region.

Figure 5-1: Development of Demand Forecast



Using a planning forecast that is net of provincial conservation targets (short- and long-term) assumes that the energy-based targets will be met and will produce corresponding local peak-demand reductions. An important aspect of plan implementation will be monitoring the actual peak-demand impacts of conservation programs delivered by area LDCs and, as necessary, adapting the plan. Additional details related to the development of the demand forecast are provided in Appendix B.

5.2 Gross-Demand Forecast

Each participating LDC in the Hamilton sub-region prepared gross-demand forecasts at the TS level, or at the station bus level for multi-bus stations.[11] Gross-demand forecasts account for increases in demand from new or intensified development, but not for the impact of future DG or new conservation measures, such as codes and standards and demand response ("DR") programs. However, LDCs are expected to account for changes in consumer demand resulting from typical efficiency improvements and response to increasing electricity prices, or "natural conservation."

LDCs have the best information on customer and regional growth expectations in the near and medium term, since they have the most direct involvement with their customers. Most LDCs cited alignment with municipal and regional official plans as a primary source for input data. Other common considerations included known connection applications and typical electrical demand for similar customer types. More details on the LDCs' load forecast assumptions can be found in Appendix B.

The Hamilton sub-region also includes three transmission-connected industrial customers. The forecast for these customers was completed based on information gathered from outreach during the planning process.

Figure 5-2 shows the gross-demand forecast information, for median weather conditions, provided by LDCs combined with the forecast for transmission-connected customers in the Hamilton sub-region, with historical data points provided for comparison.

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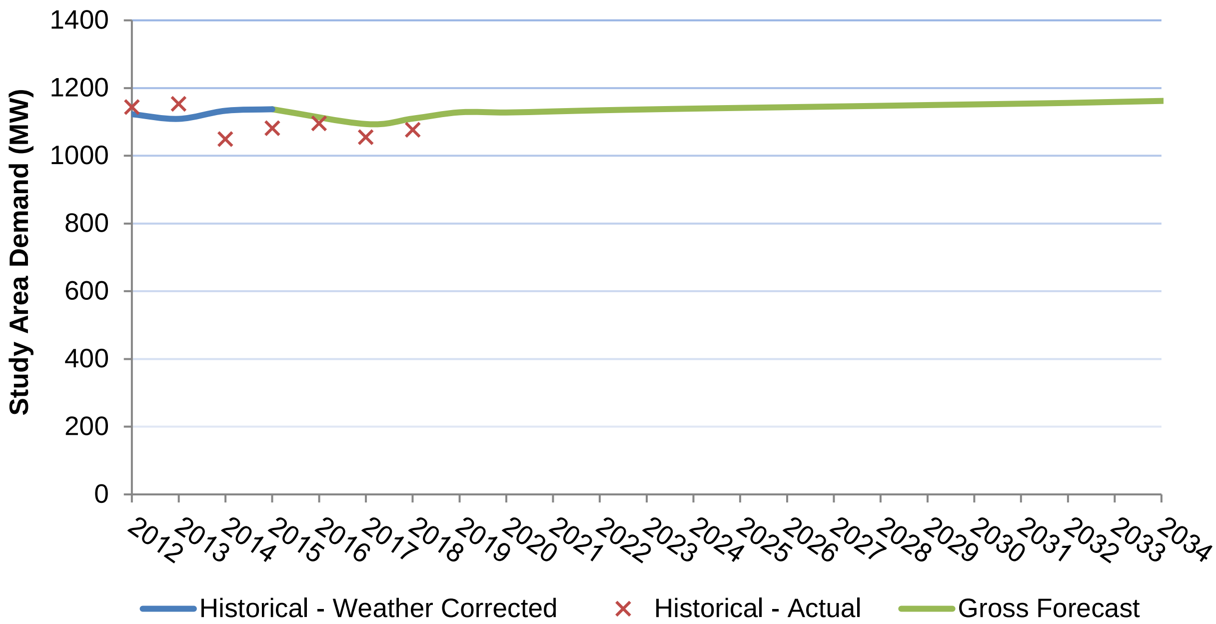
[11] Often transformers will supply multiple buses at a station. As the amount of load that a transformer can supply will vary based on how load is shared between buses, it can often be useful to have a bus-level forecast depending on the nature of the capacity needs in an area.

Figure 5-2: Hamilton Sub-region Gross Forecast



Relatively flat historical load in the sub-region is expected to continue over the study period. Total annual growth averages 0.5% per year for the study area over the 20-year planning horizon. Growth is highest in the initial two years at an average of 2.0% per year, before dropping to an average of 0.36% per year for the following years. Although the forecast is shown for the entire area, individual stations are forecast to experience different growth rates.

The forecast was provided based on best available information and, as appropriate, will be updated going forward. The gross-demand forecast by station is provided in Appendix B.

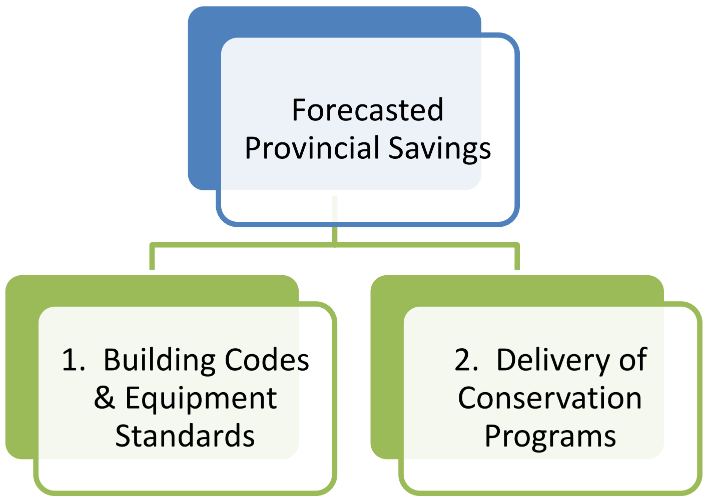
5.3 Conservation Assumed in the Forecast

Conservation is achieved through a mix of program-related activities, rate structures, and 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, helping to keep demand within equipment capability. The conservation savings forecast for the Hamilton sub-region have been applied to the gross peak-demand forecast for median weather, along with DG resources (described in section 5.4), to determine the net peak demand for the sub-region.

The reference forecast estimates and applies peak-demand impacts, assuming that 30 TWh of energy-efficiency savings will be achieved at a provincial level by 2032. As policy related to future provincial energy-efficiency activities change, the forecast assumptions will be updated accordingly.

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

Figure 5-3: Categories of Conservation Savings



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

For the Hamilton sub-region, the impacts of the estimated savings for each category were further broken down by the residential, commercial and industrial customer sectors. The IESO worked with the LDCs to establish a methodology to estimate the electrical demand impacts of the energy targets by these three customer sectors. This provides a better resolution for the forecast conservation, as conservation potential estimates vary by sector due to different energy consumption characteristics and applicable measures.

For the Hamilton 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 conservation category – codes and standards, and conservation programs. Due to the unique characteristics and available data associated with each group, estimated savings were determined separately. The final estimated conservation peak-demand reduction, 181 MW by 2036, was applied to the gross demand to create the planning forecast. Table 5-1 provides the conservation peak-demand savings for a selection of the forecast years.

Table 5-1: Peak-Demand Savings (MW) from Conservation Targets, Select Years

Year	2018	2020	2022	2024	2026	2028	2030	2032	2034	2036
Savings (MW)	28	46	55	73	96	123	149	172	179	181

Additional conservation forecast details are provided in Appendix B.

5.4 Distributed Generation Assumed in the Forecast

In addition to conservation resources, DG in the Hamilton sub-region is also forecast to offset peak-demand requirements. The introduction of the *Green Energy and Green Economy Act, 2009*, and the associated development of Ontario's FIT Program, has increased the significance of distributed renewable generation which, while intermittent, contributes to meeting the province's electricity demands.

After applying conservation savings to the demand forecast as described above, the forecast is further reduced by the expected peak contribution from contracted, but not yet in service, DG in the sub-region. The effects of projects that were already in service prior to the base year of the forecast were not included, as they are already embedded in the actual demand, which is the starting point for the forecast. Potential future (but uncontracted) DG uptake was not included and is instead considered as an option for meeting identified needs.

Based on the IESO contract list as of October 17, 2017, new DG projects are expected to offset an incremental 25.5 MW of peak demand within the Hamilton sub-region by 2021.[12] The distribution-connected contracted generators included in the forecast are a mix of solar, combined heat and power ("CHP"), and biomass generators. The majority of generators in the sub-region are CHP (63% of contracted generation), then solar (34% of contracted generation), followed by biomass (accounting for approximately 3% of contracted generation). A capacity contribution of 77%, to the regional peak, has been assumed to account for the expected output of the mix of local generation resources during summer peak conditions (due to the heavy weighting of CHP facilities).

