Peterborough to Kingston

REGIONAL INFRASTRUCTURE PLAN

May 27, 2022

hydro one

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Prepared and supported by:

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DISCLAIMER

This Regional Infrastructure Plan ("RIP") report was prepared for the purpose of developing an electricity infrastructure plan to address all needs identified in previous planning phases and any additional needs identified based on new and/or updated information provided by the RIP Technical Working Group ("TWG").

The preferred solution(s) that have been identified in this report may be re-evaluated based on the findings of further analysis. The load forecast and results reported in this RIP report are based on the information provided and assumptions made by the participants of the RIP TWG.

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EXECUTIVE SUMMARY

THIS REGIONAL INFRASTRUCTURE PLAN ("RIP") WAS PREPARED BY HYDRO ONE WITH SUPPORT FROM THE RIP TECHNICAL WORKING GROUP IN ACCORDANCE WITH THE ONTARIO TRANSMISSION SYSTEM CODE REQUIREMENTS. IT IDENTIFIES INVESTMENTS IN TRANSMISSION FACILITIES, DISTRIBUTION FACILITIES, OR BOTH, THAT SHOULD BE DEVELOPED AND IMPLEMENTED TO MEET THE ELECTRICITY INFRASTRUCTURE NEEDS WITHIN THE PETERBOROUGH TO KINGSTON REGION.

The participants of the RIP Technical Working Group (TWG) included members from the following organizations:

- Hydro One Networks Inc. (Lead Transmitter)
- Eastern Ontario Power Inc.
- Elexicon Energy Inc.
- Hydro One Networks Inc. (Distribution)
- Independent Electricity System Operator
- Kingston Hydro
- Lakefront Utilities Inc.

This RIP is the final phase of the second cycle of the Peterborough to Kingston regional planning process. It follows the completion of the Peterborough to Kingston Integrated Regional Resource Plan ("IRRP") in November 2021 and the Peterborough to Kingston Needs Assessment ("NA") in February 2020.

The Peterborough to Kingston RIP provides a consolidated summary of the needs and recommended plans for the region based on available information. It discusses the needs identified in the previous and current regional planning cycle, , any new needs identified as part of this RIP phase, and wires solutions recommended to address these needs. Implementation plans to address some of these needs are already completed or are underway from the previous planning cycle, including:

- Load transfer from Gardiner TS DESN 1 to Gardiner TS DESN 2 to provide transformation capacity relief at Gardiner TS DESN 1 (completed in 2019)

The major infrastructure investments recommended by the TWG in the near and mid-term planning horizon are provided in Table 1-1 below, along with their planned in-service date and budgetary cost estimate for planning purposes.

Table 1-1: Recommended Plans in Peterborough to Kingston over the Next 10 Years.

Stations/Lines Project	Details	In-Service Timeframe	Budgetary Cost Estimate[1] ($Million)
Cataraqui TS: Upgrade secondary conductor	Upgrade existing copper conductor on secondary side of auto transformers	2023	$0.5
Gardiner TS DESN1: Station Capacity and Transformers T1/T2 Asset Renewal	Replace the end-of-life transformers with similar type and size equipment as per current standard[2]	2028*	$30
	Load transfer from DESN1 to DESN2	2022	$0.5
Frontenac TS: Station Capacity	Develop plan to build new 230kV 75/125 MVA DESN station in the area, as needed	2025-2029	$30-$35
Otonabee TS 44kV: Station Capacity	Transfer 8MW of load from Otonabee 44kV bus to Dobbin TS	2022	$0.1
Port Hope TS: Transformers T3/T4 Asset Renewal	Replace the end-of-life transformers with similar type and size equipment as per current standard	2026	$25
Belleville TS: Build new DESN	Build a new 230 kV 75/125 MVA DESN with associated capacitor banks at the existing Belleville TS site	2026	$35-$40
Picton TS: Transformers T1/T2 Asset Renewal	Replace the end-of-life transformers with similar type and size equipment as per current standard	2025	$14.5
Dobbin TS: T1/T2/T5 Auto Transformer Asset Renewal	Replace the end-of-life auto transformers with two new 150/250 MVA unit and switchyard refurbishment	2029	$100

*Hydro One is exploring whether Gardiner TS T1/T2 transformers replacement date can be advanced to help address the station capacity need at Gardiner TS DESN 1 described in section 6.4

The Study Team recommends that:

- Hydro One and LDCs to continue with the implementation of infrastructure investments listed in Table 1-1 above while keeping the Technical Working Group apprised of project status;
- All the other identified needs/options in the long-term will be further reviewed by the Study Team in the next regional planning cycle.

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[1] Planning estimates are provided for Hydro One's portion of the work based on 2020 costs and are subject to change in the future

[2] The new standard units are expected to have a higher LTR of about 160 MW

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1. INTRODUCTION

THIS REPORT PRESENTS THE REGIONAL INFRASTRUCTURE PLAN ("RIP") TO ADDRESS THE ELECTRICITY NEEDS OF THE PETERBOROUGH TO KINGSTON REGION.

The report was prepared by Hydro One Networks Inc. ("Hydro One") on behalf of the Technical Working Group (TWG) that consists of Hydro One Inc. (Transmission), Eastern Ontario Power Inc., Elexicon Energy Inc. ("Elexicon"), Hydro One Inc. (Distribution), Independent Electricity System Operator ("IESO"), Kingston Hydro, and Lakefront Utilities Inc., in accordance with the Regional Planning process established by the Ontario Energy Board ("OEB") in 2013.

The Peterborough to Kingston region is comprised of the area bordered approximately by Clarington on the West, North Frontenac county on the North, Frontenac County on the East and Lake Ontario on the South. The boundaries of the Region are shown in Figure 1-1 below.

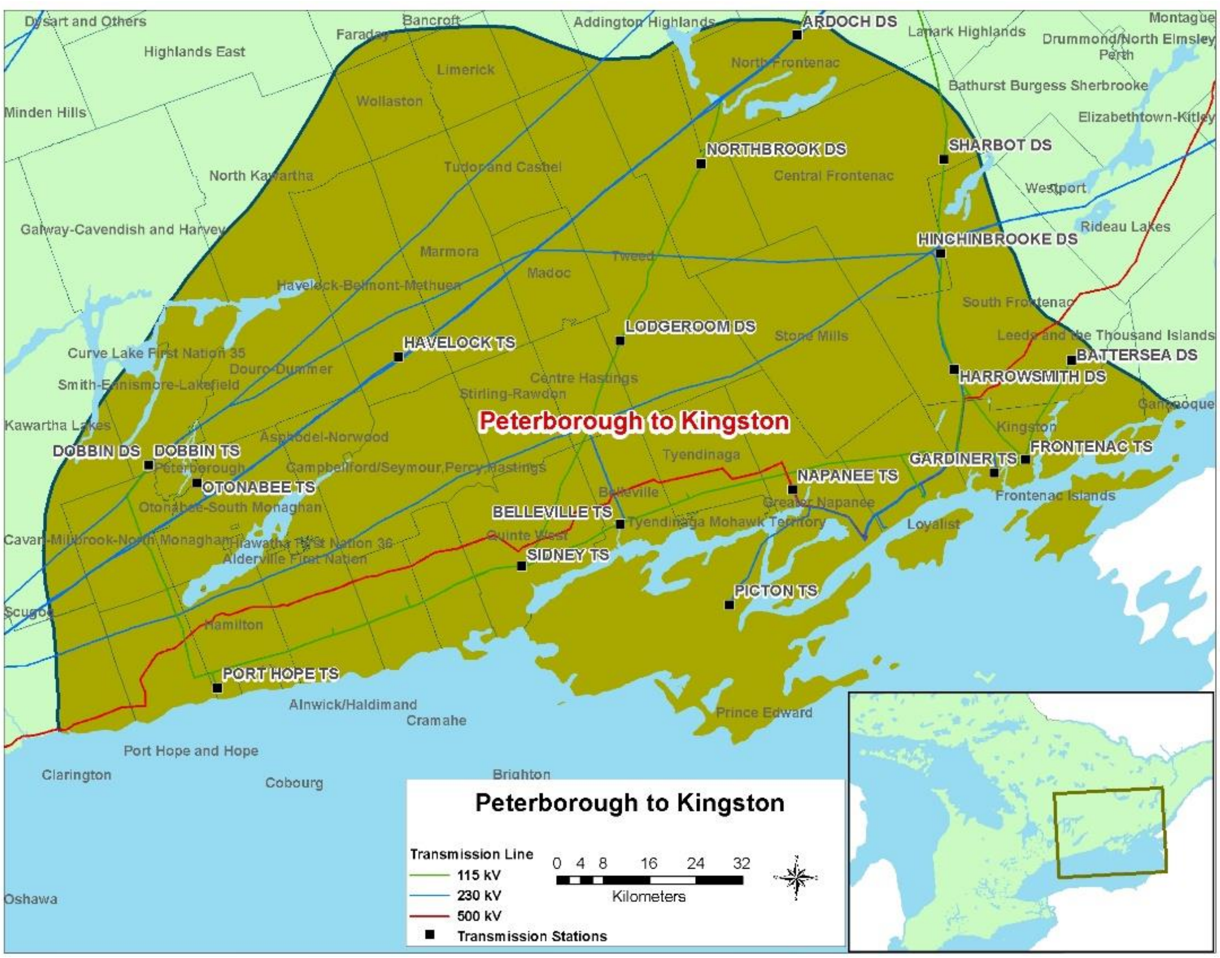

Figure 1-1: Peterborough to Kingston Region

1.1. Objectives and Scope

This RIP report examines the needs in the Peterborough to Kingston Region. Its objectives are to:

- Provide a comprehensive summary of needs and wires plans to address the needs;
- Identify any new needs that may have emerged since previous planning phases e.g., Needs Assessment (“NA”), Scoping Assessment (“SA”), and/or Integrated Regional Resource Plan (“IRRP”);
- Assess and develop a wires plan to address these needs; and,
- Identify investments in transmission and distribution facilities or both that should be developed and implemented on a coordinated basis to meet the electricity infrastructure needs within the region.

