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NEEDS ASSESSMENT REPORT

Region: Burlington to Nanticoke

Date: September 06, 2022

Prepared by: Burlington to Nanticoke Technical Working Group

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Disclaimer

This Needs Assessment Report was prepared for the purpose of identifying potential needs in the Burlington to Nanticoke Region and to recommend which need may be a) directly addressed by developing a preferred plan as part of NA phase and b) identify needs requiring further assessment and/or regional coordination. The results reported in this Needs Assessment are based on the input and information provided by the Technical Working Group (TWG) for this region.

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Executive Summary

REGION Burlington to Nanticoke Region (the "Region")

LEAD Hydro One Networks Inc. ("HONI")

START DATE: MAY 11, 2022 **END DATE:** September 06, 2022

1. INTRODUCTION

The second Regional Planning cycle for the Burlington to Nanticoke Region was completed in October 2019 with the publication of the Regional Infrastructure Plan ("RIP") report. This is the third cycle of Regional Planning for the region.

The purpose of this Needs Assessment ("NA") is to: a) identify any new needs and/or to reaffirm needs identified in the previous Regional Planning cycle; and, b) recommend which needs may be i) addressed by developing a preferred plan as part of the NA phase which do not require further regional coordination and ii) identify needs requiring further assessment and/or regional coordination.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least every five years. Considering these timelines, the 3rd Regional Planning cycle was triggered in May 2022 for the Burlington to Nanticoke Region.

3. SCOPE OF NEEDS ASSESSMENT

The scope of this NA covers the Burlington to Nanticoke Region and includes:

- Review and reaffirm needs/plans identified in the RIP;
- Identify any new needs resulting from this assessment;
- Develop options and recommend a preferred plan for need(s) that do not require further regional coordination; and
- Recommend which need(s) require further assessment/regional coordination in the next phases of the Regional Planning cycle.

The Technical Working Group ("TWG") may also identify additional needs during the next phases of the planning process, namely Scoping Assessment ("SA"), Integrated Regional Resource Plan ("IRRP") and RIP, based on updated information available at that time.

The planning horizon for this NA assessment is 10 years.

4. INPUTS/DATA

The TWG representatives from Local Distribution Companies ("LDC"), the Independent Electricity System Operator ("IESO"), and Hydro One provided input and relevant information for this Region regarding capacity

needs, reliability needs, operational issues, and major high-voltage (HV) transmission assets requiring replacement over the planning horizon. The community energy plans will be further evaluated during the next phases of this Regional Planning cycle.

5. ASSESSMENT METHODOLOGY

The assessment's primary objective is to identify the electrical infrastructure needs in the Region over the study period. The assessment methodology includes review of planning information such as load forecast, conservation and demand management ("CDM") forecast, available distributed generation ("DG") forecast information, any system reliability and operation issues, and major HV equipment requiring replacement.

A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- Reliability needs and operational concerns; and
- Any major HV equipment requiring replacement with consideration to "right-sizing".

6. NEEDS

I. Update of identified needs from previous cycle

The following near- term needs identified in the Burlington to Nanticoke 2nd Cycle RIP report have been addressed/ completed:

1. Cumberland TS: Power factor correction
2. 115 kV B3/B4: Line section from Horning Mountain Jct. to Glanford Jct. requiring refurbishment
3. Elgin TS: Transformers & switchgears requiring replacement (Replacing two DESNs with a single unit)
4. Newton TS: Transformers (T1/T2) requiring replacement
5. Kenilworth TS: Transformer & switchgear requiring replacement (Replacing two DESNs with a single unit)

The status of remaining near-term needs is as follows:

1. 115 kV B7/B8: Line section from Burlington TS to Nelson Jct. requiring refurbishment
   Planned for in-service in 2024
2. Dundas TS (Load transfers/Balancing)
   Planned for in-service in 2023
3. Gage TS: Transformers & switchgear (T3/T4 and T5/T6 DESNs) requiring replacement
   In Execution: Planned in-service in Q4 2023
4. Kenilworth TS: Power factor correction
   Planned for in-service in Q4 2023

5. Norfolk area supply capacity

Near Term:

- Load transfers from Norfolk area to Jarvis TS is planned to be completed by the end of 2022.
- Additional reactive support at Norfolk TS is planned for 2023-24 timeframe.

Mid-Term:

- Upgrade Jarvis TS and build feeders to pick up Norfolk area loads – is planned for 2027-32 timeframe

II. Newly identified needs in the region

a. Line / Station Capacity

The following station capacity needs were identified in the Region:

1. Norfolk TS and Bloomsburg DS (Norfolk Area)

The loads at Norfolk TS and Bloomsburg DS are forecasted to exceed their supply capacities in 2030 and 2025 respectively. The supply capacity needs for these stations will be addressed through load transfers to Jarvis TS by building new feeders to pick Norfolk area loads. The Jarvis TS upgrade and required feeders to pickup Norfolk area loads are currently planned for 2027-2032 timeframe as described above. This need will be further reviewed during the next phases of this Regional Planning cycle.

2. Brant Area Supply

The 115 kV Brant area is supplied by two stations, i.e. Brant TS and Powerline MTS supplied by three 115 kV. Two (2) of the three (3) 115 kV circuits are supplied from Burlington TS and the third from Karn TS. The supply capacity of 115 kV system to Brant area to 165MW.

The coincident load in the 115 kV Brant area system may exceed the LMC of 165 MW before the end of the study period (2022-32). TWG recommends that this potential need be reviewed during the next phases of this Regional Planning cycle.

3. Caledonia TS

The load at Caledonia TS is forecasted to exceed its supply in 2030. The TWG recommended monitoring on the loading at Caledonia TS and to be further reviewed during the next phases of this Regional Planning cycle.

4. Nebo TS

The load at T3/T4 230/ 13.8 kV DESN at Nebo TS had been historically around its supply capacity and is currently forecasted to grow above its supply capacity. The TWG recommended monitoring the loading at this station and take remedial measures, if required. This DESN is planned to be refurbished in the 2027-2032 timeframe replacing existing 75 MVA nonstandard

transformers with Hydro One standard 100 MVA units. This will also address the supply capacity need at this station. This need will be further reviewed during the next phases of this Regional Planning cycle.

5. Mohawk TS

   The load at Mohawk TS had been historically around its current loading levels however is forecasted to grow and exceed station supply capacity by 2024. The TWG recommended Hydro One and Alectra to monitor loading levels at this station and take necessary actions, if required e.g. load transfers to the neighboring stations. This need will be further reviewed during the next phases of this Regional Planning cycle.

b. Aging Infrastructure Transformer Station and Transmission Circuit Replacements

Based on asset condition assessment, Newton TS 115 kV breakers have been identified for replacement.

7. RECOMMENDATIONS

The TWG recommends to continue with:

- Refurbishment of section of 115 kV B7/B8 line;
- Refurbishment of Gage TS (T3/T4 and T5/T6 DESNs);
- Load transfer from Dundas TS to Dundas TS #2 to address overloading;
- Supply capacity in Norfolk area;
- Power factor correction at Kenilworth TS; and
- Refurbishment need for 115 kV breakers at Newton TS.

The TWG also recommended that the concerned LDC and Hydro One to monitor the loading levels in Norfolk and Brant areas as well at Caledonia TS, Nebo TS and Mohawk TS and take necessary action to address overloading, if required. These needs will be further reviewed during the Scoping Assessment phase of this Regional Planning cycle.

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List of Tables and Figures

1 INTRODUCTION

The second cycle of the Regional Planning process for the Burlington to Nanticoke Region was completed in October 2019 with the publication of the Regional Infrastructure Plan ("RIP") Report.

The purpose of this Needs Assessment ("NA") is to identify new needs and to reconfirm and update any needs identified in the previous Burlington to Nanticoke Regional Planning cycle.

This report was prepared by the Burlington to Nanticoke Region Technical Working Group("TWG"), led by Hydro One Networks Inc. Participants of the TWG are listed below in Table 1. The report presents the results of the assessment based on information provided by the Hydro One, the Local Distribution Companies ("LDC") and the Independent Electricity System Operator ("IESO").

Table 1: Burlington to Nanticoke Region TWG Participants

1	Burlington Hydro Inc.
2	GrandBridge Energy Inc. (Formerly Energy+ and Brantford Power)
3	Alectra Utilities Corporation (former Horizon Utilities Inc.)
4	Hydro One Networks Inc. (Distribution)
5	Oakville Hydro Electricity Distribution Inc.
6	Independent Electricity System Operator
7	Hydro One Networks Inc. (Lead Transmitter)

2 REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least every five years. As such, the 3rd Regional Planning cycle was triggered for the Burlington to Nanticoke region

3 SCOPE OF NEEDS ASSESSMENT

The scope of this NA covers the Burlington to Nanticoke region and includes:

- Review and reaffirm needs/plans identified in the RIP;
- Identify any new needs resulting from this assessment;

- Develop options and recommend a preferred plan for need(s) that do not require further regional coordination; and
- Recommend which need(s) require further assessment/regional coordination in the next phases of the Regional Planning cycle.

The TWG may identify additional needs during the next phases of the Regional Planning process, namely Scoping Assessment ("SA"), Local Planning ("LP"), IRRP, and/or RIP.

4 REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The Burlington to Nanticoke region covers the City of Brantford, Municipality of Hamilton, counties of Brant, Haldimand and Norfolk. The portions of Cities of Burlington and Oakville south of Dundas street are included in the Burlington to Nanticoke region up to Third Line road in the east. Electrical supply to the region is provided from thirty 230 kV and 115 kV step-down transformer stations. The sum of 2021 non-coincident summer station peak load of the Region was about 2341 MW. The boundaries of the Region are shown in Figure 1 below.