Additional details of the regional demand reductions from province-wide DG programs are provided in Appendix B.

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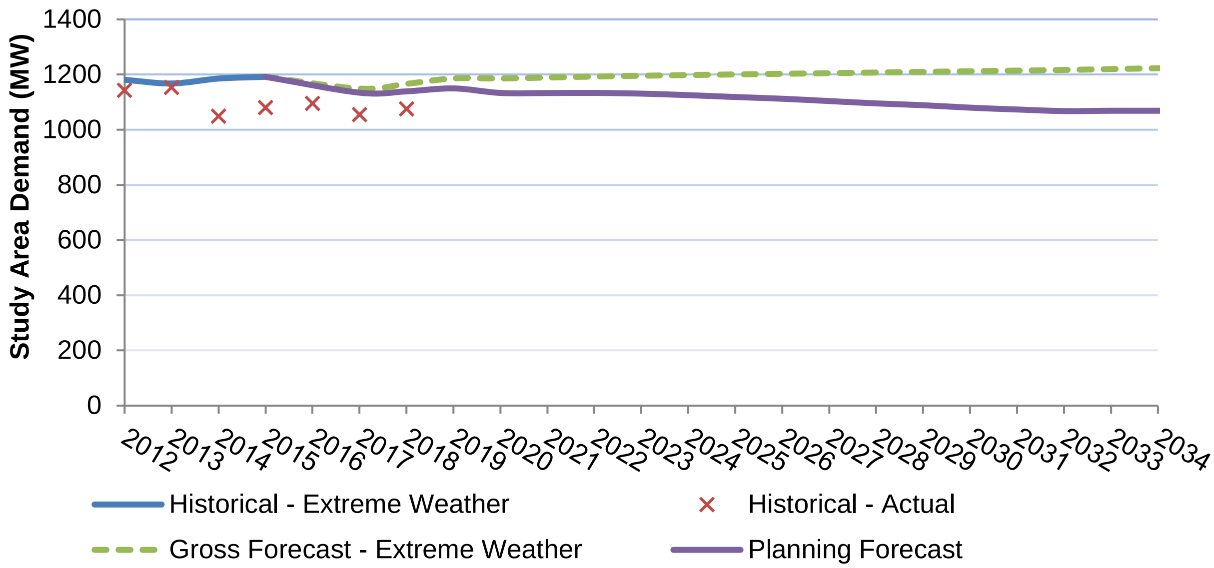
[12] Since the IRRP forecast was developed, there have been contract terminations for some generators included in the original 2017 list. This impacts 5.55 MW of contract capacity or 2.5 MW of the forecast peak demand offset for the planning sub-region.

5.5 Planning Forecasts

After taking into consideration the combined impacts of conservation and DG, a 20-year planning forecast was produced.

Figure 5-4 below illustrates the planning forecast, along with historic demand in the area. Note that the planning forecast has been adjusted for extreme weather conditions. For comparison, the gross-demand forecast has also been adjusted for extreme weather conditions. Further details of the planning forecast scenarios are provided in Appendix B.

Figure 5-4: Hamilton Sub-region Planning Forecast



Overall, the planning forecast for the Hamilton sub-region is declining over the study period. This is due to the impact of conservation programs combined with the relatively flat growth rate associated with the area's gross load forecast.

From discussions with the LDCs, the potential for any significant deviation from the forecast would arise from new large customers who may have an interest in connecting in the area due to the sub-region's available capacity at both the transmission and TS level.

As it is unknown at this time exactly where future large customers may want to connect (and where the associated load growth would be concentrated), the IESO has assessed the load-meeting capability of the 115 kV system. This assessment was used to inform the LDC of any upstream transmission concerns they should be cognizant of when dealing with proposed large customer load connection requests and to help address any changes that may arise in the load forecast between planning cycles.

6. Needs

Based on the planning forecasts, system capability, the transmitter's identified end-of-life asset replacement needs, and application of provincial planning criteria, the Hamilton sub-region IRRP Working Group identified electricity needs in the near, medium, and long term. This section describes the identified end-of-life, capacity, and reliability needs in the Hamilton sub-region.

6.1 Needs Assessment Methodology

ORTAC,[13] the provincial standard for assessing the reliability of the transmission system, was applied to assess supply capacity and reliability needs. ORTAC includes criteria related to the assessment of the bulk transmission system, and of local or regional reliability requirements (see Appendix C for more details).

By applying these criteria, three broad categories of needs can be identified:

- **Transformer Station Capacity** describes the electricity system's ability to deliver power to the local distribution network through the regional step-down transformer stations. The capacity rating of a TS is the maximum demand that can be supplied by the station and is limited by station equipment. Station ratings are often determined based on the 10-day limited time rating ("LTR") of a station's smallest transformer(s) under the assumption that the largest transformer is out of service.[14]
- **Supply Capacity** is the electricity system's ability to provide continuous supply to a local area. This is limited by the LMC of transmission supply to the area. The LMC is determined by evaluating the maximum demand that can be supplied to an area accounting for limitations of the transmission element(s) (e.g., a transmission line, group of lines, or autotransformer), when subjected to contingencies and criteria prescribed by ORTAC. LMC studies are conducted using power system simulations analysis (see Appendix C for more details). Supply capacity needs are identified when the peak demand for the area exceeds the LMC.
- **Load Security and Restoration** is the electricity system's ability to minimize the impact of potential supply interruptions to customers in the event of a major transmission

[13] http://www.ieso.ca/-/media/files/ieso/Document%20Library/Market-Rules-and-Manuals-Library/market-manuals/market-administration/IMO-REQ-0041-TransmissionAssessmentCriteria.pdf

[14] A transformer station can also be limited when downstream or upstream equipment (e.g., breakers, disconnect switches, low-voltage bus, high voltage circuits) are undersized relative to the transformer rating. LTR is further defined in section 6 of this report.

outage, such as an outage on 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. Load 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 ORTAC are described in Appendix C.

The needs assessment also identifies requirements related to equipment end of life and planned sustainment activities, which have a significant impact on the assessment and option development for the Hamilton sub-region.

End-of-life asset replacement needs are identified by the transmitter and consider a variety of factors such as asset age, the asset's expected service life, risk associated with the failure of the asset, and its condition. Replacement needs identified in the near- and early mid-term timeframe would typically reflect more condition-based information, while replacement needs identified in the medium to long term are often based on the equipment's expected service life. As such, any recommendations for medium- to long-term needs should reflect the potential for the need date to change as condition information is routinely updated.

6.2 Local Asset Replacement, Electricity Supply, and Reliability Needs

Through the needs assessment for the Hamilton sub-region IRRP, the Working Group identified three main categories of need: (1) end-of-life asset replacement needs, (2) local TS capacity needs, and (3) local load security and reliability needs.

6.2.1 Asset Replacement Needs

The transmitter identified a number of end-of-life asset replacement needs for the Hamilton sub-region, the majority in the medium to long term. These needs are captured in Table 6-1.

Since end-of-life needs are based on the best available asset condition information at each stage of the planning cycle, timing of asset needs can change as new information becomes available. As a result, the scope and timing of some asset needs has been revised since the needs assessment and scoping assessment were completed.

Table 6-1: Hamilton Sub-region End-of-Life Asset Replacement Needs

Area/Station(s)/Facilities	Description	Timing[15]
Lake TS	Hydro One has identified the low-voltage 13.8 kV metalclad switchgear supplied by T3/T4 as being at end of life.	2025
Newton TS	Hydro One has identified the load supply transformers (T1/T2) at Newton TS and components of its 115 kV supply infrastructure to be at end of life.	2025
115 kV Underground Cables	Hydro One has identified plans to refurbish the following 115 kV underground cables at end of life: • H5K/H6K (Beach TS to Kenilworth TS) • K1G/K2G (Kenilworth TS to Gage TS) • HL3/HL4 (Newton TS to Elgin TS) • HL3/HL4 (Elgin TS to Stirton TS).	2026
Beach TS	Hydro One has identified plans to refurbish the T7/T8 230 kV/115 kV autotransformers at Beach TS at end of life.	2027
	Hydro One has identified plans to refurbish the low-voltage metalclad switchgear supplied by T5/T6 DESN transformers at Beach TS at end of life. Recently, the transformers have been included in this proposed scope of replacement work.	2027

[15] Timing of all needs has changed since Hydro One's needs assessment and the IESO's scoping assessment reports were completed.