The RIP reviewed factors such as the load forecast, asset renewal for major high voltage transmission equipment , transmission and distribution system capability along with any updates to local plans, conservation and demand management (“CDM”) forecasts, renewable and non-renewable generation development, and other electricity system and local drivers that may impact the need and alternatives under consideration.

The scope of this RIP is as follows:

- A consolidated report of the needs and relevant plans to address near and medium-term needs identified in previous planning phases (Needs Assessment, Scoping Assessment, Local Plan, and Integrated Regional Resource Plan).
- Identification of any new needs over the planning horizon and wires plans to address them
- Consideration of long-term needs identified in the Peterborough to Kingston IRRP or identified by the TWG.

1.1. Structure

The rest of the report is organized as follows:

- Section 2 provides an overview of the regional planning process.
- Section 3 describes the regional characteristics.
- Section 4 describes the transmission work completed over the last ten years.
- Section 5 describes the load forecast and study assumptions used in this assessment.
- Section 6 describes the adequacy of the transmission facilities in the region over the study period.
- Section 7 discusses the needs and provides the alternatives and preferred solutions.
- Section 8 provides the conclusion and next steps.

2. REGIONAL PLANNING PROCESS

2.1 Overview

Planning for the electricity system in Ontario is done at three levels: bulk system planning, regional system planning, and distribution system planning. These levels differ in the facilities that are considered and the scope of impact on the electricity system. Planning at the bulk system level typically looks at issues that impact the system on a provincial level, while planning at the regional and distribution levels looks at issues on a more regional or localized level.

Regional planning looks at supply and reliability issues at a regional or local area level. Therefore, it largely considers the 115 kV and 230 kV portions of the power system that supply various parts of the province.

2.2 Regional Planning Process

A structured regional planning process was established by the Ontario Energy Board ("OEB") in 2013 through amendments to the Transmission System Code ("TSC") and Distribution System Code ("DSC"). The process consists of four phases: the Needs Assessment[3] ("NA"), the Scoping Assessment ("SA"), the Integrated Regional Resource Plan ("IRRP"), and the Regional Infrastructure Plan ("RIP").

The regional planning process begins with the NA phase, which is led by the transmitter to determine if there are regional needs. The NA phase identifies the needs and the TWG determines whether further regional coordination is necessary to address them. If no further regional coordination is required, further planning is undertaken by the transmitter and the impacted local distribution company ("LDC") or customer and develops a Local Plan ("LP") to address them.

In situations where identified needs require coordination at the regional or sub-regional levels, the IESO initiates the SA phase. During this phase, the IESO, in collaboration with the transmitter and impacted LDCs, reviews the information collected as part of the NA phase, along with additional information on potential non-wires alternatives, and makes a decision on the most appropriate regional planning approach. The approach is either a RIP, which is led by the transmitter, or an IRRP, which is led by the IESO and where further regional coordination is required. If more than one sub-region was identified in the NA phase, it is possible that a different approach could be taken for different sub-regions.

The IRRP phase will generally assess infrastructure (wires) versus resource (CDM and Distributed Generation) options at a higher or more macro level, but sufficient to permit a comparison of options. If the IRRP phase identifies that infrastructure options may be most appropriate to meet a need, the RIP phase will conduct detailed planning to identify and assess

[3] Also referred to as Needs Screening

the specific wires alternatives and recommend a preferred wires solution. Similarly, resource options that the IRRP identifies as best suited to meet a need are then further planned in greater detail by the IESO. The IRRP phase also includes IESO led stakeholder engagement with municipalities, Indigenous communities, business sectors and other interested stakeholders in the region.

The RIP phase is the fourth and final phase of the regional planning process and involves: discussion of previously identified needs and plans; identification of any new needs that may have emerged since the start of the planning cycle; and development of a wires plan to address the needs where a wires solution would be the best overall approach. This phase is led and coordinated by the transmitter and the deliverable is a comprehensive report of a wires plan for the region. Once completed, this report is also referenced in transmitter's rate filing submissions and as part of LDC rate applications with a planning status letter provided by the transmitter.

To efficiently manage the regional planning process, Hydro One has been undertaking wires planning activities in collaboration with the IESO and/or LDCs for the region as part of and/or in parallel with:

- Planning activities that were already underway in the region prior to the new regional planning process taking effect;
- The NA, SA, LP, and IRRP phases of regional planning;
- Planning for connection capacity requirements with the LDCs and transmission connected customers.

Figure 2-1 illustrates the various phases of the regional planning process (NA, SA, IRRP, and RIP) and their respective phase trigger, lead, and outcome.

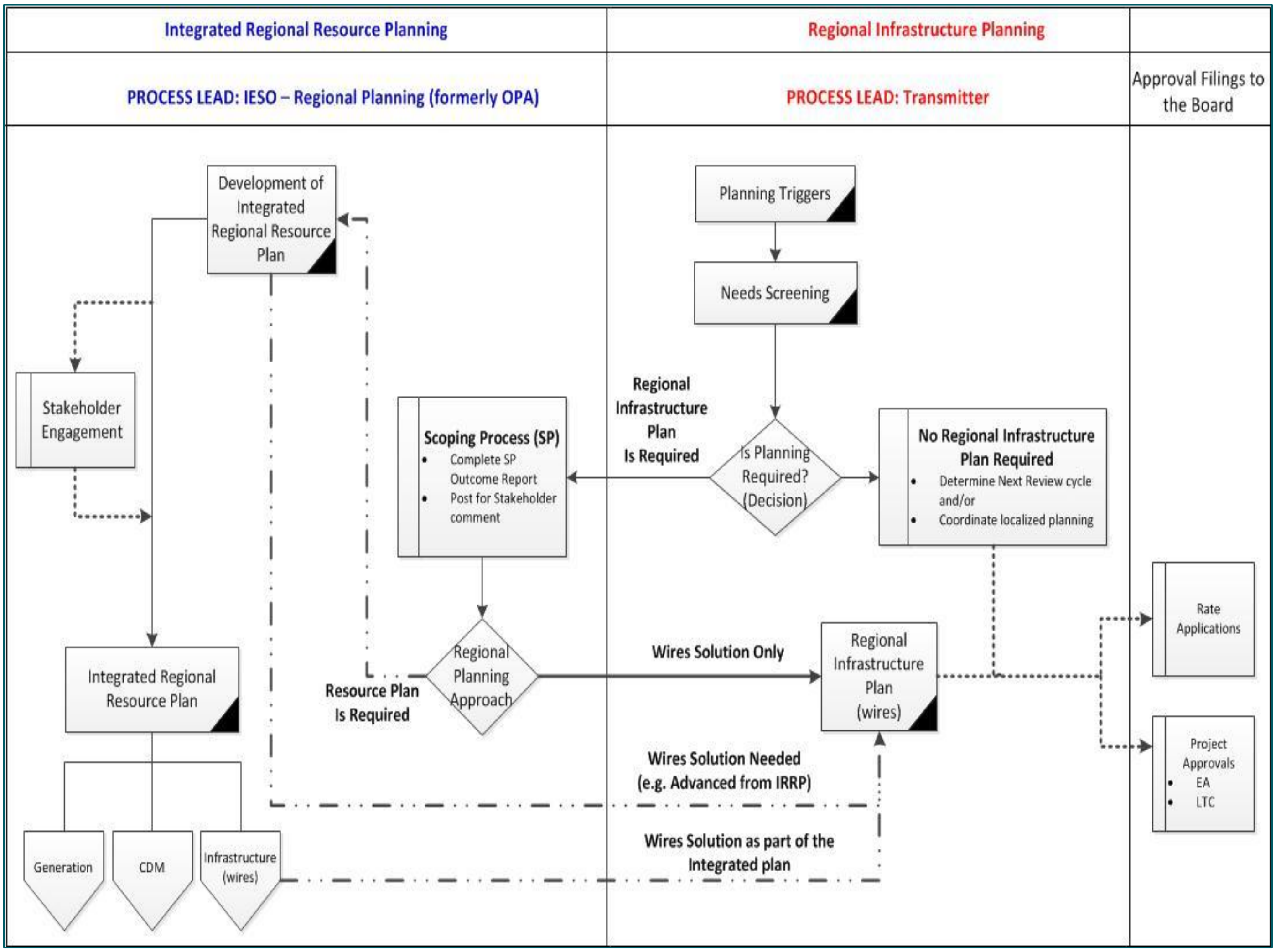

Figure 1: Regional Planning Process Flowchart

2.3 RIP Methodology

The RIP phase consists of a four step process (see Figure 2-2) as follows:

1. Data Gathering: The first step of the RIP process is the review of planning assessment data collected in the previous phases of the regional planning process. Hydro One collects this information and reviews it with the TWG to reconfirm or update the information as required. The data collected includes:
   - Net peak demand forecast at the transformer station level. This includes the effect of any distributed generation or conservation and demand management programs. As agreed by TWG members, the load forecast from the IRRP was used for this RIP.
   - Existing area network and capabilities including any bulk system power flow assumptions.
   - Other data and assumptions as applicable such as asset condition, load transfer capabilities, and previously committed transmission and distribution system plans.