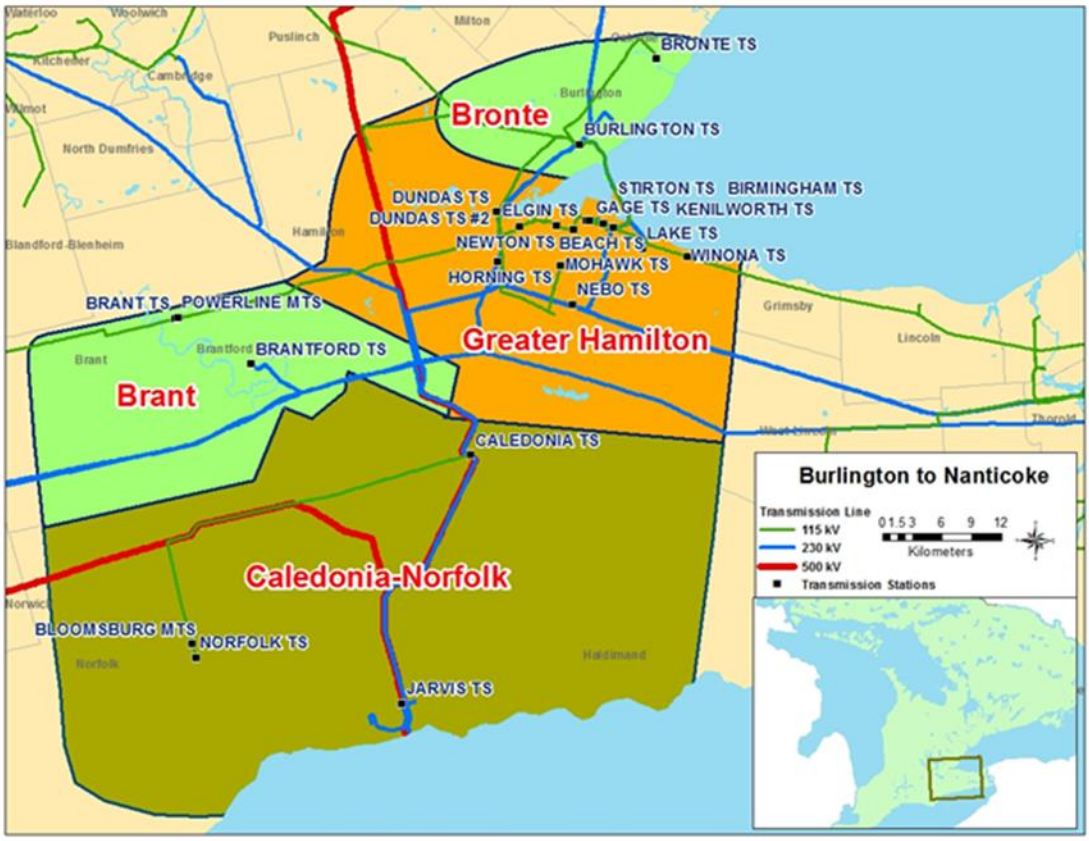

Figure 1: Map of Burlington to Nanticoke Regional Planning Area

Bulk electrical supply to the Burlington to Nanticoke Region is provided through the 500/230 kV autotransformers at Nanticoke TS and Middleport TS and 230 kV circuits from Middleport TS, Nanticoke TS and Beck TS. The 115 kV network is supplied by 230/115 kV autotransformers at Burlington TS, Beach TS and Caledonia TS. The area loads are supplied by a network of 230 kV and 115 kV transmission lines and step-down transformation facilities. The area has been divided into four sub-regions as shown in Figure 1 and described below:

- The Brant sub-region encompasses the County of Brant, City of Brantford and surrounding areas. Electricity supply to the sub-region is provided by:
  - Brant TS and Powerline MTS supplied by 115 kV double circuit B12BL/B13BL line and B2 single circuit line.
  - Brantford TS supplied by the 230 kV double circuit transmission line M32W/M33W.

  The Brant Sub-region transmission facilities are shown in Figure 2.

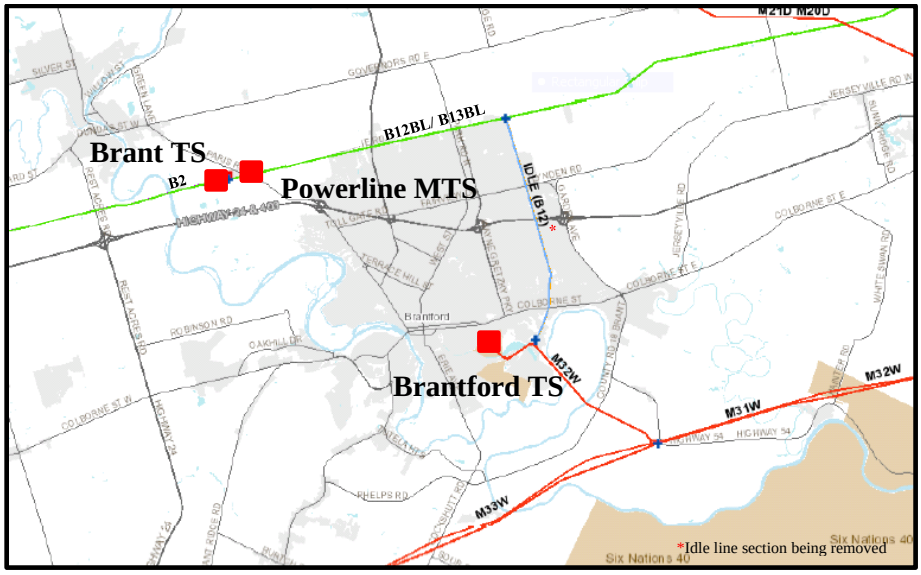

Figure 2: **Map of Brant sub-region**

The total 2021 non-coincident peak demand of the three stations was 280 MW. GrandBridge Energy (Merger of Brantford Power Inc. and Energy+ Inc.) is the main LDCs that serve the electricity demand for the City of Brantford. Hydro One Distribution supplies load in the outlying areas of the sub-region. The electricity demand is comprised of residential, commercial, and industrial customers.

- The Bronte sub-region covers the City of Burlington and the western part of the City of Oakville up to Third Line. Electricity supply to the sub-region is provided by:
  - Bronte TS supplied by 115 kV double circuit line B7/B8.
  - Burlington TS supplied by 230 kV double circuit line Q23BM/ Q25BM.
  - Cumberland TS supplied from 230 kV double circuit transmission line B40C/B41C.

The Bronte sub-region transmission facilities are shown in Figure 3.

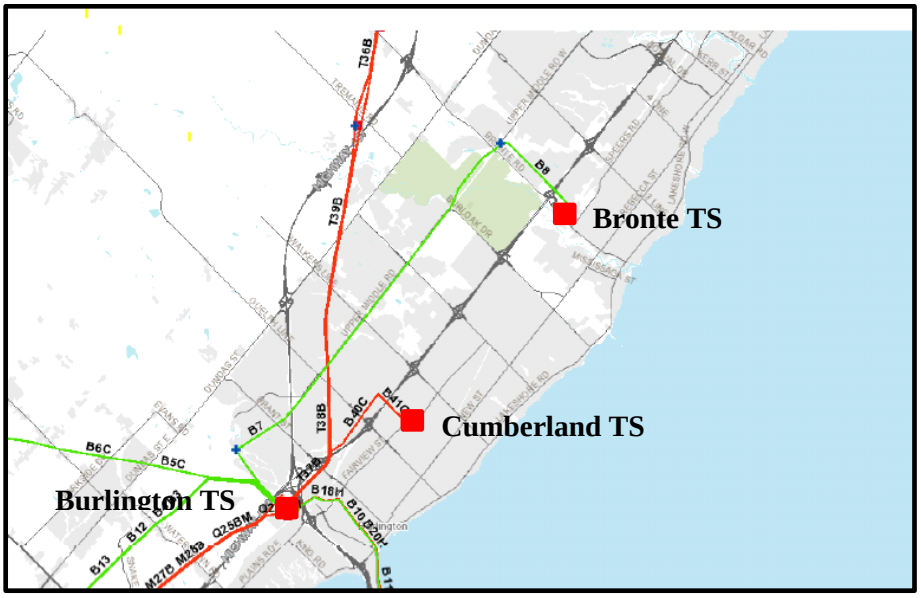

Figure 3: Map of Bronte sub-region

The area is served by Burlington Hydro and Oakville Hydro. The electricity demand is comprised of residential, commercial, and industrial customers. The total 2021 non-coincident peak station demand of the three stations was 358 MW.

- The Greater Hamilton sub-region encompasses the City of Hamilton that includes Townships of Flamborough and Glanbrook and towns of Dundas and Stoney Creek. Some of the electrical infrastructure in the sub-region was built over 50 years ago and is one of the oldest installations in the province. Electricity supply to the sub-region is grouped as follows:

  - Beach TS 115 kV area which includes four 115 kV step down stations Birmingham TS, Kenilworth TS, Stirton TS and Winona TS supplied from the 230/115 kV autotransformers at Beach TS.
  - Burlington TS 115 kV area which includes Dundas TS, Dundas #2, Elgin TS, Gage TS, Mohawk TS, Newton TS and one customer owned CTS supplied from the 230/115 kV autotransformers at Burlington TS.
  - 230 kV area which includes Beach TS (T3/T4 & T5/T6 DESNs), Horning TS, Nebo TS, Lake TS and two customer owned stations supplied from 230 kV circuits connecting into Beach TS and Burlington TS.
  - A large industrial customer currently supplied through 230 kV system is planning to connect a large additional load within his facilities.