Lake TS

Currently Lake TS is a double DESN station, with the T1/T2 DESN transformers supplying low-voltage switchgear at a distribution voltage of 27.6 kV and the T3/T4 DESN transformers supplying two low-voltage switchgears at a distribution voltage of 13.8 kV. Stations adjacent to Lake TS also supply load at either 27.6 kV or 13.8 kV.

In its needs assessment, Hydro One identified the T1/T2 transformers (230 kV/27.6 kV) and the associated 27.6 kV switchgear as potentially requiring replacement in 2022-2024. The transformers were constructed in 1971 and the switchgear components were built between the 1950s and 1970s.

Hydro One also identified both sets of 13.8 kV metalclad[16] switchgear supplied by the T3/T4 transformers (230 kV/13.8 kV), and manufactured in 1982, as being at end of life.

Since finalization of its needs assessment and the IESO's scoping assessment, Hydro One has evaluated the assets' condition and determined that only the 13.8 kV metalclad will require replacement in the 2025 timeframe.

Combined load on both the T1/T2 and T3/T4 DESN stations is currently just over 100 MW and is forecast to remain fairly flat, with a planning forecast growth rate of -0.7% per year. The current rating of the station is just over 230 MVA (mega volt amperes) or approximately 207 MW. Load supplied from Lake TS is traditionally an even mix of residential and commercial load, with a small amount of industrial load supplied from the 13.8 kV T3/T4 DESN.

Newton TS

Newton TS currently consists of two transformers T1/T2 (115 kV/13.8 kV), which supply a low-voltage switchgear at a distribution voltage of 13.8 kV, while the stations electrically adjacent to Newton TS typically supply load at 27.6 kV with some adjacent 13.8 kV supply.

The Newton TS site also encompasses a 115 kV bus which connects the 115 kV supply circuits from Burlington TS and supplies the underground cables to Elgin TS.

[16] Metalclad switchgear is a type of low-voltage switchgear built to be housed indoors, as opposed to the more common outdoor air insulated switchgear. Aside from difference in location, metalclad switchgear would also traditionally be replaced in a more integrated manner, rather than the more component-based replacement that may be used for outdoor switchgear, due to the nature of its design and installation.

The T1/T2 transformers and the associated low-voltage switchgear were originally installed in the 1950s and the 115 kV breakers were installed between 1950 and 1991.

Hydro One's needs assessment had identified the T1/T2 and the associated low-voltage switchgear as potentially requiring replacement in 2021-2022. However, over the course of the planning process, and an additional assessment of the station facilities, Hydro One has determined that the scope of the end-of-life need at Newton TS includes the T1/T2 transformers and five of the 115 kV breakers. The proposed need date has been updated a number of times and is currently expected to be 2025 based on the latest asset condition information.

Newton TS currently supplies approximately 50 MW of load. The load at Newton TS is forecast to remain fairly flat, with a planning forecast growth rate of -0.6% per year, even when accounting for potential additional loads required due to the development of the Hamilton LRT project. The existing transformers at Newton TS can supply 82 MVA or approximately 73 MW of load. Newton TS has traditionally supplied a relatively even mix of residential and commercial loads and a small portion of industrial load.

Beach TS

Beach TS currently consists of two load supply DESNs (T3/T4 and T5/T6), as well as a 230 kV and 115 kV bus and three 230 kV/115 kV autotransformers. The two DESN stations are both supplied at 230 kV and both supply two low-voltage metalclad switchgears at a 13.8 kV distribution voltage.

The T3/T4 transformers were replaced in 2018, and uprated from a 115 kV supply to a 230 kV supply. The low-voltage switchgear supplied by T3/T4 was installed in 1991. The T5/T6 transformers were manufactured in 1979 and the two low-voltage switchgear they supply are from the early 1980s.

The T1 230 kV/115 kV autotransformer was manufactured in 1975, while the T7 and T8 230 kV/115 kV autotransformers were manufactured in 1965.

Hydro One's needs assessment identified the low-voltage metalclad switchgear supplied by T5/T6 as potentially requiring replacement in 2024-2026 (recently updated to 2027) and indicated that the remaining metalclad supplied by theT3/T4, and T5/T6 transformers, would likely not require replacement in the next five to 10 years. However, in January 2019, Hydro One informed the Working Group that the T5/T6 transformers would require replacement in

2027 and the T7 and T8 autotransformers would require end-of-life replacement in 2027 (updated from 2023-2026 in the needs assessment).

The combined co-incident load of both DESNs at Beach TS is approximately 80 MW and is forecast to remain fairly flat, with a yearly growth rate of -0.45% in the planning forecast. The current rating of the combined DESNs is 240 MVA or approximately 216 MW. Load supplied from the two DESNs at Beach TS is mostly industrial and commercial, with about 20% being residential.

The total load connected on the portion of the Hamilton sub-region 115 kV system supplied by the Beach TS autotransformers (Kenilworth TS, Birmingham TS, Stirton TS, and Winona TS) is forecast to remain relatively flat over the study period (yearly growth rate ranging from -0.12% to -0.64%). However, a number of these stations are located in a traditionally industrial and commercial area, including the Beach TS DESNs themselves, and have available capacity that could be attractive to large customers looking to connect or expand.

115 kV Underground Cables

The Hamilton sub-region has a number of 115 kV underground cables, installed in the late 1960s to mid-1970s, that supply stations servicing industrial loads or customers in the downtown Hamilton area. These cables include:

- HL3 and HL4 from Newton TS to Elgin TS and from Elgin TS to Stirton TS;
- H5K and H6K from Beach TS to Kenilworth TS; and
- K1G and K2G from Kenilworth TS to Gage TS.

In its needs assessment, Hydro One also identified these cable segments as requiring replacement in 2027-2032 and has recently updated the need date to 2026. One of these cable segments, HL4 from Elgin TS to Stirton TS, failed in 1998 and has been out of service since then.

The nature of a forced or unplanned cable outage is different than an outage to an overhead transmission line. While supply from an underground cable is generally more reliable, when a failure does occur, it takes much longer to identify the source or location and the replacement or repair of the problem typically takes far longer and is far costlier. In the case of the HL4 failure, for example, the decision was made to not replace the cable segment for the time being and to install additional switches to attempt to mitigate the reliability impact of the cable being out of service.

Due to the long lead time of reactive and proactive replacement of underground cable, potential cable replacement needs must be identified early on, so that options and replacement plans can be determined. This helps to mitigate potential long-term outages and any associated reliability or resiliency impacts. As well, due to the large cost associated with underground transmission cables, it is prudent to conduct a full assessment of options when making recommendations related to asset replacement and look for any opportunities replacement may present based on the long-term plan and forecast for the impacted area.

6.2.2 Local Transformer Station and Supply Capacity Needs

Existing minor capacity needs were identified in the Hamilton sub-region at the station level. These are described in detail in Table 6-2.

Also identified was a need to assess the capability of Hamilton's 115 kV system to supply existing load stations: (1) due to the nature of load growth in the Hamilton sub-region (relatively flat growth due in part to provincial conservation programs, with the potential for attracting large/industrial customers due to available capacity), and (2) to inform future consideration of replacement options for the end-of-life needs identified for the 115 kV underground cable assets and the 230 kV/115 kV autotransformers (T7/T8) at Beach TS.

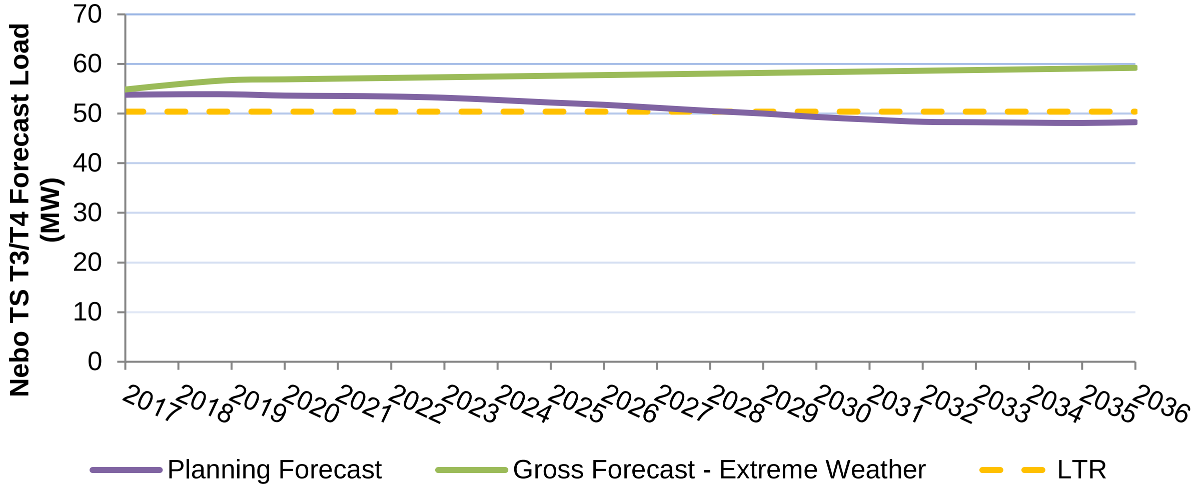
Table 6-2: Hamilton Sub-region Transformer Station Capacity Needs