2. Technical Assessment: The second step is a technical assessment to review the adequacy of the regional system including any previously identified needs. Depending upon any changes to load forecast or other relevant information, regional technical assessment may or may not be required or be limited to a specific issue(s) only. Additional needs may be identified in this phase.

3. Alternative Development: The third step is the development of wires options to address the needs and determine a preferred alternative based on an assessment of technical considerations, feasibility, environmental impact and costs.

4. Implementation Plan: The fourth and last step is the development of the implementation plan for the preferred alternative.

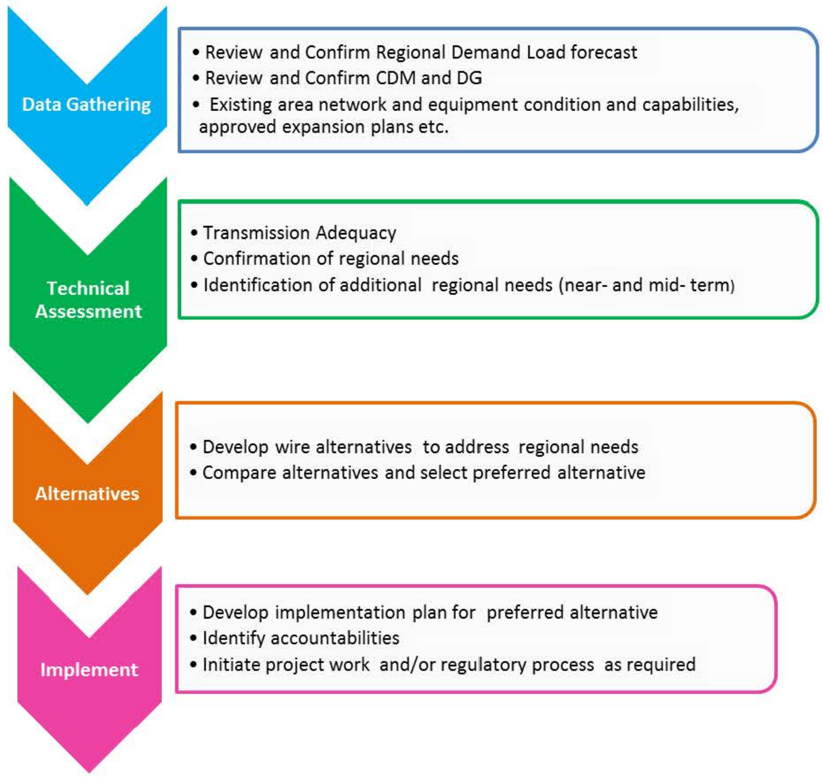

Figure 2-2: RIP Methodology

3. REGIONAL CHARACTERISTICS

THE PETERBOROUGH TO KINGSTON REGION IS COMPRISED OF THE AREA ROUGHLY BORDERED GEOGRAPHICALLY BY THE MUNICIPALITY OF CLARINGTON ON THE WEST, NORTH FRONTENAC COUNTY ON THE NORTH, FRONTENAC COUNTY ON THE EAST, AND LAKE ONTARIO ON THE SOUTH. ELECTRICAL SUPPLY TO THE REGION IS PROVIDED FROM TEN STEP-DOWN TRANSFORMER STATIONS AND EIGHT HIGH VOLTAGE DISTRIBUTION STATIONS.

Electrical supply to the region is provided through 500/230kV autotransformers at Lennox TS and 230/115kV autotransformers at Cataraqui TS and Dobbin TS, and a 230kV and 115kV transmission network supplying the various step-down TS's and HVDS's in the region. The main generation facility in the region is the 2000 MW Lennox Generation Station connected to Lennox TS.

The Local Distribution Customers (LDC) in the Peterborough to Kingston Region are Hydro One Distribution, Eastern Ontario Power, Elexicon, Kingston Hydro, and Lakefront Utilities. The high-voltage system in this Region also provides supply to five other direct transmission connected load customers.

The existing facilities in the Region are summarized below and depicted in the single line diagram shown in Figure 3-1. The 500kV system is part of the bulk power system and is not studied as part of this Needs Assessment:

- Lennox TS is the major transmission station that connects the 500kV network to the 230kV system via two 500/230 kV autotransformers.

- Cataraqui TS and Dobbin TS are the transmission stations that connect the 230kV network to the 115kV system via 230/115 kV autotransformers.

- Ten step-down transformer stations supply the Peterborough to Kingston load: Dobbin TS, Port Hope TS, Sidney TS, Picton TS, Otonabee TS, Havelock TS, Belleville TS, Napanee TS, Gardiner TS, and Frontenac TS. There are also eight HVDS that supply load in the Region: Dobbin DS, Ardoch DS, Northbrook DS, Lodgeroom DS, Hinchinbrooke DS, Harrowsmith DS, Sharbot DS, and Battersea DS

- Five Customer Transformer Stations (CTS) are supplied in the Region
- There are 7 existing Transmission connected generating stations in the Region as follows:
  - NPIF Kingston GS is a 130 MW gas-fired cogeneration facility that connects to 230 kV circuits X1H and X2H near Lennox TS
  - Lennox GS is a 2000 MW natural gas-fired station connected to Lennox TS
  - Wolfe Island GS is a 198 MW wind farm connected to circuit X4H near Gardiner TS
  - Napanee GS is a 910 MW gas-fired plant connected to Lennox TS at the 500 kV system

- Kingston Solar CGS is a 100 MW solar generation facility connected to 230 kV circuit X2H
- Stone Mills CGS is a 60 MW solar generation facility connected to 230 kV circuit H23B
- Amherst Island CGS is a 76 MW wind farm connected to 115kV circuit Q6S

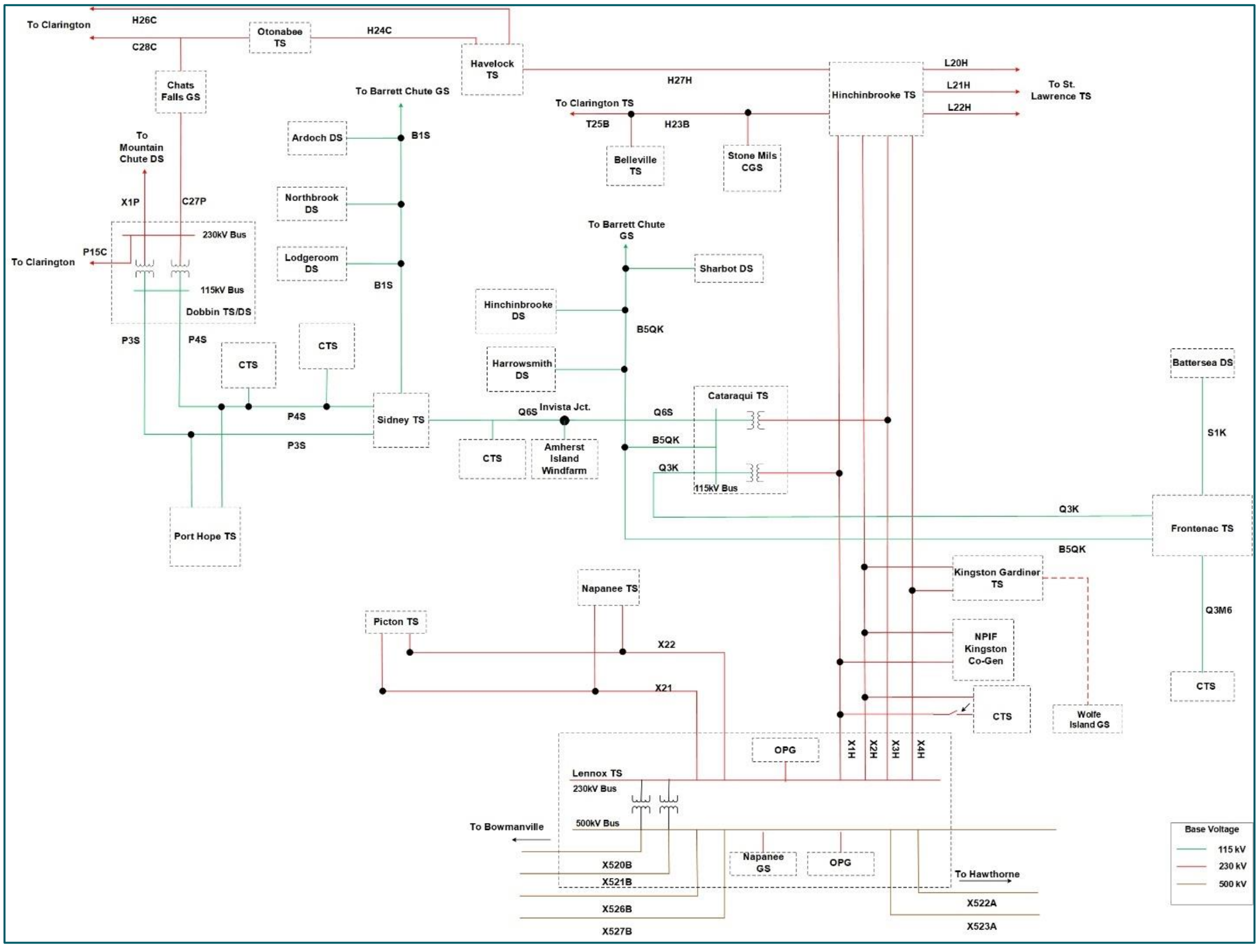

Figure 3-1: Single Line Diagram of Peterborough to Kingston's Transmission Network

4. TRANSMISSION FACILITIES/PROJECTS COMPLETED AND/OR UNDERWAY OVER THE LAST TEN YEARS

OVER THE LAST TEN YEARS, A NUMBER OF TRANSMISSION PROJECTS HAVE BEEN PLANNED AND UNDERTAKEN BY HYDRO ONE AIMED TO MAINTAIN THE RELIABILITY AND ADEQUACY OF ELECTRICITY SUPPLY TO THE PETERBOROUGH TO KINGSTON REGION.