  The Greater Hamilton sub-region transmission facilities are shown in Figure 4.

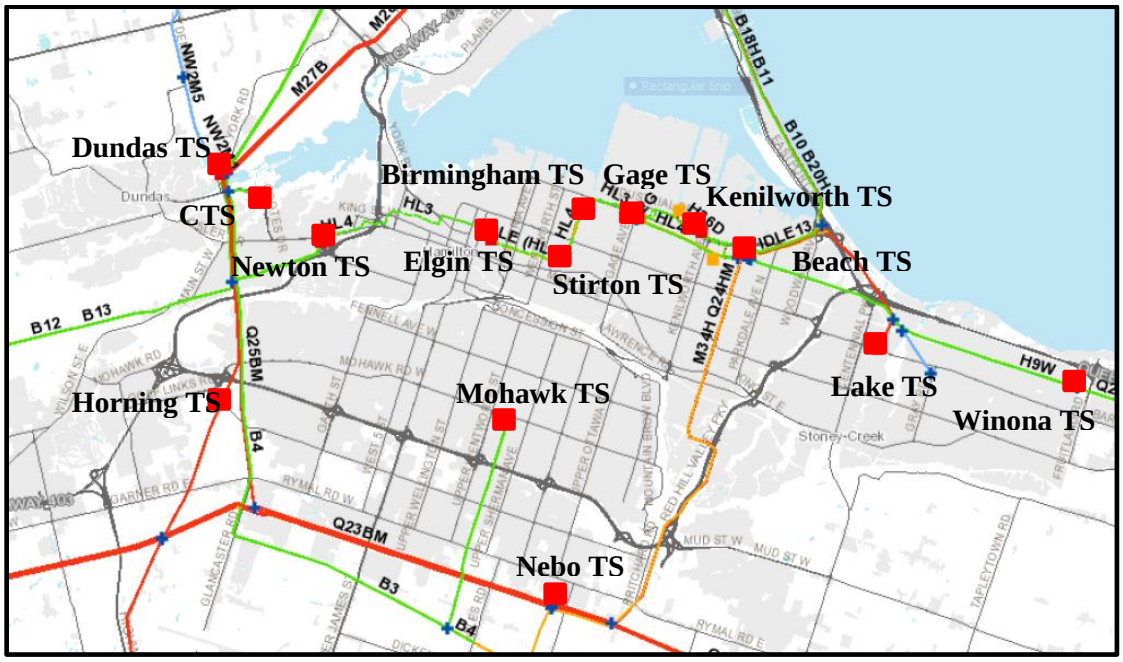

Figure 4: Map of Greater Hamilton sub-region

The total 2021 non-coincident peak demand of the Greater Hamilton sub-region was 1365 MW. The area is served by Alectra Utilities, Hydro One Distribution and Customer Transformer Stations (CTS) comprises a significant number of large industrial customers along with commercial and residential customers.

- The Caledonia Norfolk sub-region covers the eastern part of Norfolk County and the western part of Haldimand County. Electricity supply to the Sub-region is provided by:

  - Caledonia TS supplied by 230 kV double circuit line N5M/S39M.
  - Jarvis TS and two (2) CTSs supplied from the 230 kV double circuit line N21J/N22J.
  - One of the CTSs is supplied from the 230 kV single circuit N20K. This is a new station where a large industrial customer previously supplied through Jarvis TS will be supplied by a new CTS.
  - Bloomsburg DS and Norfolk TS supplied from 115 kV double circuit transmission line C9/C12.

  The Caledonia Norfolk sub-region transmission facilities are shown in Figure 5.

  The area is served by Hydro One Distribution. The electricity demand mix is comprised of residential, commercial, and industrial uses. The 2021 non-coincident peak demand of this sub-region was 381 MW.

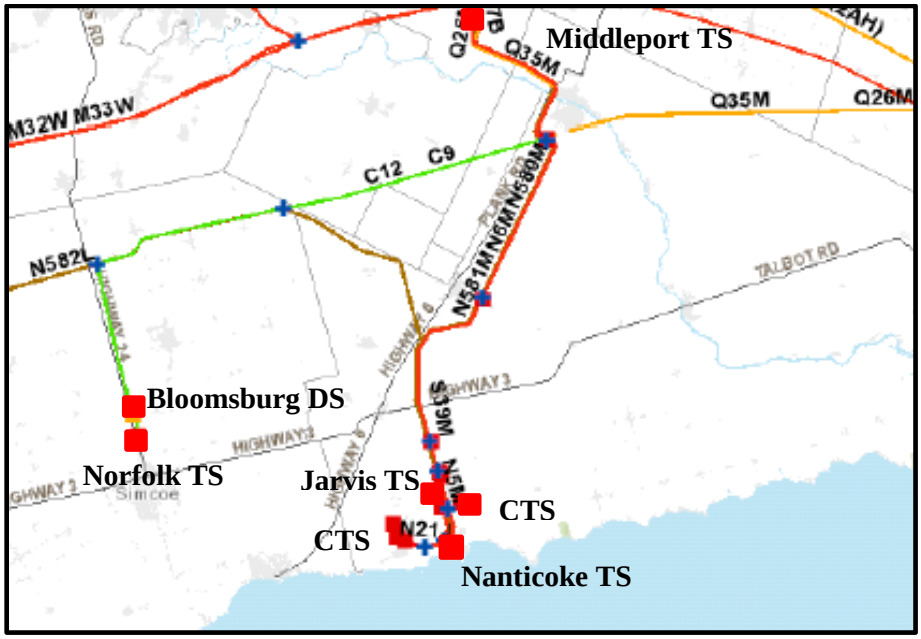

Figure 5: Map of Caledonia Norfolk sub-region

- Electrical single line diagrams for the Burlington to Nanticoke region's 500 kV/ 230 kV facilities and 115 kV facilities are shown below in Figure 6 and Figure 7.

The circuits and stations of the area are summarized in the Table 2 below:

Table 2: Transmission Station and Circuits in the Burlington to Nanticoke Region

115kV circuits	230kV circuits	Hydro One Transformer Stations
B3, B4, B5G, B6G, B7, B8, B10, B11, B12BL, B13BL, C9, C12, HL3, HL4, H5K, H6K, H9W, K1G, K2G, Q2AH	B18H, B20H, B40C, B41C, M34H, H35D, H36D, K40M, M20D, M21D, M27B, M28B, M31W, M32W, M33W, N5M, N6M, N21J, N22J, N37S, N20K Q24HM, Q23BM, Q25BM, Q30M, Q29HM, S39M,	Beach TS*, Birmingham TS, Bloomsburg DS, Brant TS, Brantford TS, Bronte TS, Burlington TS* DESN, Caledonia TS*, Cumberland TS, Dundas TS, Dundas TS #2, Elgin TS, Gage TS, Horning TS, Jarvis TS, Kenilworth TS, Lake TS, Mohawk TS, Nebo TS, Newton TS, Norfolk TS, Powerline MTS, Stirton TS, Winona TS and six (6) customer owned transformer station