Area/Station	Description	Timing
Nebo TS	An existing transformer capacity need was identified for the load supplied by the T3/T4 DESN at Nebo TS	Today
Mohawk TS	An existing transformer capacity need was identified for the load supplied by Mohawk TS	Today
Hamilton sub-region 115 kV Load Stations	A need to assess the capability of the transmission system to supply the 115 kV load stations in the Hamilton area to: • Understand the impact of higher load growth scenarios • Inform future assessments of the 115 kV underground cable assets and 230 kV/115 kV Beach TS autotransformers	N/A

Nebo TS

Nebo TS currently consists of two DESNs connected to the 230 kV system - the T1/T2 DESN supplies load at 27.6 kV, while the T3/4 DESN supplies load at 13.8 kV. The two DESNs have a capacity of 198 MVA (178 MW) and 56 MVA (50 MW), respectively. Nebo TS T3/T4 DESN is currently at its capacity. Figure 6-1 presents the forecast load growth for Nebo TS T3/T4 DESN for both gross load and the planning forecast (net of CDM and DG impacts).

Figure 6-1: Planning and Gross (Extreme Weather) Forecasts for Nebo TS T3/T4 DESN Compared to Station Rating (LTR)

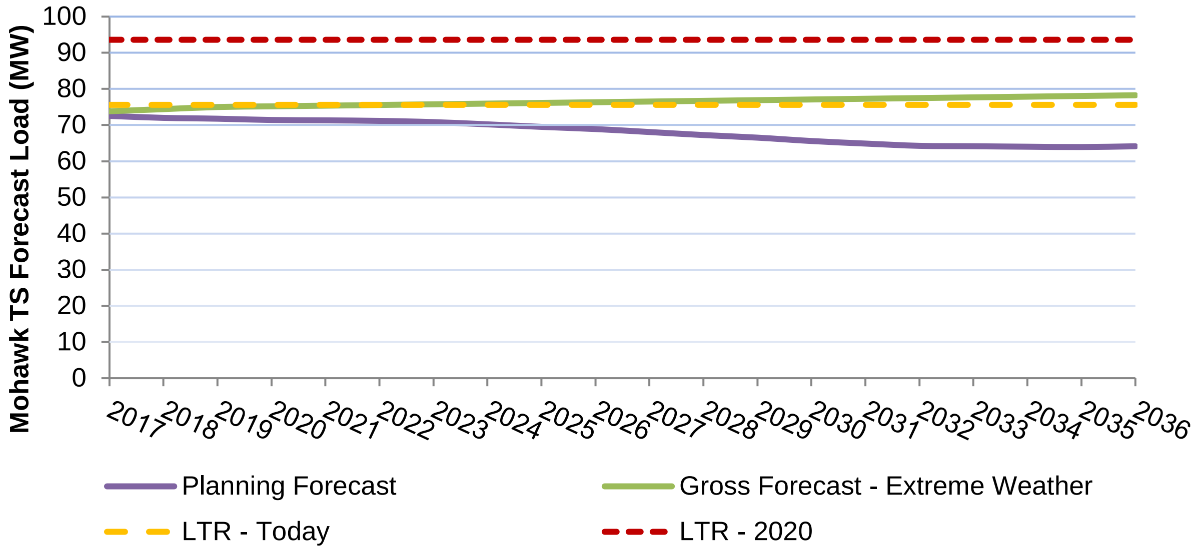


The forecast load growth for the T3/T4 DESN is relatively flat (-0.57% per year for the planning forecast). Historically, minor capacity needs have been identified at Nebo TS during past planning studies but recommended actions (i.e., installation of an additional bus on the spare transformer winding, or an increase in transformer capacity from a proposed end-of-life replacement) have not been put into place, mainly due to changes in the previous assessment to replace the Nebo TS T3/T4 transformers.

Mohawk TS

Mohawk TS currently consists of a single DESN (T1/T2) connected to the 115 kV system, supplying two low-voltage switchgear at a distribution voltage of 13.8 kV. The station has a total capacity of 85 MVA or approximately 76 MW, split evenly between the two switchgear supplies. Hydro One is currently replacing the end-of-life T1 and T2 units with slightly larger standard size units, which will increase the capacity of Mohawk TS to 104 MVA or approximately 93 MW. Hydro One is also planning to undertake end-of-life refurbishment work on the B3/B4 circuits supplying Mohawk TS. As part of this work, the new transformer capacity can be utilized without encountering an upstream limitation and alleviates the capacity need identified in the planning load forecast, shown in Figure 6-2.

Figure 6-2: Planning and Gross (Extreme Weather) Forecast for Mohawk TS Compared to Station Rating (LTR)



Without Hydro One's planned end-of-life replacements, a capacity need will arise in the mid-2020s. However, load is not evenly split between the low-voltage switchgear (or "buses") at Mohawk TS. Due to the bus-level limitation, the capability of the station is being exceeded today under the planning forecast. The bus loading issue is also resolved with Hydro One's planned transformer replacement.

6.2.3 Local Load Security and Reliability Needs

Load security criteria, as described by ORTAC Section 7.1 in Appendix C, specify a load interruption limit of 150 MW for single element contingencies and 600 MW for double element contingencies. All transformer stations in the Hamilton sub-region have dual supply, which allows the load served at the station to remain uninterrupted in the event of a single element contingency. Supply interruptions may still occur after multiple element contingencies, but are all under the load interruption limit. No load security needs were identified in the Hamilton sub-region.

Load restoration criteria, as described by ORTAC Section 7.2 in Appendix C, further specify that all interrupted load must be restored within approximately eight hours while interrupted load above 150 MW must be restored within four hours and interrupted load above 250 MW must be restored within 30 minutes. Load restoration needs, identified in the Hamilton sub-region for certain transmission outage conditions, are described in detail in Table 6-3.

Table 6-3: Hamilton Sub-region Load Restoration Needs

Transmission Outage	Description	Impacted Transformer Stations	Timing
B3 + B4	Interrupted load for the loss of the B3 and B4 115 kV circuits exceeds 150 MW must be restored within four hours.	Mohawk TS Customer-owned Transformer Station (CTS) Dundas TS Newton TS	Today
Q24HM + Q29HM	Interrupted load for the loss of the Q24HM and Q29HM 230 kV circuits exceeds 150 MW and must be restored within four hours.	Nebo TS CTS	Today

6.3 Needs Summary

The majority of needs in the Hamilton sub-region concern replacement of assets when they reach their end of life, and modest station capacity shortfalls. The table below provides a brief summary of needs considered during the development of options for the plan.

Table 6-4: Summary of Needs in Hamilton Sub-region

Area/ Facility	Need	Description	Need Date
Nebo TS	Transformer Capacity	An existing transformer capacity need was identified for the load supplied by the T3/T4 DESN at Nebo TS.	Today
Mohawk TS	Transformer Capacity	An existing transformer capacity need was identified for the load supplied by Mohawk TS.	Today