A summary and description of the major projects completed over the last 10 years is provided below:

- Connect Napanee GS (2017) – A 910 MW gas turbine (Napanee GS) was connected to the 500 kV bus in the Lennox TS switchyard

- Transformation capacity relief at Gardiner TS DESN 1 (2019) – Gardiner TS DESN 1 load exceeded its normal supply capacity. Hydro One Distribution transferred load from Gardiner TS DESN 1 to Gardiner TS DESN 2.

The following projects are currently underway:

- Lennox TS 230kV & 500kV Breaker Replacement (2026/27)
- Belleville TS T1/T2 Transformer Replacement (2022)

5. FORECAST AND OTHER STUDY ASSUMPTIONS

5.1 Load Forecast

The electricity demand in the Peterborough to Kingston Region is anticipated to grow about .8% annually from 2021 to 2031.

Figure 5-1 shows the Peterborough to Kingston Region's extreme weather coincident peak net load forecast ("load forecast") for summer and winter. The load forecast for the individual stations in the Peterborough to Kingston Region is given in Appendix D.

As per the new regional planning process requirement, the load forecast used in the RIP is same as the IRRP phase unless there is a material change or if a LDC(s) member of the TWG requests to update their load forecast.

In the case of the Peterborough to Kingston Region, the TWG decided to use the load forecast in the recently completed Peterborough to Kingston Region IRRP (Nov. 2021) for the purposes of the RIP load forecast. Note that the TWG reviewed the extreme summer non-coincident peak net load forecast from the IRRP against the actual historical peak load observed in 2020 for the stations that have been identified to have a capacity need, namely Belleville TS, Frontenac TS, Gardiner TS DESN 1, and Otonabee TS (discussed in Section 6.4). Although, the actual 2020 peak load for these stations is slightly lower than what was forecasted in the IRRP, the TWG decided to proceed with the IRRP 2020 forecasted load since it does not materially change the planning outcome. The need dates will continue to be monitored throughout the regional planning process.

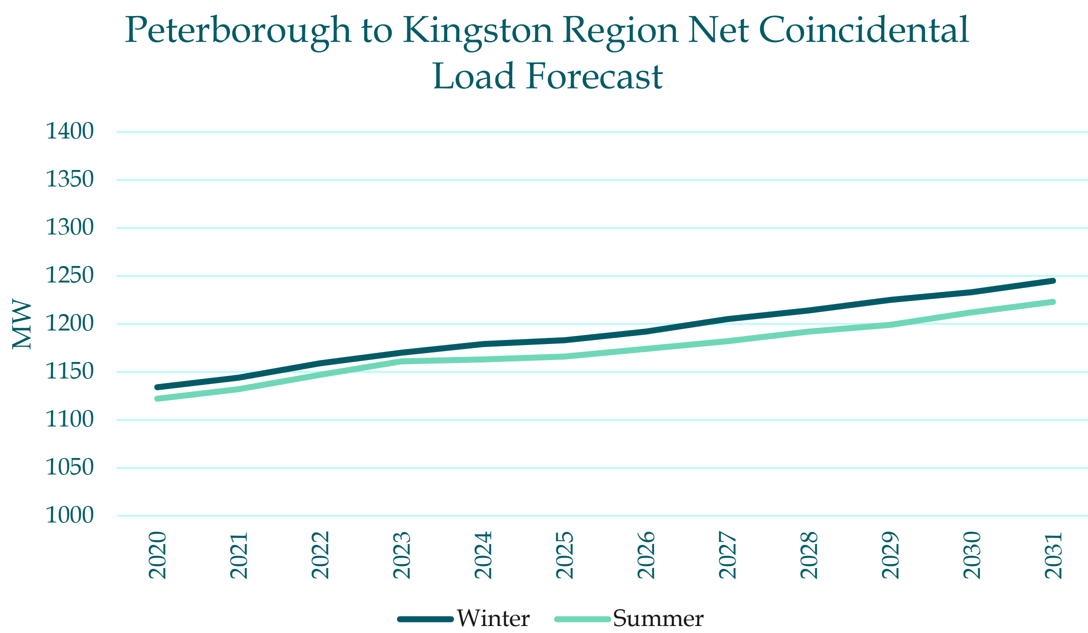

Figure 5-1: Peterborough to Kingston Region Load Forecast

5.2 Study Assumptions

The following other assumptions are made in this report.

- The study period for the RIP adequacy assessment is 2020-2031.
- All planned facilities for which work has been initiated and are listed in Section 4 are assumed to be in-service.
- Summer is the critical period with respect to line and transformer loadings. The assessment is therefore based on summer peak loads.
- Station capacity adequacy is assessed by comparing the peak load with the station's normal planning supply capacity, assuming a 90% lagging power factor for all stations for stations having no low voltage capacitor banks and .95% lagging power factor for stations having low voltage capacitor banks
- Normal planning supply capacity for transformer stations is determined by the summer 10-Day Limited Time Rating (LTR).
- Line capacity adequacy is assessed using peak loads in the area.
- Output of generating stations in the area is based on 98% dependable generation availability for transmission connected run of river hydro-electric stations as per Ontario Resource Transmission Assessment Criteria (ORTAC) criteria.
- Adequacy assessment is conducted as per ORTAC and using the load forecast described in section 5.1.

6. ADEQUACY OF EXISTING FACILITIES

THIS SECTION REVIEWS THE ADEQUACY OF THE EXISTING TRANSMISSION AND TRANSFORMER STATION FACILITIES SUPPLYING THE PETERBOROUGH TO KINGSTON REGION OVER THE PLANNING PERIOD (2021-2031).

Within the current regional planning cycle, three regional planning reports have been completed for the Peterborough to Kingston Region. The findings of these reports are inputs to this Regional Infrastructure Plan. These reports are:

- 2020 Peterborough to Kingston Region Needs Assessment (“NA”) Report;
- 2020 Peterborough to Kingston Region Scoping Assessment (“SA”) Report; and,
- 2021 Peterborough to Kingston Region Integrated Regional Resource Plan (“IRRP”)

This section provides a review of the adequacy of the transmission lines and stations in the Peterborough to Kingston Region. The adequacy is assessed using the latest regional load forecast provided in Appendix D and assumes all projects currently underway (described in section 4) are in-service. Sections 6.1 to 6.5 present the results of this review. Asset renewal needs for major HV transmission equipment were identified in previous phases of this regional planning cycle and are also addressed in Section 7 of this RIP report.

6.1 230/115 kV Autotransformers

Bulk power supply to the Peterborough to Kingston Region is provided by Hydro One’s 500kV/230kV and 230 kV/115kV autotransformers. The number and location of these autotransformers are as follows:

a) Two 500/230 kV autotransformers at Lennox TS
b) Two 230/115 kV autotransformers at Cataraqui TS
c) Three 230/115 kV autotransformers at Dobbin TS

The 500/230 kV autotransformers at Lennox TS are part of the bulk system and outside the scope of this RIP.

Based on the RIP load forecast, the load growth at Frontenac TS and other 115kV supply stations is expected to result in a supply capacity need at Cataraqui TS in 2023. The load is expected to increase over the long-term.

The 230/115 kV autotransformers at Dobbin TS are expected to be adequate over the study period.

6.2 230 kV Transmission Lines

All 230 kV transmission circuits, with the exception of circuits X21 and X22 in the Peterborough to Kingston Region are classified as part of the Bulk Electricity System ("BES"). They connect the Region to the rest of the Ontario's transmission system and to the load centers in the Greater Ottawa regions. These circuits are as follows:

- 230kV circuits: C27P, H23B, H27H, P15C, T22C, T25B, T31H, T32H, X1H, X1P, X2H, X3H and X4H.

These 230kV transmission lines can be divided into the main corridors as summarized below:

a) Clarington TS to Otonabee TS, Havelock TS, Chats Falls SS 230kV circuits T22C, T31H, T32H
   - Supplies Otonabee TS, Havelock TS
b) Clarington TS to Hinchinbrooke SS 230kV circuits T25B and H23B
   - Supplies Belleville TS
c) Lennox TS to Hinchinbrooke SS 230 kV circuits, X1H, X2H, X3H, X4H
   - Supplies Gardiner TS and a Customer CTS
d) Cherrywood TS to Dobbin TS, Chat Falls SS 230kV circuits P15C and C27P

From the circuits listed above, P15C is the limiting circuit for supply capacity needs in the region during low water conditions with a contingency on circuits X1P or C27P. This supply capacity need is being assessed as part of the bulk system planning.

6.3 115 kV Transmission Lines

The Peterborough to Kingston Region consists of several 115 kV lines. This 115 kV network serves local area load. The 115 kV transmission facilities can be divided into the main corridors as summarized below:

a) Dobbin TS to Sidney TS 115kV transmission circuits P3S/P4S
   - Supplies Port Hope TS, Sidney TS, and two Customer CTS

b) Sidney TS to Cataraqui TS 115kV transmission circuit Q6S
   - Supplies Sidney TS and a Customer CTS

c) Cataraqui TS to Frontenac TS 115kV transmission circuits Q3K/B5QK
   - Supplies Sharbot DS, Hinchinbrooke DS, Harrowsmith DS, and Frontenac TS

d) Barrett Chute GS to Sidney TS 115kV transmission circuit B1S
   - Supplies Ardoch DS, Northbrook DS, Lodgeroom DS

From the circuits listed above, Q6S is the limiting circuit for supply capacity needs in the region during low water conditions with a contingency on circuits 230kV circuits X1P, C27P, or P15C.