*Stations with Autotransformers installed

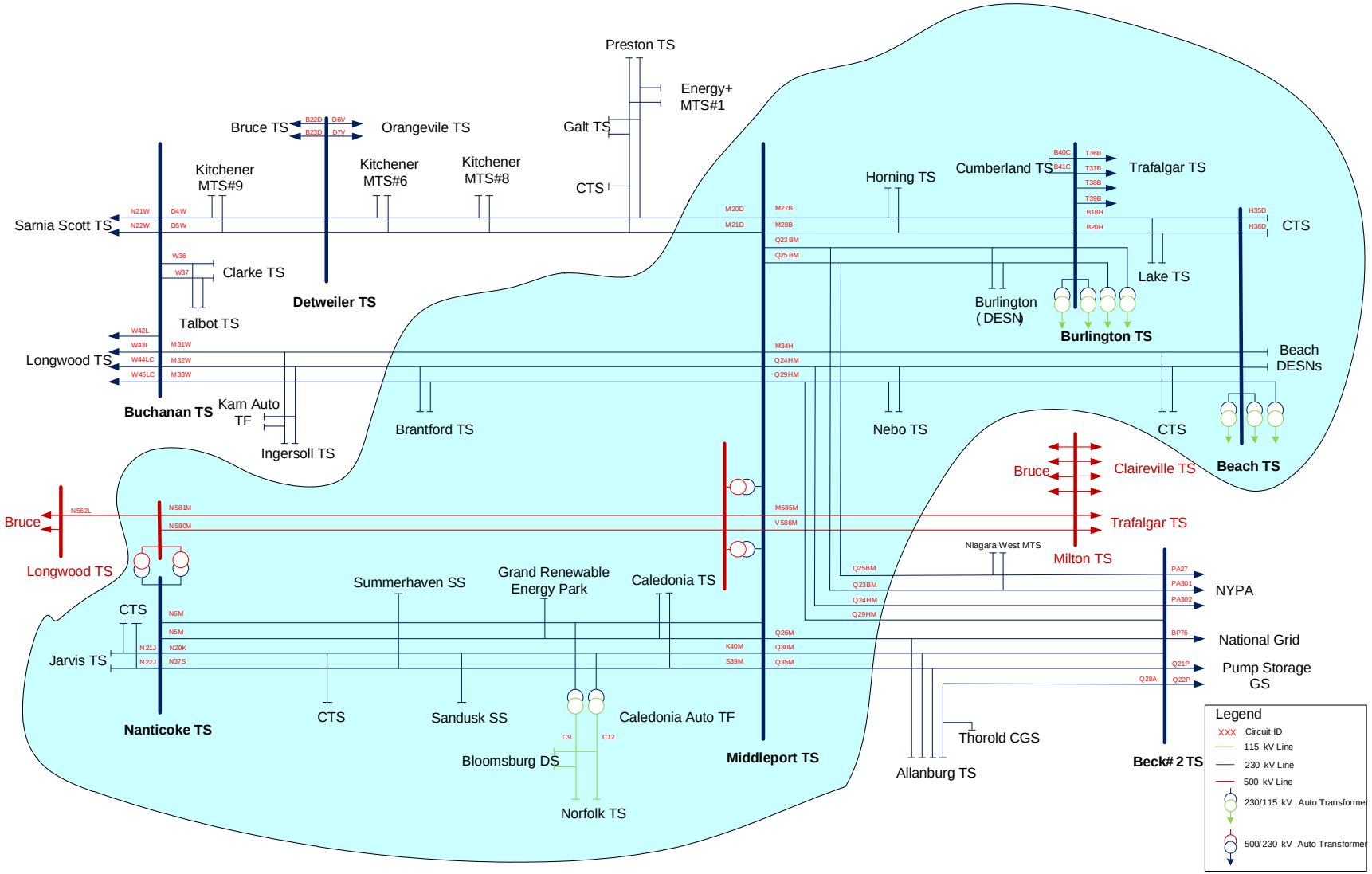

Figure 6: Burlington to Nanticoke Region 500 & 230 kV and Caledonia-Norfolk 115 kV Network

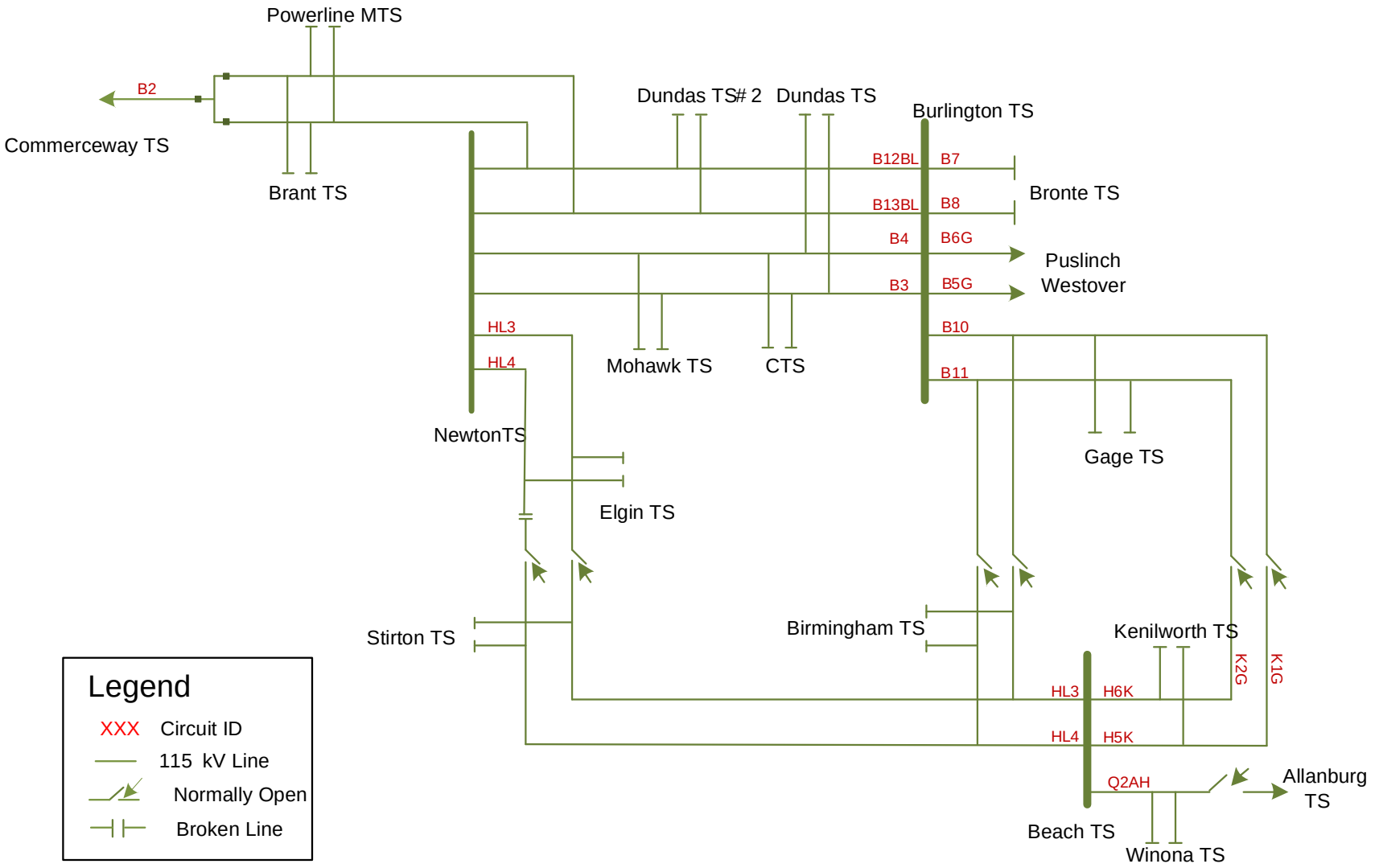

Figure 7: 115 kV Network Supplied by Burlington TS and Beach TS

5 INPUTS AND DATA

TWG participants, including representatives from LDCs, IESO, and Hydro One provided information and input for the Burlington to Nanticoke Region NA. The information provided includes the following:

- Burlington to Nanticoke Load Forecast for all supply stations;
- Known capacity and reliability needs, operating issues, and/or major assets requiring replacement/ refurbishment; and
- Planned/foreseen transmission and distribution investments that are relevant to Regional Planning for the Burlington to Nanticoke Region.

The community energy plans will be further evaluated during the next phases of this regional planning cycle.

6 ASSESSMENT METHODOLOGY

The following methodology and assumptions are made in this Needs Assessment:

Information gathering included:

i. Load forecast: The LDCs provided their load forecast for all the stations supplying their loads in the Burlington to Nanticoke region for the 10-year study period. The IESO provided a Conservation and Demand Management ("CDM") and Distributed Generation ("DG") forecast for the Burlington to Nanticoke region. The region's extreme summer non-coincident peak gross load forecasts for each station were prepared by applying the LDC load forecast growth rates to the actual 2021 summer peak extreme weather corrected loads. The extreme summer weather correction factors were provided by Hydro One. The net extreme summer weather load forecasts were produced by reducing the gross load forecasts for each station by the percentage CDM and then by the amount of effective DG capacity provided by the IESO for that station. It is to be noted that as contracts for existing DG resources in the region begin to expire, at which point the load forecast has a decreasing contribution from local DG resources, and an increase in net demand. This extreme summer weather corrected net load forecast for the individual stations in the Burlington to Nanticoke region is given in Appendix A;

ii. Relevant information regarding system reliability and operational issues in the region; and

iii. List of major HV transmission equipment planned and/or identified to be refurbished and/or replaced based on asset condition assessment, relevant for Regional Planning purposes. This includes HV transformers, autotransformers, HV Breakers, HV underground cables and overhead lines.

A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- System reliability and operational concerns;

- Any major high voltage equipment requiring replacement;
- Load forecast data was requested from industrial customers in the region; and
- The Region is summer peaking so is this assessment based on summer peak loads. Two load forecasts were developed i.e. Normal Growth scenario and High Growth scenario. The High Growth scenario load forecast was developed to conduct a sensitivity analysis to cover unforeseen developments like higher than expected EV charging trend during peak load conditions.

The following other assumptions are made in this report.

- The study period for this Needs Assessment is 2022-2032.
- Line capacity adequacy is assessed by using coincident peak loads in the area.
- Station capacity adequacy is assessed by comparing the non-coincident peak load with the station's normal planning supply capacity, assuming a 90% lagging power factor 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 Hydro One summer 10-Day Limited Time Rating (LTR) of a single transformer at that station.
- Adequacy assessment is conducted as per Ontario Resource Transmission Assessment Criteria (ORTAC).

7 NEEDS

This section describes emerging needs identified in the Burlington to Nanticoke Region, and reviews the near, mid, and long-term needs already identified in the previous Regional Planning cycle. A contingency analysis was performed for the region using the load forecast developed and no new system needs were identified.

The following near- term needs identified in the Burlington to Nanticoke 2nd Cycle RIP report have been addressed/completed:

1. Cumberland TS: Power factor correction
2. 115 kV B3/B4: Line section from Horning Mountain Jct. to Glanford Jct. requiring replacement
3. Elgin TS: Transformers & switchgears requiring replacement
4. Newton TS: Transformers requiring replacement
5. Kenilworth TS: Transformer & switchgear requiring replacement

The status of the remaining near-term needs identified in the Burlington to Nanticoke 2nd Cycle RIP report is summarized in Table 3 below.