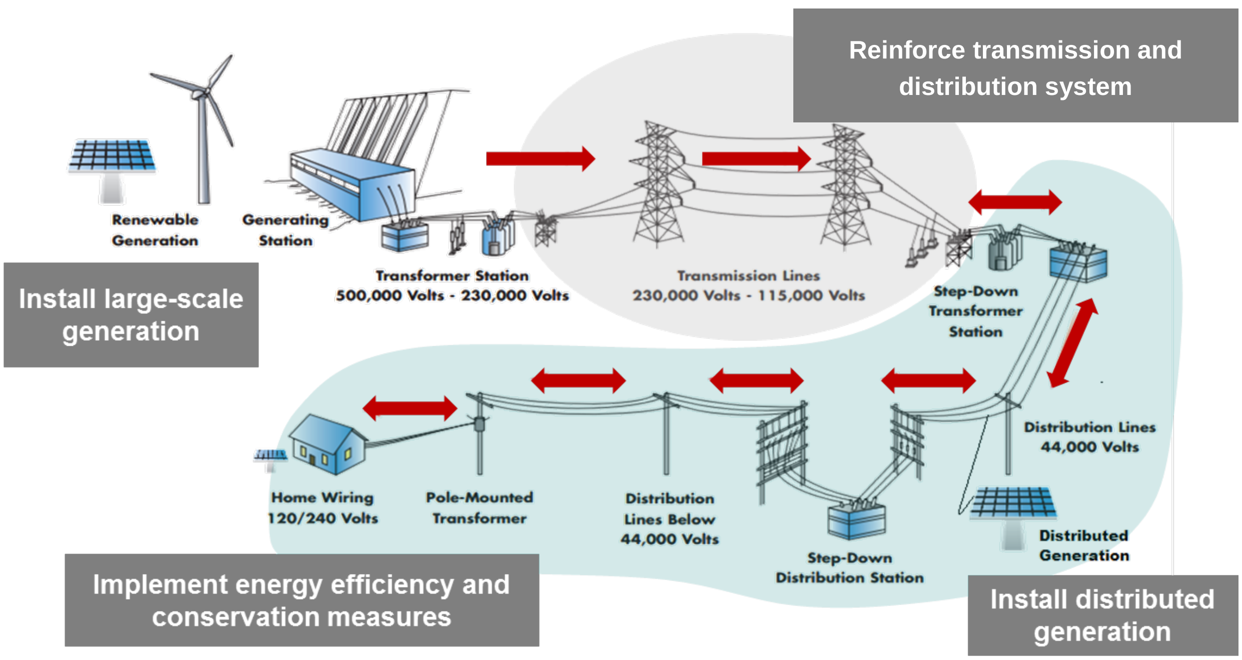
Area/ Facility	Need	Description	Need Date
B3 + B4	Restoration	Lost load for the loss of the B3 and B4 115 kV circuits exceeds 150 MW and must be restored within four hours.	Today
Q24HM + Q29 HM	Restoration	Lost load for the loss of the Q24HM and Q29HM 230 kV circuits exceeds 150 MW today and must be restored within four hours.	Today
Lake TS	End of Life	Hydro One has identified the low-voltage 13.8 kV metalclad switchgear supplied by T3/T4 as being at end of life.	2025
Newton TS	End of Life	Hydro One has identified the load supply transformers (T1/T2) at Newton TS and components of its 115 kV supply infrastructure to be at end of life.	2025
115 kV Underground Cable	End of Life	Hydro One has identified plans to refurbish the following 115 kV cables at end of life: • H5K/H6K (Beach TS to Kenilworth TS) • K1G/K2G (Kenilworth TS to Gage TS) • HL3/HL4 (Newton TS to Elgin TS) • HL3/HL4 (Elgin TS to Stirton TS).	2026
Beach TS	End of Life	Hydro One has identified plans to refurbish the T7/T8 230 kV/115 kV autotransformers at end of life.	2027
		Hydro One has identified plans to refurbish the T5/T6 transformers and the associated low-voltage metalclad switchgear at end of life.	2027

Area/ Facility	Need	Description	Need Date
Hamilton sub-region 115 kV Load Stations	Supply Capacity	A need to assess the capability of the transmission system to supply the 115 kV load stations in the Hamilton area to: • Understand the impact of higher load growth scenarios • Inform future assessments of the 115 kV underground cable assets and 230 kV/115 kV Beach TS autotransformers.	N/A

7. Options and Recommended Plan to Address Regional Electricity Needs

Since, as shown in Figure 7-1, power has traditionally been generated from large, centralized generation sources, reinforcing, the transmission and distribution infrastructure supplying the local area is one way to address regional needs. In recent years, however, communities and customers have been exploring opportunities to reduce their reliance on the provincial electricity system through local, distributed energy resources and community-based solutions. This approach includes a combination of emerging technologies and conservation programs, such as targeted DR, DG 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



Options Evaluation

When evaluating alternatives, the Working Group considered a number of factors, including technical feasibility, cost, flexibility, alignment with 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 with a long service life requires substantial capital funding and has environmental/land-use impacts. As a result, decisions should take into account the longer-term cost implications, value and potential risks (e.g., stranded or underutilized assets) associated with such investments, as well as the long lead times typically required to obtain approvals and complete construction.

When assessing the need for infrastructure investments, it is 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). Typically, 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 usually two to three years, but could be longer depending on the size and technology type.

Finally, the issue of how much is appropriate to invest and who pays needs to be addressed. In regional planning, depending on the type and classification of assets, the costs may be shared by all provincial ratepayers or recovered only by the specific customers served (e.g., LDC, industrial customers). In some cases, cost-sharing may occur when there are both provincial and local benefits.

Near-Term Actions and Long-Term Planning Considerations

For the near and medium term, the IRRP identifies specific actions and investments for immediate implementation. This ensures that necessary resources will be in service in time to address more pressing needs. For the long term, the IRRP identifies potential options to meet needs that may arise in 10 to 20 years. It is not necessary to recommend specific projects at this time (nor would it be prudent given forecast uncertainty and the potential for technological change). Instead, the long-term plan focuses on developing and maintaining the viability of long-term options, engaging with communities, and gathering information to lay the groundwork for making decisions on future options.

As discussed in section 6, actions need to be taken to address: (1) asset replacement needs, (2) local TS and supply capacity needs, and (3) local load security and restoration needs. In developing the 20-year plan, the Working Group examined a wide range of integrated solutions to address local and regional needs and identified additional studies that will help inform long-term plans and actions. These options are discussed in the following section.

7.1 Options for Addressing Asset Replacement Needs

When a piece of equipment reaches end of life and requires replacement, a number of alternatives often warrant consideration. For example, the transmission or distribution system the asset services will likely have changed over the decades the equipment has been in service, community needs may have evolved, and equipment standards been updated. At the same time, opportunities for non-traditional options, such as CDM, may increasingly play a role in determining the future of a specific asset when it comes time for renewal.

Development of options considered three main alternatives:

- Replacement of the assets "like-for-like" or with the closest available standard;
- Reconfiguration of the existing assets to "right-size" the replacement option based on: the forecast load growth, changes to the use of the asset since it was originally installed, and reliability or other system benefits that an alternate configuration may provide; or
- Retirement of a facility, considering the impact on load supply and reliability.

The asset replacement needs identified for the Hamilton sub-region all impact transmission assets that are critical to maintaining a reliable and sufficient supply of electricity. As such, complete retirement of any of the assets identified as replacement candidates was ruled out as a feasible alternative, even with consideration of existing CDM and DG forecasts or capacity that may exist at adjacent stations.

For end-of-life replacement needs identified in the mid to long term, particularly the Beach TS autotransformers, the Beach TS T5/T6 transformers and associated low-voltage switchgear, and the 115 kV system underground cables, near-term options were identified to help better inform replacement decisions in the next planning cycle or closer to when these facilities require a decision to be made on the scope of reinvestment.

Lake TS

Three transmission and distribution options were considered for addressing end-of-life needs at Lake TS, the "like for like" replacement option and two different reconfiguration options.

Since Lake TS consists of two DESNs, one distributing power at 27.6 kV and the other distributing power at 13.8 kV, the option of converting the loads on the end of life 13.8 kV switchgear to 27.6 kV was considered. This was screened out for three main reasons:

- Alectra currently has no intention of converting 13.8 kV infrastructure in the area to 27.6 kV, the cost of which would also have to be considered in the analysis;
- Conversion to 27.6 kV would mean that replacement of the 27.6 kV switchgear (not yet been deemed "end of life" by the transmitter) would need to be advanced to accommodate new feeders; and
- The existing T1/T2 230 kV/27.6 kV transformers at Lake TS would be very heavily loaded if all the load from the T3/T4 transformers was converted. Since the T3/T4 units are not at end of life, capacity on those units could no longer be utilized.

An alternate reconfiguration option was to consider consolidation of the two 13.8 kV low-voltage metalclad switchgear or a staged refurbishment, where the second switchgear would be installed when capacity was required. This was screened out based on:

- The potential cost of combining 13.8 kV feeders, with additional complexity due to the industrial loads currently supplied, and the need to maintain specific connection arrangements for some distribution customers; and
- The additional lead time that may arise from having to trigger the installation of the second switchgear if a large customer load were to materialize.

The "like for like" option was recommended by the Working Group since it maintains the existing 13.8 kV supply and offers cost savings – as the cost of maintaining both low-voltage metalclad switchgear is not as substantial as the additional costs that are expected to be incurred from the distribution work associated with either of the reconfiguration options. Table 7-1 provides further details on the analysis of the options.