This supply capacity need is being assessed as part of the bulk system. The remaining 115 kV circuits are within their thermal limits and within the voltage range as per ORTAC for the loss of a single 115 kV circuit in the Region.

6.4 230 kV and 115 kV Connection Facilities

There is a total of ten step-down transformer stations and eight high voltage distribution stations that supply the Peterborough to Kingston load as shown in Table 6-1 below:

Table 6-1: Step-Down Transformer Stations and High Voltage Distribution Stations

Dobbin TS	Port Hope TS	Sidney TS	Picton TS
Otonabee TS	Havelock TS	Belleville TS	Napanee TS
Gardiner TS	Frontenac TS	Dobbin DS	Ardoch DS
Northbrook DS	Lodgeroom DS	Hinchinbrooke DS	Harrowsmith DS
Sharbot DS	Battersea DS		

A station capacity assessment was performed over the study period for the above stations in the Region using either the summer or winter station peak load forecasts as appropriate. The results are as follows:

6.4.1 Belleville TS T1/T2 Station Capacity Need

The 2020 extreme summer weather non-coincident peak net load at Belleville TS was forecasted to be 170 MW[4]. The Summer 10-Day LTR of Belleville TS is about 161 MW.

Based on the RIP load forecast, Belleville TS is exceeding its Summer 10-Day LTR today and the magnitude of the need increases in the near and mid-term. In addition to normal load growth in the area, Elexicon has recently received approximately 30 MW of new load connection inquiries to be connected at Belleville TS.

6.4.2 Frontenac TS T3/T4 Station Capacity Need

The 2020 extreme summer weather non-coincident peak net load at Frontenac TS is 101 MW[5]. The Summer 10-Day LTR of Frontenac TS is about 111 MW.

Based on the RIP load forecast, Frontenac TS is expected to reach its Summer 10-Day LTR by 2029.

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[4] The 2020 extreme summer weather non-coincident peak net load at Belleville TS is based on the 2021 Peterborough to Kingston Region IRRP load forecast, which has been adopted by the TWG for use in this RIP. The actual, weather corrected 2020 summer peak load at Belleville TS was 157 MW, but still forecasted to exceed the 161MW LTR in 2022.

[5] The 2020 extreme summer weather non-coincident peak net load at Frontenac TS is based on the 2021 Peterborough to Kingston Region IRRP load forecast, which has been adopted by the TWG for use in this RIP. The actual 2020 summer peak load at Frontenac TS was 104 MW.

6.4.2 Gardiner TS DESN 1 (T1/T2) Station Capacity Need

The 2020 extreme summer weather non-coincident peak net load at Gardiner TS DESN 1 was forecasted to be 146 MW[6]. The Summer 10-Day LTR of Gardiner TS DESN 1 and DESN 2 is about 125 MW and 85 MW, respectively.

Based on the RIP load forecast, the loading on Gardiner TS DESN 1 is exceeding its Summer 10-Day LTR today and the magnitude of the need increases in the near and mid-term.

6.4.3 Otonabee TS (T1/T2) 44kV Capacity Need

The 2020 extreme summer weather non-coincident peak net load at Otonabee TS 44 kV bus was 103 MW . The Summer 10-Day LTR of Otonabee TS 44kV is 97 MW.

Based on the 2020 net loading and load forecast, the loading on Otonabee TS 44kV is exceeding its Summer 10-Day LTR today and the magnitude of the need increases in the near and mid-term.

6.4.4 Other TSs and HVDSs in the Region

Based on the RIP load forecast, all the other TSs and HVDSs in the Region are expected to be within their normal supply capacity during the study period. Therefore, any capacity needs for these TSs and HVDSs will be reviewed in the next regional planning cycle.

Table 6-2: Adequacy of the Step-Down Transformation Facilities

Station	Summer 10-Day LTR Capacity (MW)	2020 Summer Peak Net Forecast (MW)	Need Date
Belleville TS T1/T2	161	170	Today
Frontenac TS T3/T4	111	101	2029
Gardiner TS DESN 1 (T1/T2)	125	146	Today
Otonabee TS 44kV Bus	97	103	Today

[6] The 2020 extreme summer weather non-coincident peak net load at Gardiner TS DESN 1 is based on the 2021 Peterborough to Kingston Region IRRP load forecast, which has been adopted by the TWG for use in this RIP. The actual 2020 summer peak load at Gardner TS DESN 1 was 130 MW.

6.5 System Reliability and Load Restoration

In case of contingencies on the transmission system, ORTAC provides the load restoration requirements relative to the amount of load affected. Planned system configuration must not exceed 600 MW of load curtailment/rejection. In all other cases, the following restoration times are provided for load to be restored for the outages caused by design contingencies.

- All loads must be restored within 8 hours.
- Load interrupted in excess of 150 MW must be restored within 4 hours.
- Load interrupted in excess of 250 MW must be restored within 30 minutes.

No new significant system reliability and operating issues identified for this Region. Based on the net coincident load forecast, the loss of one element will not result in load interruption greater than 150MW. The maximum load interrupted by configuration due to the loss of two elements is below the load loss limit of 600MW by the end of the 10-year study period.

6.6 Other Needs

6.6.1 Asset Renewal Needs for Major HV Transmission Equipment

Hydro One has identified asset renewal needs for major high voltage transmission equipment that are expected to be replaced over the next 10 years in the Peterborough to Kingston Region. Hydro One is the only Transmission Asset Owner (TAO) in the Region.

These needs are determined by asset condition assessment. Asset condition assessment is based on a range of considerations such as equipment deterioration due to aging infrastructure or other factors; technical obsolescence due to outdated design; lack of spare parts availability or manufacturer support; and/or potential health and safety hazards, etc. Asset replacement work planned over the study period in the region is summarized in Table 6-3.

Table 6-3: Peterborough to Kingston Region – Planned Asset Replacement Work

No.	Station	Description	in-service Timing
1	Picton TS	T1/T2 Replacement	2025
2	Port Hope TS	T3/T4 Replacement	2026
3	Lennox TS	230kV & 500kV Breaker Replacement. Part of Bulk system	2026/27
4	Dobbin TS	Auto Transformers T1/T2/T5 Replacement	2029
5	Gardiner TS DESN 1	T1/T2 Replacement	2028*

*Hydro One is exploring whether Gardiner TS T1/T2 transformers replacement date can be advanced to help address the station capacity need at Gardiner TS DESN 1 described in section 6.4

7. REGIONAL PLANS

THIS SECTION DISCUSSES ELECTRICAL INFRASTRUCTURE NEEDS IN THE PETERBOROUGH TO KINGSTON REGION AND PRESENTS WIRES ALTERNATIVES AND PREFERRED WIRES SOLUTIONS FOR ADDRESSING THESE NEEDS. TABLE 7-1 LISTS NEEDS PREVIOUSLY IDENTIFIED IN THE NA AND IRRP FOR THE PETERBOROUGH TO KINGSTON REGION AS WELL AS THE ADEQUACY ASSESSMENT CARRIED OUT AS PART OF THIS RIP REPORT.

The electrical infrastructure near and mid-term needs in the Peterborough to Kingston Region are summarized below in Table 7-1 and Table 7-2.

Table 7-4: Identified Near and Mid-Term Needs in Peterborough to Kingston Region

Need Type	Section	Station/Circuit/Area	In-service Timing
Supply Capacity	7.1	Peterborough to Quinte West	Today
	7.2	Cataraqui TS Autotransformers	2023
Station Capacity	7.3	Belleville TS	Today
	7.4	Frontenac TS	2029
Station Capacity	7.5	Gardiner TS DESN 1 (T1/T2)	Today
Station Capacity	7.6	Otonabee TS 44kV Bus	Today

Table 7-5: Major Asset Renewal Needs in Peterborough to Kingston Region

Need Type	Section	Station/Circuit/Area	In-Service Timing
Asset Renewal for Major HV Transmission Equipment	7.7	Picton TS T1/T2 transformers	2025
	7.8	Port Hope TS T3/T4 transformers	2025
	7.9	Gardiner TS T1/T2 (DESN 1) transformers	2028*
	7.10	Dobbin Auto Transformers T1/T2/T5	2029

*Hydro One is exploring if and how Gardiner TS T1/T2 transformers replacement date can be advanced to help address the station capacity need at Gardiner TS DESN 1 described in section 6.4

Maintaining status quo is not an option for any of the end of life autotransformers or station transformers due to risk of equipment failure and would result in increased maintenance cost and prolonged customer outages and interruptions. These transformers will be replaced with standard units.

No other lines or HV station equipment in the Peterborough to Kingston region than listed above, have been identified for major replacement/refurbishment at this time.

7.1 Supply Capacity – Peterborough to Quinte West

7.1.1 Description

The Peterborough to Quinte West sub region mainly consists of Port Hope TS and Sidney TS. The area is supplied from Dobbin TS to the North West, Cataraqui TS from the East, and Barrett Chute SS to the North East. During low water conditions and contingency situations, the thermal capacity on circuits P15C and Q6S can be exceeded.

7.1.2 Alternatives and Recommendation

IESO is currently undertaking a bulk study of the area and the recommendations from the study is expected to resolve the thermal loading limits of P15C and Q6S.

7.2 Supply Capacity – Cataraqui TS Autotransformers

7.2.1 Description

Cataraqui TS supplies the 115kV stations in the Eastern sub region of the region through two 230/115kV auto transformers. It is forecasted that in 2023 the coincidental loading of the stations in the sub region will reach the supply capacity of the Cataraqui TS auto transformers.