Table 3: Near-Term Needs in Burlington to Nanticoke Region

No.	Needs	Status
1	115 kV B7/B8: Line section from Burlington TS to Nelson Jct. requiring refurbishment	Planned for in-service of 2024
2	Dundas TS: Load transfers	Hydro One Distribution is currently planning to build feeders required for load transfers from Dundas TS to Dundas TS #2. No new additional work inside Dundas TS #2 is required for these load transfers. The combined supply capacity of both Dundas stations is sufficient over and beyond the study period
3	Gage TS: Transformers & switchgear requiring replacement	Project in execution for the refurbishment of T3/ T4 and T5/ T6 DESNs to be replace with a new single DESN having larger transformers with a planned in-service in the Q4 2023
4	Kenilworth TS: Power factor correction	At Kenilworth TS the historical loading data indicated that under peak load the power factor is lagging below the ORTAC requirement of 0.9. To address this issue The TWG recommended Alectra Utilities to install capacitor bank and/or work with load customers supplied by Kenilworth TS to meet ORTAC power factor requirement of 0.9. The installation of capacitor bank at Kenilworth TS will be initiated after completion of refurbishment of this supply station in Q4 2023
5	Norfolk area supply capacity	Electrical supply to the Norfolk Area is provided through two (2) 115 kV C9/C12 transmission circuits supplied by 230/115 kV autotransformers at the Caledonia TS. These two 115 kV circuits have a load meeting capability (LMC) of approximately 88 MW and supply Norfolk area loads through two step down transformer stations, i.e. Bloomsburg DS and Norfolk TS. The load in Norfolk Area has held constant over the years below the LMC. The load however, has peaked at 94 MW during the summer of 2018. The 2nd cycle Burlington to Nanticoke RIP made recommendations to address immediate supply capacity needs in the Norfolk Area. This recommendation included distribution load transfers of approximately 6.5 MW from Norfolk area to Jarvis TS using existing feeders and additional reactive support at Norfolk TS to improve the voltage profile, resulting in an increase of the Norfolk Area LMC by approximately 10 MW. These two recommendations will increase the LMC of the pocket to approximately 105MW.

No.	Needs	Status
		The load transfers from Norfolk area to Jarvis TS are planned to be completed by end of 2022 and the additional reactive support at Norfolk TS is planned for 2023-24 timeframe. The RIP also recommended a further assessment to be carried out by the IESO and Hydro One to review the near to mid-term capacity needs. The IESO carried out this assessment and identified preferred options based on the load forecast at that time. No study report was published. These options should be reexamined with the updated forecast and an appropriate planning approach determined in the scoping assessment phase.

The current timing for the mid- and long-term electrical infrastructure needs identified in the Burlington to Nanticoke Region 2nd cycle RIP report are summarized below in Table 4.

Table 4: Status Update of Mid- and Long-Term Needs in Burlington to Nanticoke Region

No.	Needs	Planned Timeframe**
1	Birmingham TS: Transformer and metalclad switchgears requiring replacement	2027-32
2	Mid-Term Transformers at Nebo TS (T3/T4), Caledonia TS (T1) and Jarvis TS (T3/T4) requiring replacement	2027-32
3	Mid-Term replacement requirement of switchgears at Norfolk TS and Burlington TS	2027-32
4	Cables in Hamilton sub-region: H5K/H6K, K1G/K2G, HL3/HL4 requiring replacement	2033*
5	Norfolk area supply capacity: Install new 230 kV double circuit lines and a new DESN	2027-32
6	Beach TS: 230 kV autotransformers and DESN transformers requiring replacement	2027-32
7	Lake TS: Transformers and switchgear requiring replacement	2026-27
8	Burlington TS: 230 kV autotransformer requiring replacement	2027-32
9	Gage TS (T8/T9 DESN): Transformer and switchgears requiring replacement	2027-32

*- To be finalized through Hamilton IRRP Addendum by the IESO

**- Subject to change depending on multiple factors

7.1 Asset Replacement Needs for Major HV Transmission Equipment

The major HV transmission equipment considered in this assessment is shown in Table 5.

Table 5: Major High-Voltage Transmission Equipment Assessed for Replacement

No.	HV Equipment Included
1.	230/115kV Autotransformers
2.	230kV and 115kV load serving step-down transformers
3.	115kV Breakers
4.	230kV and 115kV transmission lines*
5.	230kV and 115kV underground cables*

*Requirement for a Leave to Construct (Section 92) for any alternative to like-for-like would be an appropriate threshold for which segments to include

Hydro One has identified 115 kV breakers at Newton TS with a planned in-service of 2025 as new additional asset replacement need for its major HV equipment over the next 10 years in the Burlington to Nanticoke Region. These needs are determined by asset condition assessment, which 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.

The TWG recommended continuation of addressing the new identified asset replacement need of 115 kV breakers at Newton TS as well as needs identified in the 2nd cycle RIP report for the Burlington to Nanticoke Region.

7.2 Station and Transmission Capacity Needs in the Burlington to Nanticoke Region

The Station and Transmission supply capacities have been reviewed and the following needs have been identified in the Burlington to Nanticoke region during the study period of 2022 to 2032.

7.2.1 230/115 kV Autotransformers

The 230/115 kV autotransformers in the Burlington to Nanticoke TS supplying 115 kV stations in the Region are within their ratings for the loss of a single unit and are adequate to supply the forecasted load over the study period.

7.2.2 115kV Transmission Lines

The new area supply needs identified the following which may require regional coordination:

a) Bronte Area Supply

The Bronte Sub-region is within the Burlington-Nanticoke planning region. It roughly encompasses the cities of Burlington and Oakville. An IRRP was completed in 2016 to address the supply capacity issues for the loads supplied by Bronte TS. Bronte TS is radially supplied from the double-circuit 115 kV

transmission line B7/B8 originating from Burlington TS. This IRRP recommended that the peak demand at Bronte TS be limited to 135 MW through incremental load transfers (as required) from Bronte TS to other neighboring stations. For the loads in excess of 135 MW the thermal loading of B7/B8 exceeds capacity following the loss of the companion circuit and the post contingency voltage drop exceeds 10% at Bronte TS. The loads at Bronte TS are forecasted to remain around the current supply capacity of 135 MW over the study period and beyond.

TWG recommend that the loading at Bronte TS has reached its capacity and any future loads in excess of 135 MW in this area be supplied from neighboring stations.

b) Brant Area Supply

The 115 kV Brant area is supplied by two stations i.e. Brant TS and Powerline MTS. An IRRP was completed by the IESO in 2015 to addresses the electricity needs of the area over the next 20 years up to 2033. The report recommended installation of a capacitor bank at Power line MTS and building of a new switching station integrating B12 and B13 115 kV circuits from Burlington TS with a single 115 kV circuit B8W supplied from Karn TS. These two measures increased the Load Meeting Capability (LMC) of 115 kV supply system to Brant area to 165MW.

The coincident load in the 115 kV Brant area system may exceed the LMC of 165 MW before the end of the study period (2032). Additional analysis is required to better assess the need timeframe is required.

TWG recommends Hydro One to monitor the loading on the Brant 115 kV supply system and take remedial measures, if required. This need will be reviewed during the Scoping Assessment phase of this Regional Planning cycle.

c) Norfolk Area Supply

The Norfolk area loads are supplied through Norfolk TS and Bloomsburg DS supplied through two 115 kV circuits from Caledonia autotransformers. In 2020, the IESO carried out an assessment of the supply capability in the Norfolk area when additional load growth was identified by the LDCs. As a result of this assessment, load transfers out of the Norfolk area and additional reactive support at Norfolk TS was recommended. These measures will increase the LMC of supply to Norfolk area from 88MW to 105 MW. In the mid-term the preferred option based on the load forecast at that time was to upgrade Jarvis TS and build four (4) 27.6 kV feeders from this station to Norfolk area to pick up loads limiting the loads supplied from the existing Norfolk area system to within its supply capacity.

Based on the current Normal Growth load forecast the loads are growing at a higher rate than anticipated before. TWG recommends Hydro One monitor the loading levels of Norfolk area supply system and take remedial measures, if required. This need will be reviewed during the Scoping Assessment phase of this Regional Planning cycle.

The remaining115kV circuits supplying the Region are adequate over the study period for the loss of a single 115kV circuit in the Region under the study assumptions of the Needs Assessment.

7.2.3 230 kV and 115 kV Facilities

A station capacity assessment was performed over the study period for the 230 kV and 115 kV supply stations in the Region using the summer station peak load forecasts. The results are as follows:

a) Transformer stations

i. Norfolk TS and Bloomsburg DS (Norfolk Area)

Norfolk TS and Bloomsburg DS are currently supplying loads of 66 MW and 38 MW Norfolk area loads respectively. The supply capacities of these two stations are 97 MW and 49 MW respectively.

The loads at Norfolk TS and Bloomsburg DS are forecasted to exceed their supply capacities in 2030 and 2025 under the Normal Growth scenario.

The current supply capacity of Norfolk area is limited by the capacity two (2) 115kV circuits supplying this area which is about 88 MW much lower than the combined supply capacity of Norfolk TS and Bloomsburg DS.

As described above in Table 3 and in Section 7.2.2, the supply capacity of Norfolk area is currently planned to be addressed mainly through load transfers reducing the loads on Norfolk TS and Bloomsburg DS bringing loading well below their supply capacities. This need will be reviewed during the Scoping Assessment phase of this Regional Planning cycle.

ii. Caledonia TS

Caledonia TS is currently supplying loads of 44 MW having a supply capacity of 99 MW. The load at Caledonia TS is forecasted to exceed its supply in 2030 under Normal growth load forecast scenario.

The TWG recommended Hydro One to monitor the loading at Caledonia TS and this need will be reviewed again during the Scoping Assessment phase of this Regional Planning cycle.

iii. Nebo TS

Nebo TS has two DESNs inside the station supplying loads in the city of Hamilton and surrounding areas. T1/T2 is a 27.6 kV DESN with current load of 122 MW having a supply capacity of 178 MW sufficient over the study period. The loads at T3/T4 13.8 kV DESN at Nebo TS had been historically around its supply capacity and is currently marginally overloaded supplying loads of 55 MW against its supply capacity of 51 MW.

The loads at this DESN are currently forecasted to grow above and beyond its supply capacity.