Table 7-1: Transmission and Distribution Options for Addressing Lake TS End-of-Life Needs

	"Like for Like"	**Convert Low-Voltage Switchgear and Loads to 27.6 kV**	**Consolidate the 13.8 kV Low-Voltage Metalclad**
Summary of Option	• Replace the two 13.8 kV metalclad switchgear	• Convert the 13.8 kV load and abandon the 13.8 kV metalclad	• Consolidate the two 13.8 kV metalclad switchgear into one

	"Like for Like"	Convert Low-Voltage Switchgear and Loads to 27.6 kV	Consolidate the 13.8 kV Low-Voltage Metalclad
Potential Benefits	• Maintains load supply to 13.8 kV customers in the area • Continues to utilize existing T3/T4 transformer capacity	• Conversion to a higher voltage, decreasing losses and increasing amount of load each distribution feeder supplies	• Requires installation of only one new metalclad at the time of replacement, deferring need for the second metalclad until additional load materializes
Potential Detriments/ Issues	• Maintains multiple distribution supply voltages in the area • Limits ability to transfer load between the two DESNs at Lake TS	• Existing T3/T4 transformers do not require replacement • T1/T2 transformers would be heavily loaded • Expansion or early renewal of the 27.6 kV low-voltage switchgear would be required • LDC currently has no plans to convert 13.8 kV in the area to 27.6 kV • Conversion of distribution equipment voltage would add substantial costs	• Requires consolidation of 13.8 kV feeders, resulting in additional costs and complexity • Would increase lead time to accommodate any new large customer request within the station's 13.8 kV service territory (if the single 13.8 kV metalclad could not accommodate)

Newton TS

Three transmission and distribution options were considered for the refurbishment of the T1/T2 115 kV/13.8 kV transformers at Newton TS. The options consisted of a "like for like" replacement option and two reconfiguration options.

Since Newton TS currently supplies a distribution voltage of 13.8 kV and has limited existing distribution load transfer capability to adjacent stations, a 27.6 kV conversion option was proposed, allowing for the transfer of loads between Newton TS and Dundas TS and Dundas TS #2. Additional load transfer capability could be used for managing growth or increasing reliability following outage events. Conversion to 27.6 kV was screened out for one main reason:

- Alectra had recently converted 4.16 kV assets in the Newton TS service territory to 13.8 kV, and it would not make sense to replace relatively new 13.8 kV distribution assets.

Since Newton TS is currently supplied at 115 kV and is also a key supply point for the broader 115 kV system due to the 115 kV bus at Newton TS, conversion to 230 kV was also investigated as an alternative. Potential long-term benefits could include allowing for conversion of other 115 kV stations to 230 kV in the Hamilton area and increasing the capability to supply future load at Newton TS. However, here are a number of reasons why conversion of the Newton TS site to 230 kV is not justifiable at this time:

- A number of stations supplied at 115 kV in the Hamilton sub-region, particularly those adjacent to Newton TS, have recently been, or will soon be, refurbished – meaning the conversion of these assets is not cost-effective, even beyond the planning horizon.
- The existing Newton TS site is fairly constrained, even for "like for like" refurbishment work. Conversion to 230 kV, which would include new 230 kV supply to the station site while still maintaining the 115 kV bus at Newton TS, would likely be infeasible, inefficient, and require additional land.
- The benefits of conversion to 230 kV do not justify the additional cost associated with this option, primarily due to the incremental cost of even a small line to extend the 230 kV system to the Newton TS site.

Based on this assessment, the Working Group has recommended a "like for like" option for the Newton TS T1/T2 transformers, replacing the units with the closest available standard size unit. This recommendation is based on the assumption that the refurbishment work for Newton TS can be carried out on the existing Newton TS site. Based on the considerations discussed, the Working Group has assessed this to be the most cost-effective option to meet the area's long-term needs. Table 7-2 provides further details on the options evaluated.

The Working Group recommends that Hydro One proceed with a "like for like" replacement of the five 115 kV breakers at Newton TS. In this case, no reliability improvement can be made to the 115 kV bus layout for a justifiable cost, since undergrounding sections of the existing circuits would be required to accommodate a change in layout.

Table 7-2: Transmission and Distribution Options for Addressing Newton TS End-of-Life Needs

	"Like for Like"	Convert Low Voltage to 27.6 kV	Convert High Voltage to 230 kV
Summary of Option	• Replace T1/T2 transformers with closest available standard size units	• Replace T1/T2 with 115 kV/27.6 kV units and advance replacement of the low-voltage switchgear to convert to 27.6 kV	• Build a new 230 kV tap from the adjacent 230 kV right of way to Newton TS or to a nearby site • Replace T1/T2 with 230 kV/13.8 kV or 230 kV/ 27.6 kV transformers
Potential Benefits	• Maintains existing station capacity	• Could maintain existing station capacity • Improves distribution transfer capability to and from nearby Dundas TS and Dundas #2 TS • Improves load restoration	• Could allow for increased supply at Newton TS or new site • Could allow for future conversion of 115 kV system to 230 kV
Potential Detriments/ Issues	• Constrained station site • Limited egress • Coordination with LRT	• 13.8 kV distribution infrastructure supplied by Newton TS was recently renewed • Existing Newton TS site is fairly constrained; limited egress; coordination with LRT work	• 115 kV yard would still be required at Newton TS to supply 115 kV system • Constraint of existing station site • Number of 115 kV stations recently been, or are planned to be, renewed

Beach TS

Two replacement options were considered for the low-voltage metalclad switchgear supplied by the T5/T6 transformers at Beach TS. These included a "like for like" replacement option and a reconfiguration option focused on future station consolidation. In January 2019, Hydro One informed the IESO of the need to replace the T5/T6 transformers at the same time as the low-voltage switchgear, increasing the likelihood that a non-like for like replacement option may present for the work at Beach TS.

Beach TS currently has four 230 kV/ 13.8 kV transformers that can supply up to 240 MVA of load using four low-voltage metalclad switchgear. Planning the refurbishment of the T5/T6 transformers and the associated low-voltage metalclad switchgear to allow for future consolidation when the T3/T4 low-voltage metalclad switchgear reaches end of life would maintain 140 – 210 MVA of capacity, while saving the cost of at least one or two transformer replacements, depending on the reconfiguration option chosen. Table 7-3 provides further details on the options identified for replacing the T5/T6 transformers and associated low-voltage switchgear.

Based on the existing forecast at Beach TS, decreasing the amount of capacity at the station would make sense over the long-term. The Working Group recommends monitoring load growth and forecast growth, as well as the condition of assets near end of life at Beach TS between now and the next planning cycle. In parallel, Alectra and Hydro One should investigate the distribution costs associated with consolidating the low-voltage metalclad switchgear to better inform the decision on replacement options.

Table 7-3: Transmission and Distribution Options for Addressing Beach TS T5/56 and Associated Low-Voltage Metalclad End of Life

	"Like for Like"	Consolidation of DESNs
Summary of Option	• Replace the T5/T6 transformers with the closest available standard and build a new J1/J2 and Q1/Q2 metalclad to supply current feeder arrangement from T5/T6	a) Replace the J1/J2 and Q1/Q2 metalclad supplied by T5/T6 to accommodate load from the T3/T4 metalclad, and supply from T3/T4, allowing T5/T6 to be retired b) Consolidate/Enable consolidation of J1/J2 and Q1/Q2 into a single metalclad Replace/Enable replacement of one T5/T6 unit and consolidate arrangement to three dual winding transformers supplying three sets of metalclad
Potential Benefits	• Maintains the existing station capacity • Limits scope and cost of 13.8 kV feeder work required	• Enables more appropriate sizing of transformation over the long-term, while maintaining 60-130 MW of free capacity based on the current load forecast – depending on the reconfiguration option • Frees up station space for any future replacement work
Potential Detriments/ Issues	• Eliminates options for future right-sizing of the station if load growth remains low	• Required consolidation of 13.8 kV feeders would add additional costs and complexity • Could increase lead time to accommodate new large customer requests if re-expansion of the downsized station was required

Beach TS Autotransformers

In order to investigate replacement options for the Beach TS autotransformers once they reach end of life, the IESO's scoping assessment recommended that the autotransformers be studied as part of the broader Middleport area bulk transmission planning study. This work will occur later than originally anticipated due to the ongoing development of the IESO's formalized bulk planning process and the timing of the next cycle of regional planning for the KWCG region, which also falls within the Middleport area.

Since it is anticipated that the Beach TS autotransformers will need to be replaced in 2027, the Working Group recommended that the Middleport area bulk transmission planning study proceed over the course of 2019 and into 2020, and that the outcomes be used to inform recommendations for the scope of replacement, either when condition warrants near-term asset replacement or in the next regional planning cycle.

115 kV Underground Cable

The long-term need to replace the 115 kV underground cables in the Hamilton sub-region once they reach end of life encompasses a large scope of work and will take many years to complete. Due to its magnitude and significance, this initiative would benefit from a detailed study investigating the impact of sustained cable outages if a failure were to occur. This analysis/research will inform replacement options and provide valuable information to the transmitter in terms of managing risk on the 115 kV system by staging required cable replacements to avoid potential combinations of cable outages with more negative reliability impacts.