7.2.2 Alternatives and Recommendation

The current limitation of the Cataraqui TS auto transformers are due to a short span of copper conductors connected the secondary side of the auto transformers within the station. Upgrading the conductors will allow the long term emergency to increase by 35 MW and resolve this need in the near term.

7.3 Station Capacity – Belleville TS

7.3.1 Description

Belleville TS consists of one DESN supplied by 230kV circuits, H23B and T25B. The station has a summer 10-Day LTR of 161 MW. The station is also limited by voltage drop limitations when transmission circuit H23B is lost along with the companion transformer by configuration and the maximum loading can be as low as 130 MW, depending on the load composition at the station.

Based on the 2020 net load forecast, the station will exceed its capacity in 2022. In addition, Elexicon has also recently received approximately 30 MW of load connection inquiries to be connected at Belleville TS, but not including in the current load forecast. Hence, there is an immediate need for additional transformation capacity at Belleville TS today.

While the Belleville TS T1/T2 transformer replacement is currently underway, with an expected in-service date of 2022, this refurbishment is not expected to result in any significant improvement to the station's capacity and does not solve the voltage limitation issue.

7.3.2 Alternatives and Recommendation

The following alternatives were considered to address the Belleville TS station capacity need:

1. **Alternative 1 – Install a new DESN with two 75/125 MVA transformers with two 32 MVAR Capacitor banks and assess transmission line capacity**: Installing a second DESN at Belleville TS with two 32 MVAR capacitor banks will help mitigate the voltage drop at the Belleville TS LV bus and will resolve the station capacity need over the long-term (20 years) based on the current load forecast. Belleville TS switchyard also has space for a second DESN. The estimated cost for this option is approximately $35-40 M. However, it should be noted that preliminary studies indicate that there will be voltage constraints on the transmission lines supplying Belleville TS for a H23B contingency, which will restrict the full utilization of the additional station capacity in the long term as the total load at Belleville TS DESN1 and the new Belleville TS DESN2 is expected to be limited to 210 MW total, but should be sufficient capacity to meet the forecasted demand in the next 20 years. To fully utilize the capacity of the second DESN and increase the capacity beyond 210 MW, new supply lines into Belleville will be required to alleviate the voltage drop limits at Belleville TS. A possible reinforcement option is to extend X21/X22 from Napanee TS to Belleville TS along an existing Q6S Right of Way. There may also be upstream bulk system impacts with this option, therefore a full bulk planning study is needed to identify any impacts when looking beyond 20 years.

2. **Alternative 2 – Install an additional third 75/125 MVA transformer at Belleville TS and assess transmission line capacity**: Installing a third transformer at Belleville TS would resolve the need over the study period, however it is not a long term solution as compared to alternative 1 as it does not provide reliability of a full DESN, will significantly increase short circuit level at the 44kV bus, and does not alleviate the current voltage limitation. The estimated cost for this option is also similar to alternative 1 at approximately $30-35 M.

3. **Alternative 3 – Load transfers:** Since Belleville TS does not currently have any distribution load transfer capability, due to a lack of adjacent stations, distribution load transfers was not recommended by the TWG.

Considering the above alternatives, the TWG recommends Alternative 1. To address today's station capacity need at Belleville TS, as well as the growing electricity demand in the region, Hydro One (Transmission and Distribution) and Elexicon have started development of a new DESN transformer station at Belleville, with an expected in-service date of 2026. This will increase the supply capacity to the region and will resolve the capacity need at Belleville TS in the near and mid term.

The TWG will continue to monitor the load growth at Belleville TS and revisit the capacity need in the next regional planning cycle in order to re-assess whether/when a transmission line reinforcement to Belleville is required in the long term. In case of a H25B contingency where voltage violations are exceeded, operational measures will be taken to resolve the issue. Furthermore, IESO will undertake any necessary bulk system studies regarding the transmission reinforcement to Belleville TS.

7.4 Station Capacity – Frontenac TS

7.4.1 Description

Frontenac TS consists of one DESN supplied by 115kV circuits, Q3K and B5QK. The Summer 10-Day LTR of Frontenac TS is about 111 MW.

Based on the 2020 net load forecast, Frontenac TS is expected to exceed its Summer 10-Day LTR by 2029 but can be as early as 2022 for a high growth scenario. As there is limited load transfer capability between Frontenac TS and Gardiner TS DESN1 and excess load in Eastern Kingston area may not be able to supply from Gardiner TS DESN1, there is a need for additional transformation capacity at Frontenac TS in the mid-term.

7.4.2 Alternatives and Recommendation

The following alternatives were considered to address the Frontenac TS station capacity need:

1. **Alternative 1 – Upgrade Frontenac T3/T4 transformers**: The transformers at Frontenac TS are already the largest size for a 115/44kV DESN and therefore upgrading these transformers is not feasible.

2. **Alternative 2 – Install a new DESN with 50/83MVA transformers at Frontenac TS**: As the 115kV circuits supplying Frontenac TS have little thermal capacity, adding a second DESN at Frontenac TS will require significant upgrades to the existing 115kV transmission circuits. In addition, the cost of converting 115 kV transmission line to 230 kV is large and has been a deterrent due to low load growth in the area.

3. **Alternative 3 – Extend 230kV circuits X2H and X4H 13 km to the East of St. Lawrence River and install a new 75/125 MVA DESN**
   This option was assessed and reject due to the high cost and many environmental and real estate issues with the line extension.

4. **Alternative 4 –Build a new 230kV 75/125 MVA DESN near Gardiner TS**
   Load transfer capability exists between Frontenac TS and Gardiner TS DESN 1 via 44kV feeder ties but is limited and for operation measures and is not be suitable for permanent new loads forecasted in Eastern Kingston. Building a new 230 kV DESN near the current X2H/X4H corridor can alleviate this constraint by supplying new load in the area as well as providing an extra station where load can be transferred from Frontenac TS to the new DESN, as needed.

Considering the above alternatives, the TWG recommends Alternative 4. Hydro One transmission will work with Kingston Hydro and Hydro One Distribution to undertake development work for a new station in the area in the near term, which may be built by the Transmitter or the LDC.

The development of additional energy efficiency, could defer the new station ultimately required to accommodate load growth in the City of Kingston. This is cost-effective, under the reference load growth scenario, if cost-allocation can reflect the system benefits the non-wires alternative would provide. Additional barriers to implementation also exist around who would implement the solution and how they would seek cost-recovery, particularly if the transmitter or both benefiting LDCs were to implement a part of the solution. The IESO will work with the impacted transmitter and LDCs between regional planning cycles to address these barriers to implementation and cost allocation for a non-wires alternative, in tandem with developing plans for a new transformer station

7.5 Station Capacity – Gardiner TS DESN 1 (T1/T2)

7.5.1 Description

Gardiner TS DESN 1 is supplied by 230 kV circuits X2H and X4H. The Summer 10-Day LTR of Gardiner TS DESN1 is 125 MW.

Based on the 2020 net load forecast, Gardiner TS has exceeded its Summer 10-Day LTR. Hence, there is a need for additional transformation capacity at Gardiner TS DESN1 in the near term.

7.5.2 Alternatives and Recommendation

The following alternatives were considered to address the Gardiner TS DESN1 station capacity need:

1. **Alternative 1 – Expedite Gardiner TS DESN1 refurbishment**:
   As the current transformers 10 Day LTR is 125 MW, replacing it with new standard 75/125 MVA transformers will increase the LTR to about 160 MW. This will provide enough capacity to meet the load growth at DESN 1 until 2033.

2. **Alternative 2 – Load Transfer from Gardiner TS DESN1 to Gardiner TS DESN2**:
   Gardiner TS DESN2 was built within the last 15 years and has a 10 day LTR of 85 MW. DESN2 has available capacity at the station to supply additional loading. Hydro One distribution has confirmed that an permanent additional 11 MW load transfer from Gardiner TS DESN1 to Gardiner TS DESN2 is possible by reconfiguring its distribution system.

Considering the above alternatives the TWG recommends to proceed with both Alternatives 1 and 2. As the cost of the distribution load transfer is low and the load transfer work is much faster than the Gardiner TS DESN1 refurbishment, Hydro One Distribution can proceed with the work to alleviate the immediate loading constraint on Gardiner TS DESN1 with an expected completion date end of 2022, while Hydro One Transmission will explore opportunity to accelerate the Gardiner TS DESN1 refurbishment. The combination of these two options will address the current capacity limit at Gardiner TS DESN1. Hydro One Transmission will provide an update to the Technical Working Group for Gardiner TS DESN1 refurbishment in Q3 2022.

7.6 Station Capacity – Otonabee TS 44kV bus (T1/T2)

7.6.1 Description

The 2020 non-coincident peak net load at Otonabee TS 44 kV bus was 103 MW . The Summer 10-Day LTR of Otonabee TS 44kV winding is 97 MW.

Based on the 2020 net load forecast, the loading on Otonabee TS 44kV is exceeding its Summer 10-Day LTR today. Hence, there is a need for additional transformation capacity at Otonabee TS 44 kV bus in the near term.

7.6.2 Alternatives and Recommendation

The following alternatives were considered to address the Otonabee TS 44kV station capacity need:

1. **Alternative 1 – Transfer load from Otonabee TS 44kV to Dobbin TS**:
   Dobbin TS is nearby station that have over 50MW of remaining capacity and is not expected to reach its LTR of 160 MW in the long term. The secondary voltage is also 44kV, which allows load transfer between the two stations. Although there is an existing plan to transfer 4 MW of load from Otonabee TS 44kV bus to Dobbin TS, that is not enough to alleviate the capacity limits at Otonabee TS 44kV bus. Hydro One Distribution has confirmed that an additional 8 MW of load can be transfer from

Otonabee TS 44kV to Dobbin TS. This will provide enough capacity to meet the load growth forecast at Otonabee TS 44 kV bus until 2030.