The TWG recommended that Hydro One and Alectra monitor the loading at Nebo TS T3/T4 DESN and take remedial measures, if required until refurbishment of this DESN is completed. This refurbishment is currently planned to be completed in the 2027-2032 timeframe replacing existing 75 MVA nonstandard transformers with Hydro One standard 100 MVA units. This need will be reviewed during the Scoping Assessment phaseof this Regional Planning cycle.

iv. Mohawk TS

Mohawk TS is a single DESN station supplying loads in the city of Hamilton. This station is currently supplying 81 MW of load having a supply capacity of 90 MW.

The peak load at Mohawk TS had been historically around its current loading levels, however the load at this station is forecasted to exceed its supply in 2024 under Normal growth scenario.

The TWG recommended that Hydro One and Alectra to monitor the loading Mohawk TS and take necessary actions, if required e.g. load transfers to the neighboring stations. This need will be reviewed during the Scoping Assessment phaseof this Regional Planning cycle.

All other transformer stations in the region are forecasted to remain within their normal supply capacity during the study period. Capacity needs for these stations will be reviewed in the next planning cycle.

Depending on the load growth and the future decisions on contracts for distributed energy resources connected to the station, the capacity of some stations could be reached in the long term (10+ years). The TWG will continue to monitor the load growth at the stations and will re-evaluate the capacity at the next planning cycle.

7.3 System Reliability, Operation and Restoration Review

No new significant system reliability and operating issues have been identified for this Region. Based on the net 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.

8 SENSITIVITY ANALYSIS

The objective of a sensitivity analysis is to capture uncertainty in the load forecast as well as variability of electric demand drivers to identify any emerging needs and/or advancement or deferment of recommended investments. The TWG determined that the key electric demand driver in the Burlington to Nanticoke region to be considered in this sensitivity analysis is electric vehicle (EV) penetration and unforeseen electrification.

The TWG reviewed EV scenarios and any unforeseen electrification needs to develop high demand growth forecasts by applying + 50% additional growth to the growth rate on the extreme summer corrected Normal Growth net load forecasts. The normal and high growth forecasts are shown in Tables A.1, A.2, A.3 and A.4.

The impact of sensitivity analysis for the high growth scenario identified the following updates or new station capacity needs:

No.	Need	Normal Growth Scenario	High Growth Scenario
1	Brant Area Supply**	-*	-*
2	Norfolk Area Supply***	-*	-*
3	Norfolk TS***	2030	2028
4	Bloomsburg DS***	2025	2025
5	Caledonia TS	2030	2027
6	Nebo TS	2022	2022
7	Mohawk TS	2024	2023
8	Brant TS**	-	2031
9	Elgin TS	-	2027
10	Newton TS	-	2030

*- To be further assessed during the next phases of this Regional Planning cycle.

**- Supply capacity at Brant TS will be addressed along with Brant Area Supply capacity need

***- Supply capacity at Norfolk TS and Bloomsburg DS will be addressed along with Norfolk Area Supply capacity need

The sensitivity analysis identified the additional capacity needs at Brant TS, Elgin TS and Newton TS towards the end of the study period. These needs will be assessed again during the next phases of this Regional Planning cycle.

There are two (2) new CTSs one each in Caledonia-Norfolk and Hamilton sub-regions supplied through 230 kV systems. None of these CTS are expected to impact the supply capacity or reliability in the Burlington to Nanticoke Region.

9 CONCLUSION AND RECOMMENDATIONS

The TWG recommends to continue with the refurbishment of section of 115 kV B7/B8 line and Gage TS (T3/T4 and T5/T6 DESNs), load transfer from Dundas TS to Dundas TS #2 to address overloading at this station, supply capacity in Norfolk area, power factor correction at Kenilworth TS as well continue with new identified refurbishment need for 115 kV breakers at Newton TS.

The TWG also recommended that the concerned LDC and Hydro One to monitor the loading levels in Norfolk and Brant areas as well at Caledonia TS, Nebo TS and Mohawk TS and take necessary action to address overloading, if required. These needs will be further reviewed during the Scoping Assessment phase of this Regional Planning cycle.

10 REFERENCES

1. Regional Infrastructure Plan Report – Burlington to Nanticoke – October 2019
2. IESO Ontario Resource and Transmission Assessment Criteria (ORTAC) – Issue 5.0
3. Bronte IRRP (2016)
4. Brant IRRP (2015)

Appendix A: Extreme Summer Weather Adjusted Net Load Forecast

Table A.1: Burlington to Nanticoke Region – Non-Coincident- Normal Growth Net Load Forecast

Area	Station	LTR	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Brant 115 kV	Brant TS (T1 / T2)	101	74	81	86	87	88	88	89	89	90	94	95	96	97	98	100	101	102	103	105	106	108
	Powerline MTS (T1 / T2)	114	85	76	77	84	98	99	99	100	101	102	103	104	105	107	109	110	112	113	115	117	118
Brant 230 kV	Brantford TS (T3 / T4)	188	159	159	163	166	151	159	160	161	163	164	165	167	168	170	172	174	176	178	180	182	184
Burlington and Oakville 115 kV	Bronte TS (T2 / T5 / T6)	198	138	135	132	132	133	133	134	135	135	137	136	135	135	135	134	134	134	134	134	134	134
Burlington and Oakville 230 kV	Burlington TS (T15 / T16)	185	141	149	157	156	155	154	153	152	152	151	150	149	149	149	148	148	148	148	148	148	148
	Cumberland TS (T3 / T4)	174	113	125	137	137	138	138	138	139	140	142	142	141	141	140	140	140	140	140	140	140	140
Greater Hamilton 115 kV	Birmingham TS (T1 / T2)	76	14	15	15	16	16	16	17	17	17	18	18	18	19	19	19	20	20	21	21	21	21
	Birmingham TS (T3 / T4)	91	65	66	68	70	72	73	74	75	76	77	79	80	81	83	85	87	89	90	92	92	92
	Dundas TS (T1 / T2)	99	104	104	105	106	107	107	108	108	109	110	111	112	113	123	124	125	126	128	129	130	130
	Dundas TS #2 (T5 / T6)	89	52	52	52	52	53	53	53	53	54	55	56	56	57	59	60	61	62	64	65	65	65
	Elgin TS (T1 / T2)	134	90	97	101	110	116	120	122	124	126	128	130	132	137	140	142	146	149	152	155	155	155
	Gage TS (T3 / T4)	57	21	21	21	29	37	37	37	37	37	37	38	38	39	40	41	42	43	43	44	44	44
	Gage TS (T5 / T6)	57	12	12	12	14	16	16	16	16	16	16	16	17	17	17	18	18	18	19	19	19	19
	Gage TS (T8 / T9)	123	16	15	15	18	20	20	20	20	20	20	20	21	21	22	22	23	23	24	24	24	24
	Kenilworth TS (T2 / T3)	124	67	69	71	73	75	77	79	80	82	83	85	86	88	89	91	93	95	97	99	99	99
	Mohawk TS (T1 / T2)	90	86	89	92	95	97	100	102	105	107	109	111	112	114	117	119	122	124	127	129	129	129
	Newton TS (T1 / T2)	75	48	48	52	61	62	63	64	65	66	67	69	70	71	72	74	76	77	79	81	81	81
	Stirton TS (T3 / T4)	112	55	55	55	56	57	59	60	62	63	64	65	66	67	69	70	71	73	75	76	76	76
	Winona TS (T1 / T2)	89	61	64	66	68	70	71	72	73	74	75	76	77	79	80	82	84	85	87	89	89	89
	CTS		1	1	23	23	24	22	21	19	15	13	11	9	9	9	9	9	9	9	9	9	9
Greater Hamilton 230 kV	Beach TS (T3/T4)	135	33	34	36	37	38	39	40	41	42	42	43	44	44	45	46	47	48	49	50	50	50
	Beach TS (T5 / T6)	96	62	64	68	70	72	74	75	77	79	80	81	83	84	86	88	90	91	93	95	95	95
	Horning TS (T3 / T4)	113	71	73	76	78	81	83	85	87	89	90	92	93	95	97	99	101	103	105	107	107	107
	Lake TS (T1 / T2)	75	50	50	50	50	50	50	50	50	50	50	50	50	50	50	51	51	51	51	52	52	52
	Lake TS (T3 / T4)	113	54	56	58	59	59	59	60	62	63	64	65	66	67	69	70	71	73	75	76	76	76
	Nebo TS (T1/T2)	178	129	131	132	133	135	136	141	143	144	146	147	149	150	152	154	156	158	160	162	165	167
	Nebo TS (T3 / T4)	51	56	57	59	61	63	64	66	68	69	70	72	73	74	76	77	79	80	82	84	84	84
	CTS		262	259	257	255	254	252	250	249	247	246	245	244	242	242	241	241	241	241	241	241	241
Caledonia Norfolk 115 kV	Norfolk TS (T1/T2)	97	71	74	77	82	87	86	93	96	99	103	105	108	110	113	115	118	121	123	126	129	132
	Bloomsburg DS (T1/T2)	49	35	37	40	50	57	55	57	59	64	66	68	70	72	75	77	79	81	83	85	87	89
Caledonia Norfolk 230 kV	Caledonia TS (T1/T2)	99	57	63	68	79	84	85	95	98	100	103	105	108	110	113	115	118	121	124	127	129	132
	Jarvis TS (T3/T4)	105	51	55	58	62	69	72	74	76	79	82	84	86	90	92	94	97	100	102	105	107	110
	CTS		195	195	194	193	192	190	189	188	187	187	186	185	184	184	184	184	184	184	184	184	184

Table A.2: Burlington to Nanticoke Region – Coincident – Normal Growth Net Load Forecast