Since the current forecast date for end-of-life cable replacement was updated by Hydro One in January 2019 to 2026 from 2027-2032, the Working Group recommends that a detailed study of the associated contingencies be initiated in Q2 2019 and completed before the next planning cycle as an addendum to the IRRP. A plan for the proposed work is provided in Appendix C.

7.2 Options for Addressing Local Supply Capacity Needs

Identified capacity needs in the Hamilton sub-region, based on the planning forecast, can be met using a combination of CDM and asset refurbishment plans that are already underway.

Under the planning forecast assumptions, the capacity need at Nebo TS will be minor throughout the early 2020s, and could be addressed in the mid to long term through both existing CDM programs and changes to codes and standards. The Working Group recommends monitoring demand growth and CDM achievement at Nebo TS. If required, due to higher-than-forecast load growth or changes to the CDM forecast, the Working Group also recommends that the IESO work with Alectra to assess additional measures to use CDM or other non-wires solutions to continue to defer Nebo TS capacity needs, where cost effective.

The identified capacity need at Mohawk TS will be addressed by the end-of-life asset replacement work that Hydro One had identified in the RIP for Mohawk TS and the 115 kV supply circuits B3/B4. To address the existing capacity need at this station, the Working Group recommends that this work continue to proceed in a timely manner.

Regarding the long-term supply to the broader area, a need to assess the ability of the 115 kV system to supply the existing stations was identified. This was due to the forecast uncertainty Alectra highlighted around large customers who may be looking to connect at existing stations on the 115 kV system with available capacity. After conducting an assessment, the IESO determined the LMC of the 115 kV system substantially exceeds the forecast load level today and can accommodate a majority of the stations being loaded to their rated capacity.

The study results are dependent on the assumed peak load and potential growth in other regional planning areas supplied by infrastructure in the Hamilton sub-region (namely the 230 kV /115 kV autotransformers at Burlington TS). As well, specific stations on the 115 kV system may be limited by more local issues for certain contingencies, depending on the load at adjacent stations. These considerations are highlighted in further detail in Appendix C.

7.3 Options for Addressing Local Security and Load Restoration Needs

The load restoration needs identified for the loss of the B3/B4 115 kV and the Q24HM/Q29HM 230 kV supply circuits can be addressed through a combination of load transfers and transmission reconfiguration options. Table 7-4 specifies approximate load restoration capability identified by Alectra and reconfiguration options available.

Table 7-4: Load Transfer and Transmission Reconfiguration Options for B3/B4 and Q24HM/Q29HM Outages

Transmission Outage	Load Transfer Capability	Transmission Reconfiguration Options
B3/B4 115 kV	Approximately 80 MW from Mohawk TS and Dundas TS can be transferred to nearby stations	Resupply Newton TS load from the 115 kV bus at Newton TS utilizing available disconnect switches
Q24HM/Q29HM	Approximately 40 MW from Nebo TS can be transferred to nearby stations	Resupply Customer-owned Transformer Station (CTS) from the 230 kV bus at Beach TS utilizing available disconnect switches

Existing distribution load transfer capability and available transmission reconfiguration options are sufficient to restore interrupted load beyond 150 MW. Through conversations with the transmitter and in consideration of typical circuit outage restoration timelines for the Hamilton sub-region, restoration of the remaining load under 150 MW is expected to occur within eight hours.

7.4 Recommended Plan and Implementation to Address Local Needs

To meet identified electricity needs in the Hamilton sub-region until the late 2020s/early 2030s, the Working Group recommends implementation of the actions described below, in addition to achievement of targeted conservation measures.

Rebuild End-of-Life Equipment at Lake TS

The low-voltage switchgear supplied by one set of station transformers at Lake TS will require replacement in the 2025 timeframe. To ensure that load in the Lake TS area can be adequately supplied and to maintain desired distribution supply voltages, the Working Group recommends that existing equipment be replaced with the closest available standard without resulting in downsizing of the facilities.

Rebuild End-of-Life Equipment at Newton TS

To mitigate challenges posed by the station transformers and a number of the 115 kV breakers at Newton TS reaching end of life, the Working Group recommends that existing equipment be replaced with the closest available standard without resulting in any downsizing of facilities. The targeted in-service date for the project is currently 2025, based on the latest assessments of asset condition and the need to coordinate work with the Hamilton LRT project.

Explore Feasibility of Future Consolidation at Beach TS as Equipment Continues to Reach End of Life

In the mid to long term, both the switchgear at Beach TS and the T5/T6 DESN transformers will reach their end of life. Based on the current load forecast for the Beach TS service area, this could present an opportunity to consolidate the number of transformers and/or the amount of low-voltage switchgear at the station. Because the T5/T6 DESN transformers and the associated low-voltage switchgear are expected to require replacement in 2027, the Working Group will monitor load growth and asset condition at the station, and undertake any necessary studies of the distribution work required for transformer consolidation, before making a final determination in the next planning cycle.

Undertake a Comprehensive Study of the Hamilton 115 kV Cables

The long-term need to replace 115 kV underground cable in the Hamilton sub-region at end of life would benefit from a detailed study investigating the impact of sustained cable outages if a failure were to occur. Since the current forecast need for end-of-life cable replacement is 2026, the Working Group recommends that a detailed study of the associated contingencies be initiated in Q2 2019 and completed before the next planning cycle as an addendum to the IRRP. A plan for the proposed work is provided in Appendix C.

Undertake a Bulk Transmission Planning Study of the Broader Area

To investigate replacement options for the Beach TS autotransformers once they reach end of life, the Working Group recommends that the autotransformers be studied as part of the broader Middleport area bulk transmission planning study. This work will occur later than anticipated in the terms of reference of the IESO's scoping assessment, due to the ongoing development of its formalized bulk planning process and the timing of the next cycle of regional planning for the KWCG region, which also falls within the Middleport area. Since the replacement need for the Beach TS autotransformers is anticipated to occur in 2027, outcomes of the bulk study will inform recommendations for the scope of replacement.

Ensure End-of-Life Replacement Work Proceeds as Planned for Mohawk TS

In the 2017 RIP, Hydro One recommended both a plan to replace the supply transformers at Mohawk TS with the closest available standard, and the refurbishment of the 115 kV line section supplying Mohawk TS. As the planned refurbishment will provide Mohawk TS with the incremental capacity to address the minor capacity need identified in the IRRP, the Working Group recommends that this work proceed toward its associated in-service dates.

Implement Conservation and Distributed Generation

The implementation of provincial conservation is key to the Hamilton sub-region's near-term plan and continues to offer benefits into the medium and long term. In developing the demand forecast, peak-demand impacts associated with meeting provincial targets were assumed before identifying the residual needs, consistent with the approach taken in all IRRPs.

Meeting provincial conservation targets amounts to approximately 96 MW, or 165%, of the forecast demand growth in the sub-region during the first 10 years, and a total of 181 MW, or 184% of the total forecast demand growth in the Hamilton sub-region by the end of the study period. The existing conservation targets, combined with the relatively flat growth rate of gross load forecast for the area result in an overall negative growth rate over the study period.

In particular, implementation of these targets helps address the existing capacity need at Nebo TS and maintain load levels below the available station capacity into the medium and long term based on the forecast. Up to 34 MW of demand growth at Nebo TS is addressed by existing CDM targets over the study period. The implementation of provincial conservation targets is key to ensuring that capacity needs do not arise in the Hamilton sub-region over the mid to long term, particularly in the Nebo TS and Mohawk TS service territories.

Absent of provincial targets, or if the forecast load were to increase for these areas, additional studies into the local achievable potential of CDM for impacted areas should be undertaken by the Working Group as part of the work to monitor the study area between regional planning cycles.

On an annual basis, the IESO, with the Working Group, will review CDM achievement, the uptake of provincial distributed generation projects, and actual demand growth in the Hamilton sub-region. This information will be used to determine when decisions on the long-term plan are required, and to inform the next cycle of regional planning for the area. Information on conservation and DG will also inform the ongoing development of non-wires options as potential long-term solutions.

Utilize Identified Load Transfer Capability on the Distribution System to Restore Load

Existing load restoration needs were identified for the loss of both the B3/B4 115 kV and Q24HM/Q29HM 230 kV supply circuits. In both instances, Alectra was able to identify existing distribution load transfer capability that can be utilized in conjunction with existing transmission reconfiguration options to restore the lost load in excess of 150 MW within four hours, satisfying the ORTAC planning criteria.

7.4.1 Implementation of Recommended Plan

To ensure that the near-term electricity needs of the Hamilton sub-region are addressed, plan recommendations will need to be implemented as soon as possible. The specific actions and deliverables, along with recommended timing, are outlined in Table 7-4.