2. **Alternative 2 – Transfer load from Otonabee TS 44kV to Otonabee 27.5kV**: As the voltage levels are different between the 2 low voltage winding of the bus, transferring the load between the different voltages is extremely difficult, costly, and time consuming as it requires all the downstream DS's to be converted to 27.6kV, and in many cases due to distance is not feasible.

The TWG recommends that Hydro One Distribution proceed with the above work in Alternative 1 to ensure continued supply reliability to customers at Otonabee TS 44 kV. Otonabee TS 44kV bus will be monitored after the load transfer and plans should be made if more load transfer from Otonabee TS 44kV bus to Dobbin TS is needed in the long term.

7.6 Asset Renewal Need – Picton TS T1/T2 Transformer Replacement

7.6.1 Description

Picton TS is a 230/44kV transformer station serving Hydro One Distribution. The station comprises two 50/83MVA transformers, T1/T2. The station's 2020 actual peak load was 59 MW and it has a Summer 10-Day LTR of approximately 78MW.

Transformers T1 and T2 are currently about 60 years old and are planned for similar standard units based on their asset condition assessment and taking "right sizing" into consideration. The tentative in-service date is expected in 2025.

The TWG recommends that Hydro One proceed with the above work to ensure continued supply reliability to customers.

7.6.2 Alternatives and Recommendation

1. Alternative 1 - Maintain Status Quo: This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance expenses and will not meet Hydro One's obligation to provide reliable supply to the customers.

2. Alternative 2 - Like-for-like replacement with similar equipment: Proceed with these end of life asset replacement as per the existing refurbishment plan for the transformers at Picton TS T1/T2. This alternative would address the end-of-life assets need and would maintain reliable supply to the customers in the area.

7.7 Asset Renewal Need – Port Hope TS T3/T4 Transformer

7.7.1 Description

Port Hope TS is located in the city of Port Hope, Ontario and supplies Hydro One Distribution and Elexicon loads. Port Hope TS T3/T4 are 50/83 MVA transformers with a 10 day LTR of 104 MW. T3/T4 currently supplies about 70 MW of load and the long term forecast is well within the current LTR.

The T3/T4 transformers were built in 1959 and have been identified as has reached the end of service life and requiring replacement. The scope of this project is to replace T3/T4 step-down transformers, associated spill containment structure and majority of assets within 44 kV BY switchyard. The targeted in-service is in year 2025.

The Study Team has assessed right sizing approach to downsizing and/or upsizing these transformers based on needs. The Working Group concluded that reducing the size of these transformers is not an option as the load in the area is not decreasing. Upsizing is also not an option as the long term forecast does not justify upgrade. Accordingly, it is recommended to replace these transformers with similar size.

7.7.2 Alternatives and Recommendation

1. Alternative 1 - Maintain Status Quo:
This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance expenses and will not meet Hydro One's obligation to provide reliable supply to the customers.

2. Alternative 2 - Like-for-like replacement with similar equipment:
Proceed with these end of life asset replacement as per the existing refurbishment plan for the transformers at Port Hope TS T3/T4. This alternative would address the end-of-life assets need and would maintain reliable supply to the customers in the area.

7.8 Asset Renewal Need – Gardiner TS T1/T2 (DESN 1) Transformer

7.8.1 Description

Gardiner TS is located in the city of Kingston, Ontario and supplies Hydro One Distribution and Kingston Hydro loads. Gardiner TS DESN1 T1/T2 are 75/125 MVA transformers with a 10 day LTR of 125 MW. The current loading on T1/T2 have exceeded its 10 day LTR.

The T1/T2 transformers were built in mid 1970s and has reached the end of service life requiring replacement in the previous planning cycle. Following recent inspections of the transformers, the conditions of the transformers were found to be acceptable and the plan to replace the transformers were deferred to 2028.

The Study Team has assessed downsizing and/or upsizing need for these transformers. As the 10 day LTR of the current transformers are substandard, the Working Group concluded that replacing the current transformers which new standard 75/125 MVA units will increase the supply capacity to about 160 MW and alleviate the current overloading at DESN1. Reducing the size of these transformers is not an option as the load in the area is increasing. Upsizing is also not an option as the current units are already the largest size for a 230/44kV step-down transformers.

7.8.2 Alternatives and Recommendation

1. Alternative 1 - Maintain Status Quo:
This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance expenses and will not meet Hydro One’s obligation to provide reliable supply to the customers.

2. Alternative 2 - Like-for-like replacement with similar equipment:
Expedite this end of life asset replacement as the current transformers are already overloaded. This alternative would address the end-of-life assets need and would maintain reliable supply to the customers in the area.

7.9 Asset Renewal Need – Dobbin TS T1/T2/T5 Auto Transformers

7.9.1 Description

Dobbin TS is located near the city of Peterborough, Ontario and supplies Peterborough to Quinte loads. Dobbin TS consists of three 230/115 kV auto transformers. T1 is rated at 150/250 MVA and T5 is rated at 115 MVA. T2 is rated at 36/78 MVA and currently out of service.

During the previous planning cycle, T2 and T5 were planned to be replaced with one 150/250 MVA unit. However, as T1 has also reached the end of service life, it would be more efficient and cost effective to replace all three transformers with two 150/250 MVA units.

7.9.2 Alternatives and Recommendation

1. Alternative 1 - Maintain Status Quo:
This alternative was considered and rejected as it does not address the risk of failure due to asset condition and would result in increased maintenance expenses and will not meet Hydro One's obligation to provide reliable supply to the customers.

2. Alternative 2 – Replace three existing autotransformers with two units:
Proceed with these end of life asset replacement as per the existing refurbishment plan for the transformers at Dobbin TS. This alternative would address the end-of-life assets need and would maintain reliable supply to the customers in the area.

8. CONCLUSION AND NEXT STEPS

THIS REGIONAL INFRASTRUCTURE PLAN REPORT CONCLUDES THE REGIONAL PLANNING PROCESS FOR THE PETERBOROUGH TO KINGSTON REGION.

This RIP report addresses near term and mid-term regional needs identified in the earlier phases of the Regional Planning process and during the RIP phase. The major infrastructure investments recommended by the TWG in the near and mid-term planning horizon are provided in Table 8-1 below. As the industry is currently witnessing supply chain issues and delays in procurement of equipments, it can impact the near term planning horizon if left unresolved.

Investments to address the mid-term needs, for cases where there is time to make a decision, will be reviewed and finalized in the next regional planning cycle. These needs are summarized in Table 8-1.

Table 8-1: Recommended Plans in Peterborough to Kingston Region over the Next 10 Years.

Stations/Lines Project	Details	In-Service Timeframe	Budgetary Cost Estimate[7] ($Million)
Cataraqui TS: Upgrade secondary conductor	Upgrade existing copper conductor on secondary side of auto transformers	2023	$0.5
Gardiner TS DESN1: Station Capacity and Transformers T1/T2 Asset Renewal	Replace the end-of-life transformers with similar type and size equipment as per current standard[8]	2028*	$30
	Load transfer from DESN1 to DESN2	2022	$0.5
Frontenac TS: Station Capacity	Develop plan to build new 230kV 75/125 MVA DESN station in the area, as needed	2025-2029	$30-$35
Otonabee TS 44kV: Station Capacity	Transfer 8MW of load from Otonabee 44kV bus to Dobbin TS	2022	$0.1
Port Hope TS: Transformers T3/T4 Asset Renewal	Replace the end-of-life transformers with similar type and size equipment as per current standard	2026	$25
Belleville TS: Build new DESN	Build a new 230 kV 75/125 MVA DESN with associated capacitor banks at the existing Belleville TS site	2026	$35-$40
Picton TS: Transformers T1/T2 Asset Renewal	Replace the end-of-life transformers with similar type and size equipment as per current standard	2025	$14.5
Dobbin TS: T1/T2/T5 Auto Transformer Asset Renewal	Replace the end-of-life auto transformers with two new 150/250 MVA unit and switchyard refurbishment	2029	$100

*Hydro One is exploring whether Gardiner TS T1/T2 transformers replacement date can be advanced to help address the station capacity need at Gardiner TS DESN 1 described in section 6.4

The Study Team recommends that:

- Hydro One and LDCs to continue with the implementation of infrastructure investments listed in Table 8-1 above while keeping the Study Team apprised of project status;
- All the other identified needs/options in the long-term will be further reviewed by the Study Team in the next regional planning cycle.