Area	Station	LTR	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Brant 115 kV	Brant TS (T1 / T2)	101	57	62	66	66	67	67	68	68	69	73	73	74	75	76	77	78	79	80	81	82	83
	Powerline MTS (T1 / T2)	114	72	65	65	72	83	84	85	85	86	87	88	89	90	92	93	94	95	97	98	100	101
Brant 230 kV	Brantford TS (T3 / T4)	188	139	139	142	145	132	140	140	141	143	144	145	147	148	149	151	153	154	156	158	160	161
Burlington and Oakville 115 kV	Bronte TS (T2 / T5 / T6)	198	114	111	109	109	109	110	110	111	111	112	112	111	111	111	111	111	111	111	111	111	111
Burlington and Oakville 230 kV	Burlington TS (T15 / T16)	185	123	131	138	137	136	135	134	133	133	132	131	131	130	130	130	130	130	130	130	130	130
	Cumberland TS (T3 / T4)	174	98	109	119	119	120	120	121	121	122	123	123	123	123	122	122	122	122	122	122	122	122
Greater Hamilton 115 kV	Birmingham TS (T1 / T2)	76	4	4	4	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6
	Birmingham TS (T3 / T4)	91	48	49	50	51	53	54	54	55	56	57	58	59	60	61	62	64	65	67	68	68	68
	Dundas TS (T1 / T2)	99	93	94	94	95	96	96	97	97	98	99	100	100	101	111	112	113	114	116	117	117	118
	Dundas TS #2 (T5 / T6)	89	46	46	46	46	47	47	47	47	47	48	49	50	51	52	53	54	55	56	58	58	58
	Elgin TS (T1 / T2)	134	72	77	80	87	92	95	97	99	100	102	103	105	109	111	114	116	119	121	124	124	124
	Gage TS (T3 / T4)	57	7	7	7	10	13	13	13	13	13	13	13	13	14	14	14	14	15	15	15	15	15
	Gage TS (T5 / T6)	57	8	8	8	10	11	11	11	11	11	11	11	12	12	12	12	13	13	13	13	13	13
	Gage TS (T8 / T9)	123	11	11	11	13	15	15	15	15	15	15	15	15	16	16	16	17	17	17	18	18	18
	Kenilworth TS (T2 / T3)	124	41	42	43	45	46	47	48	49	50	51	51	52	53	54	55	56	58	59	60	60	60
	Mohawk TS (T1 / T2)	90	69	71	73	76	78	80	82	84	86	87	88	90	91	93	95	97	99	101	103	103	103
	Newton TS (T1 / T2)	75	43	43	47	54	56	57	58	58	60	61	62	63	64	65	66	68	69	71	73	73	73
	Stirton TS (T3 / T4)	112	49	50	50	50	51	53	54	55	57	58	59	59	60	62	63	64	66	67	68	68	68
	Winona TS (T1 / T2)	89	48	50	52	53	55	56	57	57	58	59	60	61	62	63	64	66	67	69	70	70	70
	CTS		0	0	14	14	14	13	12	11	8	6	4	3	3	3	3	3	3	3	3	3	3
Greater Hamilton 230 kV	Beach TS (T3/T4)	135	17	17	18	19	19	20	20	21	21	21	22	22	22	23	23	24	24	25	25	25	25
	Beach TS (T5 / T6)	96	49	51	54	56	58	59	60	62	63	64	65	66	67	69	70	72	73	75	76	76	76
	Horning TS (T3 / T4)	113	60	62	64	66	68	70	72	73	75	76	77	79	80	82	83	85	87	89	91	91	91
	Lake TS (T1 / T2)	75	44	44	44	44	44	44	44	44	44	45	45	45	45	45	45	45	45	46	46	46	46
	Lake TS (T3 / T4)	113	48	50	52	52	52	52	53	55	56	57	58	59	59	61	62	63	65	66	67	67	67
	Nebo TS (T1/T2)	178	115	116	117	118	119	121	125	127	128	129	131	132	133	135	137	139	140	142	144	146	148
	Nebo TS (T3 / T4)	51	48	50	51	53	54	56	57	58	60	61	62	63	64	65	67	68	70	71	73	73	73
	CTS		197	195	193	192	191	189	188	187	186	185	184	183	182	182	181	181	181	181	181	181	181
Caledonia Norfolk 115 kV	Norfolk TS (T1/T2)	97	60	62	65	69	73	74	79	83	85	89	91	93	95	97	99	102	104	106	108	111	113
	Bloomsburg DS (T1/T2)	49	32	34	37	46	52	50	52	54	59	61	63	65	66	69	71	73	75	77	78	80	82
Caledonia Norfolk 230 kV	Caledonia TS (T1/T2)	99	56	61	67	77	82	83	93	96	98	100	103	105	108	110	113	115	118	121	124	126	129
	Jarvis TS (T3/T4)	105	28	30	31	34	38	39	40	41	43	44	46	47	49	50	52	53	55	56	57	59	60
	CTS		123	124	123	123	122	121	121	120	120	119	119	118	118	118	118	118	118	118	118	118	118

Table A.3: Burlington to Nanticoke Region Non-Coincident – High Growth Net Load Forecast

Area	Station	LTR	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Brant 115 kV	Brant TS (T1 / T2)	101	74	84	92	93	94	95	96	97	98	104	106	107	109	111	112	114	116	118	120	122	124
	Powerline MTS (T1 / T2)	114	85	72	72	84	104	105	107	108	109	111	112	114	116	119	121	123	125	128	130	133	135
Brant 230 kV	Brantford TS (T3 / T4)	188	159	159	165	170	155	167	168	169	173	174	176	178	180	183	185	188	191	194	197	201	204
Burlington and Oakville 115 kV	Bronte TS (T2 / T5 / T6)	198	138	133	129	130	131	131	132	133	134	136	135	134	133	133	133	133	133	133	133	133	133
Burlington and Oakville 230 kV	Burlington TS (T15 / T16)	185	141	153	166	164	163	161	159	158	157	156	155	154	153	153	152	152	152	152	152	152	152
	Cumberland TS (T3 / T4)	174	113	131	149	149	150	151	151	152	154	156	156	155	155	154	154	154	154	154	154	154	154
Greater Hamilton 115 kV	Birmingham TS (T1 / T2)	76	14	15	15	16	17	17	18	18	19	19	20	20	21	21	22	22	23	24	24	24	24
	Birmingham TS (T3 / T4)	91	65	67	69	73	75	77	79	80	82	84	86	88	90	92	95	98	101	103	106	106	106
	Dundas TS (T1 / T2)	99	104	105	105	107	108	109	110	111	112	113	114	116	117	132	134	136	138	140	142	143	144
	Dundas TS #2 (T5 / T6)	89	52	52	52	53	54	54	54	54	55	56	57	59	60	62	64	66	68	70	72	72	72
	Elgin TS (T1 / T2)	134	90	100	106	120	128	135	138	141	144	147	150	153	160	164	168	173	178	183	188	188	188
	Gage TS (T3 / T4)	57	21	21	21	33	46	45	45	44	44	45	46	47	48	49	50	52	53	55	56	56	56
	Gage TS (T5 / T6)	57	12	12	12	15	18	18	18	18	18	18	19	19	19	20	20	21	22	22	23	23	23
	Gage TS (T8 / T9)	123	16	15	15	19	23	22	22	22	22	22	23	23	24	25	25	26	27	28	28	28	28
	Kenilworth TS (T2 / T3)	124	67	70	73	77	79	82	85	87	90	91	93	95	98	100	103	106	109	112	115	115	115
	Mohawk TS (T1 / T2)	90	86	90	94	99	103	107	110	114	118	120	123	126	128	132	135	139	143	147	151	151	151
	Newton TS (T1 / T2)	75	48	49	54	67	69	71	72	74	76	77	79	81	83	85	87	90	92	95	97	97	97
	Stirton TS (T3 / T4)	112	55	55	55	56	58	61	63	65	67	69	70	72	73	75	77	80	82	84	87	87	87
	Winona TS (T1 / T2)	89	61	65	68	71	74	77	78	79	80	82	84	86	88	90	92	95	98	100	103	103	103
	CTS		1	1	34	34	35	33	31	28	22	19	16	13	13	12	12	12	12	12	12	12	12
Greater Hamilton 230 kV	Beach TS (T3/T4)	135	33	35	37	38	40	41	43	44	46	47	48	49	50	51	53	54	56	57	59	59	59
	Beach TS (T5 / T6)	96	62	65	71	74	77	79	82	85	88	89	91	93	95	98	100	103	106	109	112	112	112
	Horning TS (T3 / T4)	113	71	75	78	82	85	88	91	94	98	100	102	104	106	110	112	116	119	122	125	125	125
	Lake TS (T1 / T2)	75	50	50	50	50	50	50	50	50	50	50	50	50	50	51	51	51	52	52	52	53	53
	Lake TS (T3 / T4)	113	54	57	61	61	61	61	63	65	68	69	70	72	74	76	78	80	82	85	87	87	87
	Nebo TS (T1/T2)	178	129	132	133	135	137	140	147	149	151	154	156	158	161	163	166	169	173	176	179	182	186
	Nebo TS (T3 / T4)	51	56	58	61	64	66	69	71	74	76	78	80	81	83	86	88	90	93	95	98	98	98
	CTS		262	262	262	262	262	262	262	262	262	262	262	262	262	262	262	262	262	262	262	262	262
Caledonia Norfolk 115 kV	Norfolk TS (T1/T2)	97	71	75	80	87	94	94	103	109	113	119	123	126	130	134	137	142	146	150	154	158	162
	Bloomsburg DS (T1/T2)	49	35	38	43	57	68	65	68	70	79	82	85	88	91	95	98	101	104	107	110	113	116
Caledonia Norfolk 230 kV	Caledonia TS (T1/T2)	99	57	66	74	89	98	100	115	118	122	126	129	133	137	141	144	149	153	157	161	166	170
	Jarvis TS (T3/T4)	105	51	57	62	68	79	82	86	89	93	97	100	104	109	113	116	120	124	128	132	136	140
	CTS		195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195