Table 7-4: Summary of Needs and Recommended Actions in Hamilton Sub-region

Need	Recommended Action(s)/Deliverable(s)	Lead Responsibility	Timeframe/ Need Date
- End of life of Lake TS low-voltage switchgear	Rebuild Lake TS low-voltage switchgear supplied by T3/T4 at end of life	Hydro One	In service 2025 based on transmitter's condition assessment
- End of life of Newton TS T1/T2 - End of life of five 115 kV breakers at Newton TS	Replace Newton TS T1/T2 with the closest available standard at end of life; replace the 115 kV breakers at end of life	Hydro One	In service 2025 based on transmitter's condition assessment
- End of life of Beach TS T5/T6 and the associated low-voltage metalclad switchgear	Monitor equipment condition and forecast load for the Beach TS DESNs; explore opportunities to consolidate transformers and switchgear at the station over the long-term	Hydro One/ Alectra	Prior to next planning cycle
- End of life of the Beach TS T7 and T8 autotransformers	Complete a bulk transmission study of the broader Middleport area to inform replacement recommendations	IESO	2020
- End of life of the 115 kV underground cable	Complete a study of the impact of long-duration outages on transmission cables resulting from failure to inform a replacement plan	IESO	2020
- Need for additional capacity at Mohawk TS	Complete planned end-of-life replacement of Mohawk TS transformers and limiting section of B3/B4	Hydro One	2019/2020

Need	Recommended Action(s)/Deliverable(s)	Lead Responsibility	Timeframe/ Need Date
- Need for additional capacity at Nebo TS	Implement existing CDM program, monitor demand and undertake additional study of non-wires alternatives if necessary	IESO/Alectra	Ongoing
- Load restoration need for B3/B4 - Load restoration need for Q24HM/Q29HM	Utilize existing distribution load transfer capability and available transmission reconfiguration options	All	2019

To implement the recommended near-term actions in a timely manner, a RIP should be initiated for the broader Burlington to Nanticoke planning region upon IRRP completion.

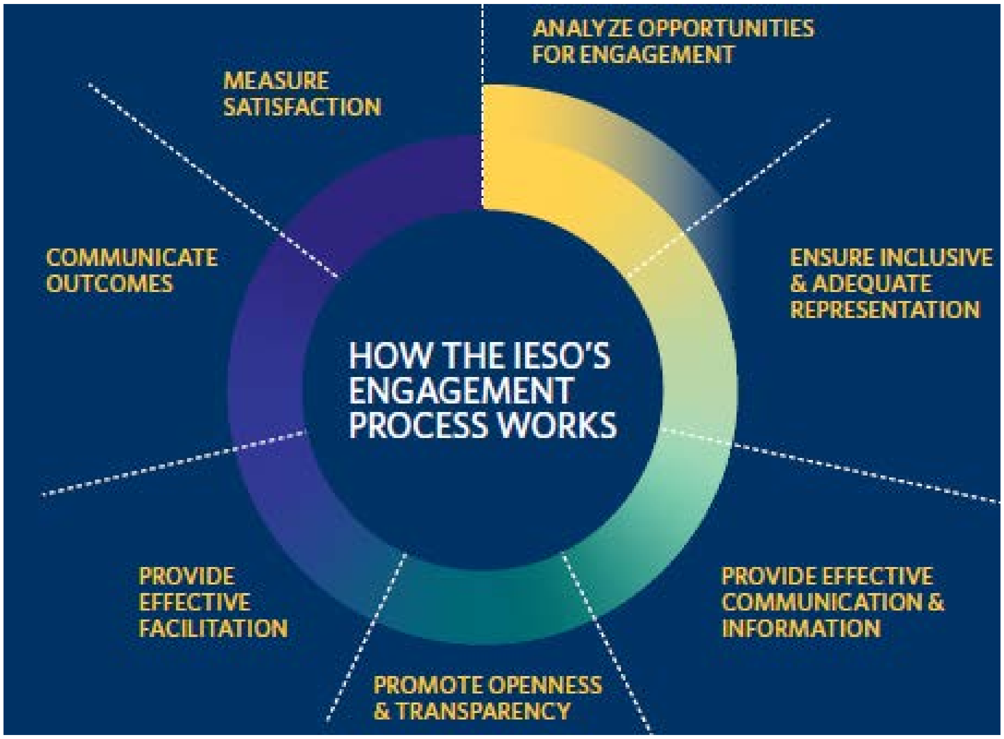
8. Community and Stakeholder Engagement

Community engagement is an important aspect 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 IESO's engagement principles, as well as the engagement activities undertaken for the Hamilton sub-region IRRP.

8.1 Engagement Principles

IESO engagement principles[17] help ensure that all interested parties are aware of and can contribute to the development of this IRRP. The IESO will use these principles to ensure inclusiveness, sincerity, respect and fairness in its engagements, striving to build trusting relationships as a result.

Figure 8-1: IESO Engagement Principles



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

8.2 Creating Opportunities for Engagement

The dialogue on the Hamilton sub-region IRRP commenced in August 2017. A dedicated IRRP Hamilton sub-region engagement web page,[18] including information on why an IRRP was being developed for the Hamilton sub-region, the IRRP terms of reference and a listing of the organizations involved, was created on the IESO website. This webpage posts all engagement activities in a transparent manner, including background information, and presentations and public webinars on the development of this IRRP.

An email subscription service for the broader Burlington to Nanticoke planning region was used to send information to interested communities and stakeholders who subscribed to receive email updates about this planning region. Targeted outreach to municipalities, Indigenous communities and business sectors in the region was conducted at the outset of this engagement and throughout the planning process.

In addition, regular communications were sent to subscribers of the Bulletin, the IESO's weekly enewsletter.

8.3 Engage Early and Often

Early communication and engagement activities for the Hamilton sub-region IRRP began with invitations to targeted communities to learn more about the draft Burlington-Nanticoke Region Scoping Assessment Outcome Report, and provide comments before it was finalized in September 2017. This report identified the need for an IRRP for the Hamilton sub-region and presented the terms of reference for the development of the plan.

Once a draft IRRP was developed, targeted communities in the planning area were invited to discuss the development of the plan and provide input on the contents. These communities included the City of Hamilton and the Mississaugas of the New Credit and Six Nations of the Grand River. Broader outreach on this engagement initiative was sent to a subscriber list to ensure that all interested parties were made aware of this opportunity for input.

8.4 Bringing Communities to the Table

In February 2019, the IESO followed a meeting with representatives from the City of Hamilton with a webinar to give broader interested parties an opportunity to learn about the draft IRRP

[18] http://www.ieso.ca/Get-Involved/Regional-Planning/Southwest-Ontario/Hamilton-sub-region

and provide comment. A 14-day comment period followed the webinar. No feedback was received.

All background information, as well as engagement presentations and recorded webinars, are available on the Integrated Regional Resource Plan engagement webpage.[19]

Other opportunities for engagement in this region included the IESO Southwest Ontario Regional Electricity Forum, which was held in Kitchener in November 2018 to explore how the unique characteristics of communities can factor into and align with regional and broader provincial electricity planning, as well as enable continuing dialogue with respect to regional planning.

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[19] http://www.ieso.ca/en/Get-Involved/Regional-Planning/Southwest-Ontario/Hamilton-sub-region

9. Conclusion

This report documents an IRRP that has been carried out for the Hamilton sub-region, one of four sub-regions of the Burlington to Nanticoke planning region. The IRRP identifies electricity needs in the Hamilton sub-region over the 20-year period from 2017-2036, makes recommendations to address near-term needs, and lays out actions to monitor, defer, and address needs that may arise in the long term.

To further refine and implement the preferred near- and mid-term "wires" solutions that primarily address end-of-life asset replacement needs, the Working Group recommends that an RIP be initiated. The RIP for the broader Burlington to Nanticoke region is to be led by Hydro One Transmission. The IESO will continue to provide support throughout the RIP process, and assist with any regulatory matters that may arise during plan implementation.

To support the development of the plan, actions have been identified to recommend alternatives, implement CDM, and monitor load growth in the sub-region. Responsibility for these actions has been assigned to the appropriate members of the Working Group. Information gathered and lessons learned as a result of these activities will inform development of the next iteration of the IRRP for the Hamilton sub-region.

The Working Group will continue to meet at regular intervals to monitor developments in the sub-region and track progress toward plan deliverables. In particular, the actions and deliverables associated with mid- to long-term end-of-life equipment will require annual review of system demand, program achievement and asset condition to determine whether recommendations require further review by the Working Group. In the event that underlying assumptions change significantly, local plans may be revisited through an amendment, or by initiating a new regional planning cycle sooner than the typical five-year schedule.