[7] Planning estimates are provided for Hydro One's portion of the work based on 2020 costs and are subject to change in the future

[8] The new standard units are expected to have a higher LTR of about 160 MW

9. REFERENCES

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[5]. 2nd Cycle Peterborough to Kingston Needs Assessment Report (2020)
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APPENDIX A: STATIONS IN THE PETERBOROUGH TO KINGSTON REGION

Station	Voltage (kV)	Supply Circuits
Ardoch DS (T1)	115	B1S
Battersea DS (T1/T2)	115	S1K
Belleville TS (T1/T2)	230	T25B, H23B
Dobbin DS (T1/T2)	115	P3S, P4S
Dobbin TS (T3/T4)	115	Q20H, Q20A
Frontenac TS (T3/T4)	115	B5QK, Q3K
Gardiner TS (T1/T2)	230	X4H, X2H
Gardiner TS (T3/T4)	230	X2H, X4H
Harrowsmith DS (T1/T2)	115	B5QK
Hinchinbrooke DS (T1)	115	B5QK
Lodgeroom DS (T1/T2)	115	B1S
Napanee TS (T1)	230	X21, X22
Northbrook DS (T1)	115	B1S
Otonabee TS (T1/T2)	230	T22C, T31H
Otonabee TS (T1/T2)	230	T22C, T31H
Picton TS (T1/T2)	230	X21, X22
Port Hope TS (T1/T2)	115	P3S, P4S
Port Hope TS (T3/T4)	115	P3S, P4S
Sharbot DS (T1)	115	B5QK
Sidney TS (T1/T2)	115	Q12AT, Q6S

APPENDIX B: TRANSMISSION LINES IN THE PETERBOROUGH TO KINGSTON REGION

Location	Circuit Designations	Voltage (kV)
Hinchinbrooke SS – Lennox TS	X1H, X2H, X3H, X4H	230
Picton TS – Lennox TS	X21, X22	230
Belleville TS – Hinchinbrooke SS	H23B	230
Hinchinbrooke SS – Havelock TS	H27H	230
Dobbin TS – Chenaux TS	X1P	230
Dobbin TS – Chat Falls GS	C27P	230
Clarington TS – Havelock TS	T32H	230
Chat Falls GS – Havelock TS	C25H	230
Clarington TS – Chat Falls GS	T22C	230
Cherrywood TS – Dobbin TS	P15C	230
Clarington TS – Belleville TS	T25B	230
Dobbin TS – Sidney TS	P3S, P4S	115
Cataraqui TS – Sidney TS	Q6S	115
Barrett Chute TS – Sidney TS	B1S	115
Cataraqui TS – Frontenac TS	Q3K	115
Cataraqui TS – Frontenac TS to Barrett Chute TS	B5QK	115

APPENDIX C: DISTRIBUTORS IN THE PETERBOROUGH TO KINGSTON REGION

Distributor Name	Station Name	Connection Type
Eastern Ontario Power Inc.	Frontenac TS	Dx
Elexicon Energy Inc. – Veridian Connections Inc.	Belleville TS	Tx
	Port Hope TS	Dx
Hydro One Distribution	Ardoch DS	Tx
	Battersea DS	Tx
	Belleville TS	Tx
	Dobbin DS	Tx
	Dobbin TS	Tx
	Frontenac TS	Tx
	Gardiner TS	Tx
	Harrowsmith DS	Tx
	Hinchinbrooke DS	Tx
	Lodgeroom DS	Tx
	Napanee TS	Tx
	Northbrook DS	Tx
	Otonabee TS	Tx
	Otonabee TS	Tx
	Picton TS	Tx
	Port Hope TS	Tx
	Sharbot DS	Tx
	Sidney TS	Tx
	Dobbin DS	Dx
	Dobbin TS	Dx
	Otonabee TS	Dx
Kingston Hydro Corporation	Frontenac TS	Tx
	Frontenac TS	Dx
	Gardiner TS	Dx
Lakefront Utilities Inc.	Port Hope TS	Dx

APPENDIX D: AREA STATIONS LOAD FORECAST

Table D-1: Net Summer Coincidental Load Forecast (MW)

Station	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Ardoch DS	2	2	2	2	2	2	2	2	2	2	2	2
Battersea DS	9	9	9	9	9	9	9	9	9	9	9	9
Belleville TS	170	174	179	183	186	186	187	187	188	189	190	191
Dobbin DS	6	6	6	6	6	6	6	6	6	6	6	6
Dobbin TS	111	111	117	122	123	123	125	126	127	129	131	132
Frontenac TS	97	96	100	102	104	104	105	107	108	109	111	112
Gardiner TS (T1/T2)	146	148	151	152	153	154	155	156	158	159	161	163
Gardiner TS (T3/T4)	25	28	28	28	28	28	28	28	28	28	28	28
Harrowsmith DS	16	16	16	16	16	16	16	16	16	16	17	17
Havelock TS	74	74	74	75	74	74	75	75	76	76	76	77
Hinchinbrooke DS	6	6	6	6	6	6	6	6	6	6	6	6
Lodgeroom DS	9	9	9	9	9	9	9	9	9	9	9	9
Napanee TS	61	62	62	63	63	64	64	65	66	66	67	68
Northbrook DS	6	6	6	6	6	6	6	6	6	6	6	6
Otonabee TS	123	124	119	119	115	115	116	118	119	120	122	124
Picton TS	43	43	44	44	44	45	45	45	46	46	47	47
Port Hope TS	121	121	122	122	122	122	123	123	124	124	125	126
Sharbot DS	4	4	4	4	4	4	4	4	4	4	4	4
Sidney TS	79	79	79	79	79	79	79	80	80	81	81	82
CTS	14	14	14	14	14	14	14	14	14	14	14	14
Total	1122	1132	1147	1161	1163	1166	1174	1182	1192	1199	1212	1223

Table D-2: Net Winter Coincidental Load Forecast (MW)

Station	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Ardoch DS	3	3	3	3	3	3	3	3	3	3	3	3
Battersea DS	11	11	11	11	11	11	11	11	11	11	11	11
Belleville TS	164	167	171	175	179	179	180	181	182	183	184	185
Dobbin DS	6	6	6	6	6	6	6	6	6	6	6	6
Dobbin TS	87	87	93	98	99	100	101	102	104	105	106	107
Frontenac TS	101	101	104	106	109	109	111	112	113	115	116	118
Gardiner TS (T1/T2)	132	133	135	137	139	140	141	143	144	146	147	149
Gardiner TS (T3/T4)	29	32	32	32	32	32	32	33	33	33	33	33
Harrowsmith DS	19	19	19	19	19	19	19	19	19	19	19	19
Havelock TS	69	69	69	69	70	70	70	71	71	72	72	73
Hinchinbrooke DS	7	7	7	7	7	7	7	7	7	7	7	7
Lodgeroom DS	10	10	10	10	10	10	10	11	11	11	11	11
Napanee TS	70	70	71	71	72	72	73	74	75	75	76	77
Northbrook DS	7	7	7	7	7	7	7	7	7	7	7	7
Otonabee TS	145	146	146	142	138	139	140	142	143	146	147	149
Picton TS	48	49	49	50	50	50	51	51	52	52	53	53
Port Hope TS	127	128	128	129	130	130	130	131	132	132	133	134
Sharbot DS	4	4	4	4	4	5	5	5	5	5	5	5
Sidney TS	69	69	68	68	68	68	69	70	70	71	71	72
CTS	26	26	26	26	26	26	26	26	26	26	26	26
Total	1134	1144	1159	1170	1179	1183	1192	1205	1214	1225	1233	1245

Table D-3: Net Summer Load Forecast for stations with capacity needs (MW)

Station	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Belleville TS	170	174	179	183	186	186	187	187	188	189	190	191
Frontenac TS	101	101	108	107	107	107	108	109	110	111	112	114
Gardiner TS (T1/T2)	146	148	151	152	153	154	155	156	158	159	161	163
Otonabee TS 44 kV	102	102	98	98	95	95	96	97	98	99	100	102

Table D-4: Net Winter Load Forecast for stations with capacity needs (MW)

Station	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Belleville TS	164	167	171	175	179	179	180	181	182	183	184	185
Frontenac TS	111	113	117	117	117	118	119	120	121	122	123	125
Gardiner TS (T1/T2)	132	133	135	137	139	140	141	143	144	146	147	149
Otonabee TS 44 kV	115	116	116	113	109	110	111	113	114	115	116	118

Table D-5: Net Summer Non-Coincidental Load Forecast Growth Scenario 1 (MW)

Station	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Belleville TS	170	174	179	183	187	187	187	188	189	190	191	192
Frontenac TS	101	102	109	110	111	113	117	121	125	129	133	137
Gardiner TS (T1/T2)	146	148	151	153	155	156	158	159	161	163	165	168

Table D-6: Net Winter Non-Coincidental Load Forecast Growth Scenario 1 (MW)

Station	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Belleville TS	164	168	172	176	180	180	181	182	183	184	185	186
Frontenac TS	111	114	119	120	121	124	128	132	136	140	144	148
Gardiner TS (T1/T2)	132	134	136	138	141	142	144	146	148	150	152	155

Table D-7: Net Winter Non-Coincidental Load Forecast Growth Scenario 2 (MW)

Station	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Belleville TS	164	168	172	176	180	180	181	182	183	184	185	186
Frontenac TS	111	116	124	126	130	136	145	155	165	174	183	193
Gardiner TS (T1/T2)	132	135	138	142	145	148	151	154	157	160	163	167

APPENDIX E: LIST OF ACRONYMS

Acronym	Description
A	Ampere
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DG	Distributed Generation
DSC	Distribution System Code
GS	Generating Station
GTA	Greater Toronto Area
HV	High Voltage
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
LDC	Local Distribution Company
LP	Local Plan
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low Voltage
MTS	Municipal Transformer Station
MW	Megawatt
MVA	Mega Volt-Ampere
MVAR	Mega Volt-Ampere Reactive
NA	Needs Assessment
NERC	North American Electric Reliability Corporation
NGS	Nuclear Generating Station
NPCC	Northeast Power Coordinating Council Inc.
NUG	Non-Utility Generator
OEB	Ontario Energy Board
OPA	Ontario Power Authority
ORTAC	Ontario Resource and Transmission Assessment Criteria
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
ROW	Right-of-Way
SA	Scoping Assessment
SIA	System Impact Assessment
SPS	Special Protection Scheme
SS	Switching Station
TS	Transformer Station
TSC	Transmission System Code
UFLS	Under Frequency Load Shedding
ULTC	Under Load Tap Changer
UVLS	Under Voltage Load Rejection Scheme