Table A.4: Burlington to Nanticoke Region Region – Coincident – High Growth Net Load Forecast

Area	Station	LTR	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Brant 115 kV	Brant TS (T1 / T2)	101	57	64	70	71	72	73	73	74	75	81	82	83	85	86	87	89	90	92	93	95	96
	Powerline MTS (T1 / T2)	114	72	61	62	71	89	90	91	92	93	95	96	97	99	101	103	105	107	109	111	113	115
Brant 230 kV	Brantford TS (T3 / T4)	188	139	139	144	149	135	147	148	149	152	154	155	157	159	161	163	166	169	171	174	177	179
Burlington and Oakville 115 kV	Bronte TS (T2 / T5 / T6)	198	114	110	106	107	107	108	109	109	110	112	111	110	110	110	109	109	109	109	109	109	109
Burlington and Oakville 230 kV	Burlington TS (T15 / T16)	185	123	134	145	144	142	141	140	138	138	136	135	135	134	134	133	133	133	133	133	133	133
	Cumberland TS (T3 / T4)	174	98	114	130	130	131	131	132	132	134	136	136	135	135	135	134	134	134	134	134	134	134
Greater Hamilton 115 kV	Birmingham TS (T1 / T2)	76	4	4	5	5	5	5	5	5	6	6	6	6	6	6	6	7	7	7	7	7	7
	Birmingham TS (T3 / T4)	91	48	49	51	53	55	57	58	59	60	62	63	65	66	68	70	72	74	76	78	78	78
	Dundas TS (T1 / T2)	99	93	94	94	96	97	98	98	99	100	102	103	104	105	120	122	123	125	127	129	130	130
	Dundas TS #2 (T5 / T6)	89	46	46	46	47	48	47	48	48	48	50	51	52	53	55	57	58	60	62	64	64	64
	Elgin TS (T1 / T2)	134	72	80	84	95	102	107	110	112	114	117	119	122	128	131	134	138	142	146	150	150	150
	Gage TS (T3 / T4)	57	7	7	7	12	16	16	16	15	15	16	16	16	17	17	18	18	18	19	19	19	19
	Gage TS (T5 / T6)	57	8	8	8	11	13	13	13	13	12	13	13	13	14	14	14	15	15	16	16	16	16
	Gage TS (T8 / T9)	123	11	11	11	14	17	17	16	16	16	16	17	17	18	18	19	19	20	20	21	21	21
	Kenilworth TS (T2 / T3)	124	41	42	44	46	48	50	51	53	54	55	57	58	59	61	62	64	66	68	70	70	70
	Mohawk TS (T1 / T2)	90	69	72	75	79	82	85	88	91	94	96	98	100	103	105	108	111	114	118	121	121	121
	Newton TS (T1 / T2)	75	43	44	49	60	62	64	65	66	68	69	71	73	74	76	78	81	83	85	87	87	87
	Stirton TS (T3 / T4)	112	49	50	50	50	52	54	56	58	60	62	63	65	66	68	70	72	74	76	78	78	78
	Winona TS (T1 / T2)	89	48	51	54	56	58	60	61	62	63	65	66	68	69	71	73	75	77	79	81	81	81
	CTS		0	0	21	21	22	20	19	16	11	9	7	4	4	4	4	4	4	4	4	4	4
Greater Hamilton 230 kV	Beach TS (T3/T4)	135	17	18	19	19	20	21	22	22	23	24	24	25	25	26	27	27	28	29	30	30	30
	Beach TS (T5 / T6)	96	49	52	57	59	62	64	66	68	70	72	73	75	76	79	81	83	85	87	90	90	90
	Horning TS (T3 / T4)	113	60	63	66	69	72	75	77	80	83	84	86	88	90	93	95	98	100	103	106	106	106
	Lake TS (T1 / T2)	75	44	44	44	44	44	44	44	44	44	45	45	45	45	45	45	46	46	46	47	47	47
	Lake TS (T3 / T4)	113	48	51	54	54	54	54	56	58	60	61	62	64	65	67	69	71	73	75	77	77	77
	Nebo TS (T1/T2)	178	115	117	118	120	122	124	131	133	135	137	139	141	143	145	148	151	153	156	159	162	165
	Nebo TS (T3 / T4)	51	48	50	53	55	58	60	62	64	66	68	69	70	72	74	76	78	80	83	85	85	85
	CTS		201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201	201
Caledonia Norfolk 115 kV	Norfolk TS (T1/T2)	97	60	63	68	74	80	80	89	94	98	103	106	109	112	116	119	122	126	129	133	136	139
	Bloomsburg DS (T1/T2)	49	32	35	39	53	62	59	62	64	73	75	78	81	84	88	91	93	96	99	102	104	107
Caledonia Norfolk 230 kV	Caledonia TS (T1/T2)	99	56	64	72	87	95	97	112	115	119	123	126	130	134	137	141	145	149	154	158	162	166
	Jarvis TS (T3/T4)	105	28	31	33	37	43	44	46	48	50	53	55	57	60	62	64	66	68	70	72	74	77
	CTS		123	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125

Appendix B: Lists of Step-Down Transformer Stations

Sr. No.	Transformer Station	Voltage (kV)	Supply Circuits
1	CTS	230	H35D, H36D
2	Beach TS	230	Beach TS 230 kV Bus (1)
3	Birmingham TS	115	HL3, HL4
4	Bloomsburg DS	115	C9, C12
5	Brant TS	115	B12BL, B13BL
6	Brantford TS	230	M32W, M33W
7	Bronte TS	115	B7, B8
8	Burlington TS DESN	230	Q23BM, Q25BM
9	Caledonia TS	230	N5M, S39M
10	Cumberland TS	230	B40C, B41C
11	CTS	230	Q24HM, Q29HM
12	Dundas TS	115	B3, B4
13	Dundas TS #2	115	B12BL, B13BL
14	Elgin TS	115	HL3, HL4
15	Gage TS	115	B10, B11
16	Horning TS	230	M27B, M28B
17	CTS	230	N20K
18	Jarvis TS	230	N21J, N22J
19	Kenilworth TS	115	H5K, H6K
20	Lake TS	230	B18H, B20H
21	CTS	115	B3, B4
22	Mohawk TS	115	B3, B4
23	Nebo TS	230	Q24HM, Q29HM
24	Newton TS	115	Newton TS 115 kV Bus (2)
25	Norfolk TS	115	C9, C12
26	Powerline MTS	115	B12BL, B13BL
27	Stirton TS	115	HL3, HL4
28	CTS	230	N21J, N22J
29	Winona TS	115	Q2AH

(1) Beach TS 230 kV bus is supplied by five 230 kV B18H, B20H, Q24HM, Q29HM and M34H circuits

(2) Newton TS 115 kV bus is supplied by four 115 kV B3, B4, B12BL and B13BL circuits

Appendix C: Lists of Transmission Circuits

Sr. No.	Connecting Stations	Circuit ID	Voltage (kV)
1	Beach TS – CTS	H35D, H36D	230
2	Beach TS – Burlington TS	B18H, B20H	230
3	Beach TS – Middleport TS	M34H	230
4	Beach TS – Middleport TS – Beck #2 TS	Q24HM, Q29HM	230
5	Burlington TS – Cumberland TS	B40C, B41C	230
6	Burlington TS – Middleport TS	M27B, M28B	230
7	Burlington TS – Middleport TS – Beck #2 TS	Q23BM, Q25BM	230
8	Middleport TS – Beck #2 TS	Q30M	230
9	Middleport TS – Buchanan TS	M31W, M32W, M33W	230
10	Middleport TS – Detweiler TS	M20D, M21D	230
11	Middleport TS – Nanticoke TS	N5M, N6M	230
12	Middleport TS – Summerheaven SS	S39M	230
13	Middleport TS – Sandusk SS	K40M	230
14	Nanticoke TS – Jarvis TS	N21J, N22J	230
15	Summerhaven SS – Nanticoke TS	N37S	230
16	Sandusk SS – Nanticoke TS	N20K	230
17	Beach TS – Gage TS	B10, B11	115
18	Beach TS – Kenilworth TS	H5K, H6K	115
19	Beach TS – Newton TS	HL3, HL4	115
20	Beach TS – Winona TS	Q2AH	115
21	Beach TS – CSS	H9W	115
22	Burlington TS – Brant TS	B12BL, B13BL	115
23	Burlington TS – Bronte TS	B7, B8	115
24	Burlington TS – Cedar TS	B5G, B6G	115
25	Burlington TS – Newton TS	B3, B4	115
26	Caledonia TS – Norfolk TS	C9, C12	115
27	Kenilworth TS – Gage TS (Idle)	K1G, K2G	115

Appendix D: Acronyms

Acronym	Description
A	Ampere
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CEP	Community Energy Plan
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CSS	Customer Switching Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DG	Distributed Generation
DS	Distribution Station
GS	Generating Station
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
MEP	Municipal Energy Plan
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
ORTAC	Ontario Resource and Transmission Assessment Criteria
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
SA	Scoping Assessment
SIA	System Impact Assessment
SPS	Special Protection Scheme
SS	Switching Station
STG	Steam Turbine Generator
TS	Transformer Station